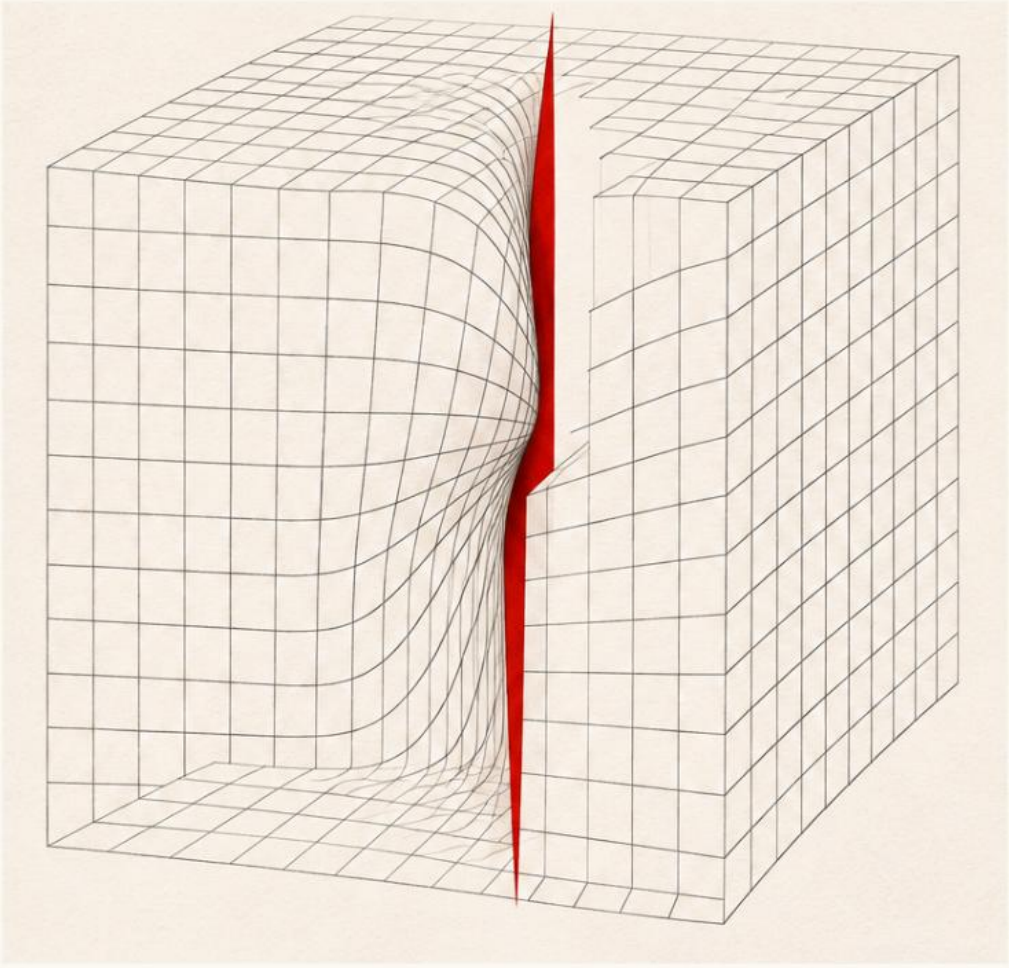
# Bright Red



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Protocols for Working with Anomalies
of Space, Time, Matter, and Information

2026

# Preface

An unusual phenomenon presents a researcher with two tasks. We must preserve the possibility of discovering a new effect while checking whether the observation arises from a known process, a feature of the instrument, or the way it is interpreted. These tasks require a common language. In that language, an event's description connects to measurement, a model, a decision, and conditions for reconsideration.

Bright Red develops such a language and explores its practical use. The book considers discrepancies in time, spatial inconsistencies, unusual fields, light and thermal processes, changes in matter, experiences, digital anomalies, and apparently meaningful responses. Each area is framed in terms of observable quantities, alternative explanations, and tests capable of changing the assessment of a case.

Readers are not asked to accept in advance that all unusual events share a single nature. The term "anomaly" denotes a problem relative to a stated model of expectations. Some problems end with a known explanation; others require more data or new measurement tools. Individual chapters investigate conditional models, including local changes in the rate of time and unusual spatial connectivity. Their assumptions and limits are identified directly in the text.

This structure allows the book to be read sequentially or consulted according to the situation. The first two parts establish general rules. The next five examine particular classes of manifestations. The organizational and management sections connect measurement to a team's actions. Part X concerns instruments and the development of a research program. Working forms in the appendices help transfer this logic into the record of a particular case.

The book develops a path from a stable observation to a model of its origin, parameter calculations, and engineering tests. Instrument designs show how measurement chains are structured and the conditions for qualifying them. The concluding practical section contains teaching cases with data, decisions, and bounded conclusions. Working forms and indexes connect these cases to the relevant chapters.

### Reading Scientific and Applied Claims

References in square brackets point to sources in the bibliography. Published findings are used within the conditions described. Our own research schemes are identified as proposals by the authors. They require validation for a particular apparatus and do not replace current requirements in the relevant field. Specific operating limits are determined by the chosen measurement tools, the task, and applicable standards.

The teaching scenarios are fictional. Their purpose is to demonstrate a sequence of reasoning and action. Numbers in these examples serve only to analyze the problem and do not become universal safety or detection thresholds. A mathematically defined conditional model likewise does not establish that its source exists in nature. It lets us derive consequences that can be compared with observations.

As you read, keep four questions distinct: what was recorded, how the result was obtained, what explains it, and what action is permissible. Confidence in one answer does not transfer automatically to the others. A well-recorded signal may have an unknown cause. A convincing explanation may provide no means of intervention. Successfully limiting an effect may leave its source operating.

### The Purpose of a Protocol

A protocol organizes the acquisition of knowledge and the making of decisions. It specifies who acts, the entry conditions, the action, its observable result, grounds for stopping, and the procedure for subsequent testing. Its value depends on whether the procedure can be understood and repeated, its failures explained,

and its terms revised when new data appear. Detailed instructions do not eliminate uncertainty about an unknown phenomenon; they make that uncertainty visible to the participants.

The book addresses readers willing to distinguish observation from hypothesis and to seek the relevant expertise for specialized operations. Basic concepts are explained as they are introduced. More advanced physical models appear where they help clarify measurable consequences. When consulting the book for a particular situation, begin with the navigation table, then turn to the general chapters on data, hazards, and choosing an operating mode.

Scientific work with the unknown begins with a carefully framed question. Its result is a more precise description of the world and better-justified action. If a new record cannot distinguish among explanations, it may still reveal what the next instrument or experiment lacks. This passage from uncertainty to a testable problem connects every part of the treatise.

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# Navigate by situation

The table links the original observation to the measurement task and thematic chapters. It does not establish the cause of the event. Working forms are given in Appendices A–D and G; subject and situational indexes are in Appendix J.

| Situation | Chapters | Initial question | Related Sections |
|---|---|---|---|
| The clocks are diverging | 12–13 | Time source and independence of comparison | 8, 9, 47 |
| A period of memory is missing | 32 | Separation of memory, behavior and contemporaneous records | 2, 5, 13 |
| The event seems to be repeated | 14 | Checking the cycle record and remaining traces | 3, 15, 40 |
| The message looks like a prediction | 15 | Time of recording and usual channels of information | 4, 39, 46 |
| Route or distance does not match | 17–18 | Geometry and measuring signal path | 3, 19, 38 |
| Local time domain assumed | 16 | Conditional model and compatible observable consequences | 12, 13, 21 |
| An object moves unusually | 26 | Trajectory, forces and limitations of reconstruction | 19, 22, 24 |
| A glowing object appears | 23 | Source frames, spectrum and geometry | 17, 22, 38 |
| Fields or interference occur | 22 | Sensor bandwidth and shared dependencies | 10, 35, 47 |
| Unusual sounds are heard | 24 | Suitability of the acoustic path and transmission of vibrations | 9, 34, 38 |
| Temperature changes | 25 | Temperature measurement and balance limit | 3, 30, 49 |
| Material or weight has changed | 27, 31 | Origin of sample and independent methods | 8, 29, 44 |
| The dosimeter gives an unusual result | 28 | Range, performance and saturation | 7, 9, 44 |

| Situation | Chapters | Initial question | Related Sections |
|---|---|---|---|
| Organisms or ecosystem change | 29 | Comparable background and nature of impact | 5, 30, 31 |
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Part I

# Foundations of Inquiry

Chapter 1

## The Subject of a Science of Anomalies

An unusual event becomes the subject of research when it is possible to formulate what exactly about it requires explanation. The clock diverges, the image doubles, the object changes position, the person senses a presence, the sensor produces an unexpected signal. These messages may relate to different physical processes and different levels of observation. The first action of the researcher is to isolate the statement being tested. Without it, any new measurement risks increasing the number of impressions without reducing uncertainty.

In this book, an anomaly is a deviation of observations from an explicitly stated expectation that deserves separate testing. The expectation can be a physical model, the previous state of an object, a control area, or a characteristic of a measuring device. This definition makes the term relative to knowledge and the procedure of observation. It does not attribute an unknown nature to a phenomenon in advance. Once the mechanism is elucidated, the unusual case retains research value: it becomes clear under what conditions the previous model stopped working.

### From story to research object

The original message usually contains several layers. The sentence “time stopped in the room and someone else appeared” combines the experience of duration, the supposed change in physical time and the interpretation of presence. To work, they are asked to ask independent questions. Are there any records of the hours? What happened to the movement and sound? What was the state of the observer? What exactly did the external source suggest? The separation preserves the content of the story and opens up the possibility of independent verification.

The object of study may be an area of the environment, an event, a sequence of measurements, a pattern, an experience, or a discrepancy between channels. At the beginning of work, it is advisable to select one unit of analysis. If it declares an event, it needs to determine its beginning and end. If a territory is being explored, the boundaries of the survey and the conditions for changing them are needed. If a series of reports is being considered, a rule for including a case in the series is necessary. Otherwise, the composition of the data will subtly change in response to the preferred explanation.

The universality of the treatise is ensured by the way the problem is stated. For an as yet unknown class, all manifestations cannot be listed in advance, but a description of the observed quantity, the origin of the record, the expectation model, and the decision conditions can be required. This structure can be expanded. If a new phenomenon does not fit into the proposed classification, its original description is retained and the classification is revised. The mere lack of a suitable name should not be a reason for discarding data.

### Assertion levels

A stated result in a book means a narrow statement provided by said research. A working hypothesis relates an observation to a proposed mechanism and can be tested. The conditional model explores the consequences of an additional assumption: for example, a certain change in the space-time metric. The

author's protocol specifies the proposed procedure and requires verification of suitability for a specific task. These statuses answer different questions and can be present in the same chapter.

When describing an unusual time deviation, the records themselves and the characteristics of the watch may be established. An explanation through a local physical effect will remain a hypothesis. The geometry of the area allowing the expected readings to be calculated will be a conditional model. The station deployment scheme will become the author's protocol. The transition between levels occurs when new bases appear; the persuasiveness of terms does not replace it.

### Tasks of extrascience

extrascience here refers to a research program for phenomena that go beyond the usual description, while maintaining the testability of reasoning. It involves searching for alternatives, developing measurements, and analyzing one's own limitations. If the intended effect does not yet have an established channel of interaction with the device, the first task is to find such a channel. If the explanation allows for several different outcomes without specifying the choice conditions, it is necessary to refine the model before the decisive experiment begins.

The practical outcome of the work may be the discovery of a new mechanism, a correction of a measurement procedure, a constraint on the parameters of a hypothesis, or a documented recognition of a data deficiency. Each of these results changes subsequent actions. A lack of sensitivity report is useful in showing how much improvement is needed. Reporting an instrument artifact is useful when it allows it to be recognized under other conditions. The criterion for advancement is reducing the space of acceptable explanations and increasing the quality of solutions.

### Training scenario

A fictional research team receives three reports of a small object missing. In the first case there is only a memory, in the second there is a video recording with missing frames, in the third there is a continuous recording of two cameras with unknown synchronization. All three cases are reported but require different next steps. The first allows you to study circumstances and evidence. The second requires investigating the record break. The third allows the sequence to be restored after checking the clock and geometry. The general word “disappearance” does not create a general mechanism.

The work begins with a question that the available data can answer. As this issue is clarified, a case record is generated, classes of manifestations are selected, and the acceptable research regime is assessed. The next chapter considers how to maintain the boundary between the observation itself and the explanation that arises almost simultaneously with it.

Chapter 2

## Observation and explanation

An observation is rarely reported in its original form. Between the event and the final description are the senses, the device, the software transformation and the language. Each transition selects some information and adds assumptions. Therefore, it is useful to begin a scientific description by restoring the chain: what interacted with what, what signal arose, how it was stored, and by what rule the conclusion was drawn. This chain is important both for the camera and for the eyewitness's story.

### Four recording layers

The first layer contains the available source material: the file, the testimony, the direct recording of the person's words, the sample and the conditions for obtaining it. The second layer describes processing: filtering, synchronization, unit conversion, highlighting event boundaries. The third layer represents the result of the measurement or reconstruction. The fourth contains the interpretation of the cause. Connections must be maintained between the layers, allowing you to return to the previous state and change the analysis method without changing the source.

The video recording of the luminous point is the original material. The coordinates of the point after frame stabilization refer to the processed data. Angular velocity is the result of the measurement model. The trajectory and acceleration statement requires additional information about the camera's range and motion. The assumption about the flight mechanism is even further down the chain. The more transitions there are, the more important it is to document the parameters of each of them.

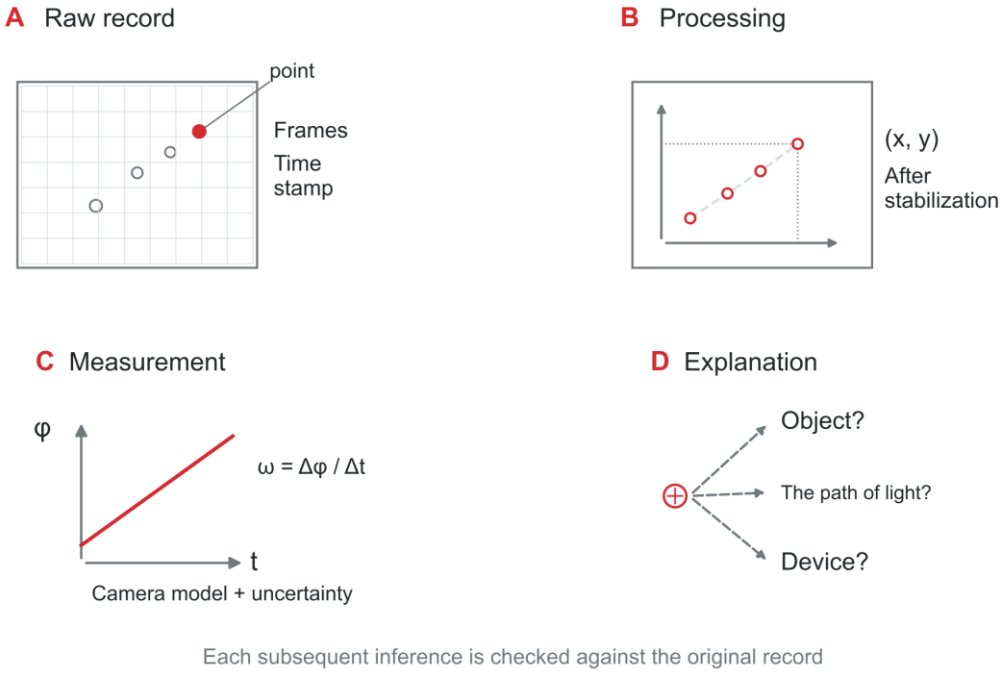



Figure 1. Four layers: record, process, measure, explain. Method diagram. One material goes through four layers: recording, processing, measurement model and possible explanations. The line of movement is conditional and does not contain a numerical result. Question marks indicate competing hypotheses; You can return to the original recording at any stage.

For evidence, the structure is similar. The initial free description is kept separate from the answers to clarifying questions. Information obtained after viewing someone else's recording or talking with another eyewitness is noted according to the time of receipt. This allows the history of a message to be examined without accusations of unreliability. Experiments with eyewitness memory show that subsequent discussion can influence the content of a memory; a specific message requires its own analysis. [1]

### Neutral wording

Neutrality consists in the accuracy of the statement. The wording "the sensor detected an excess of its background range" is more useful than the general phrase about the release of energy, while it is not known what value the sensor measured. The formulation "the observer reported a sensation of presence"

preserves the fact of the report and allows a possible external stimulus to be examined separately. Words are preferred whose meaning does not change when the hypothesis changes.

Interpretations should not be removed from the journal. They show why the next experience was chosen and what expectations might have influenced the operator. For them, a separate field is allocated with the author, date and reasons. When a version is rejected, the record remains. Such a story explains the progress of the work and helps to distinguish a pre-proposed prediction from a successful explanation that appeared after getting acquainted with the result.

### Checking the measuring intermediary

The device perceives a certain type of interaction and operates within a limited range. The description of an unusual reading requires the device model, mode, unit, averaging period, settings, and status information. It's rare for a screenshot to contain all of these options. For reproducible testing, save the original stream or the earliest available format, then note the inevitable conversions.

A decrease in signal after changing settings may indicate a change in sensitivity. An increase in image detail may be a consequence of processing. Therefore, before comparing two records, the metrologist determines whether the modes are comparable. If they differ, a way to bring them to a common measurement model or a separate assessment of each mode is needed. Comparing beautiful final images does not replace this work.

### Author's order of layer separation

1. The data custodian stores the original material and assigns it an identifier; the absence of the source is clearly noted.
2. The operator describes the circumstances of receipt, available settings and any known omissions.
3. The analyst lists the operations necessary to obtain the result under consideration and stores versions of them.
4. The metrologist specifies assumptions for converting the signal into a physical quantity and significant limitations.
5. The research director formulates individual explanations and relates each to the prediction being tested.
6. If it is impossible to restore a critical transition, the result is limited to the layer that is actually provided with data.

Stopping analysis does not necessarily mean stopping recording. If recording continues without added risk, the original materials can be preserved while the processing problem is investigated. On the contrary, if the operator changes exposure to an unknown environment in order to obtain the desired image, a new experiment arises. It requires a separate solution because both the state under study and the safety conditions change.

### Educational analysis

The fictional camera shows a figure emerging from a dark corridor. Automatic contrast enhancement makes the outline clearer. The researcher saves the source file, the processing result and the algorithm parameters. At the first level, the presence of a certain structure in the record is established. The next check determines its stability in the original frames, neighboring pixels and an independent channel. Until then, the shape of the outline does not specify either the physical nature of the source or its intent.

This separation allows the explanation to be changed without rewriting the history of the observation. It also makes the argument productive: participants discuss the specific transition between data and conclusion. The next step is to evaluate how accurate the result is and what deviation can be considered meaningful.

Chapter 3

# Evidence and uncertainty

The number on the screen takes on a scientific meaning along with the definition of the value and the conditions for obtaining it. The reading can be repeated with high accuracy and still contain a stable offset. It may be true in the laboratory but unreliable once transferred. Investigating an anomaly requires evaluating the entire measurement model, including the relationships between its inputs. The Introduction to the Guide to the Expression of Uncertainty in Measurement (JCGM GUM-1) discusses just such an approach to measuring and expressing uncertainty. [2]

### What compares to waiting?

For any deviation, record the observed value, the expected value and the rule for comparing them. Waiting can also be uncertain. For example, the background temperature changes over time, the geometric model has a coordinate error, and the instrument’s forecast depends on the state of the environment. The difference between two numbers cannot be estimated by knowing the accuracy of only one of them. General corrections are especially significant: they can simultaneously shift both results.

It is useful to distinguish between the spread of repeated observations, systematic influences, model uncertainty, and lack of data. These components require different actions. Additional averaging may reduce random variation within acceptable conditions, but will not eliminate miscalibration. A more detailed model may change the expected value, but its extra parameters may make the test less certain. Therefore, each improvement must answer a specific question about the origin of uncertainty.

### Levels of evidence

A one-time message ensures the existence of a message. The saved recording allows you to examine the recorded signal. The tested measuring path gives grounds to discuss the value. Repetition under controlled conditions maintains the connection with these conditions. Independent verification shows the transferability of the result to another implementation. This is a sequence of tasks, not a mandatory ladder for each case: a rare natural event may not be repeated, but high-quality multi-channel recording will still limit possible explanations.

A weak link cannot be compensated for by the amount of subsequent reasoning. If the distance to the source is unknown, the accuracy of estimating its angular motion does not translate into accuracy of linear velocity. If a sample is no longer traceable, detailed chemical analysis describes the material examined but does not automatically reconstruct its location. The report should indicate which claim is limited by the specific deficiency.

### Detection limit and negative result

The absence of a registered signal is informative only regarding the known ability to detect it. You need to name the range, time window, geometry, background level and applied criterion. If a signal is expected in a band that the sensor does not measure, the result does not constrain the corresponding hypothesis. If the device worked only part of the time, observation cannot be transferred to the missed intervals.

False alarms and misses are different characteristics. A device with infrequent alarms may have difficulty detecting the effect of interest. The US National Institute of Standards and Technology (NIST) report on testing false alarms links the findings to the test design and volume; such an inference does not automatically specify the probability of missing. [3] For a research complex, it is required to separately confirm both properties in those conditions where they are important for the solution.

### Numerical tutorial example

Consider a fictitious comparison of two temperature channels. The first shows the difference with the background 0.4 degrees, the second - 0.3 degrees. If the unknown correction of the first channel is comparable to 0.5 degrees, and the second one is comparable to 0.4 degrees, the proximity of the central values does not yet provide accurate confirmation of the effect. If both channels share the same erroneous estimate of background temperature, their agreement may be maintained under a common bias. The numbers here serve to illustrate the structure of the problem and are not a criterion for the actual instrument.

The next useful step is to check the common background channel or independent reference. Repeating the same readings many times without changing the source of bias will produce a longer record of the same ambiguity. When choosing the next measurement, it is useful to ask what part of the uncertainty it will reduce and how much it will change the decision.

### Practical recording of the result

- Magnitude and unit; coordinates, time and averaging boundaries.
- Model of transformation of the original signal and the origin of its parameters.
- Uncertainty assessment indicating covered and uncovered impacts.
- Comparable waiting model and reasons for choosing background interval.
- Information about saturation, skips, failures, and general channel dependencies.
- A claim that is supported by evidence and a nearby stronger claim for which there is currently insufficient evidence.

Statistical oddity also applies to the chosen model. A small probability value given its premises is not the probability of the truth of the new explanation. If the search covered many windows, channels and filtering methods, you need to consider the search procedure itself. To assess the robustness of a finding, a new data set with a pre-fixed rule is useful. Fitting the noise model after an event is detected should remain a visible part of the analysis.

The last point protects the study from imperceptibly expanding the conclusion. The cause of the deviation has yet to be determined. This requires multiple competing models and experiences whose outcomes will vary.

### Change of distribution as a research object

The subject of the study may be the distribution of ordinary events. Each individual registration fits into a known range, but the frequency, spread, sequence or dependence between channels changes. The description of such a case begins with many possibilities, among which the event stands out. For a match, this is a list of pairs being compared and an acceptable time window; for device failure, the number of usable cycles; for a rare impulse - a suitable observation duration. The number of successful examples without this denominator does not determine the frequency.

Before observation, the inclusion rule is written down. It includes the channel, threshold, duration, permissible state of the device and the method of combining adjacent alarms. One long interruption can produce a hundred log lines but remain one episode. Changing the merging algorithm requires recalculation of all compared material. If the previous original records are lost, the comparison of the old and new frequencies is correspondingly limited.

| Change being tested | Necessary denominator | A significant alternative |
|---|---|---|
| Pulse frequency | Suitable time and efficiency of the selected detector | The threshold, idle time, or background have changed |
| Match rate | All valid pairs and pre-selected window | The number of comparisons increased after viewing |
| Range of readings | Comparable series taking into account the connection of samples | The temperature or averaging duration has changed |
| Event grouping | Entire sequence, including intervals without events | One source generated multiple entries |
| Conditional dependency | All combinations of predefined conditions | Conditions are related to operator, location or schedule |

In the training example, the network logged 20 messages in the first period and 60 in the second. The number of active nodes has increased from 10 to 40, and the duration of the periods is the same. Even with the same sensitivity, the original numbers do not support an increase in frequency per node: the ratio changed from 2 to 1.5 messages. These numbers are not yet an estimate of the frequency of independent events: first it is necessary to combine repeated messages, take into account the real time of each node and check the comparability of places. The example shows why a message archive and a physical event stream are described by different units.

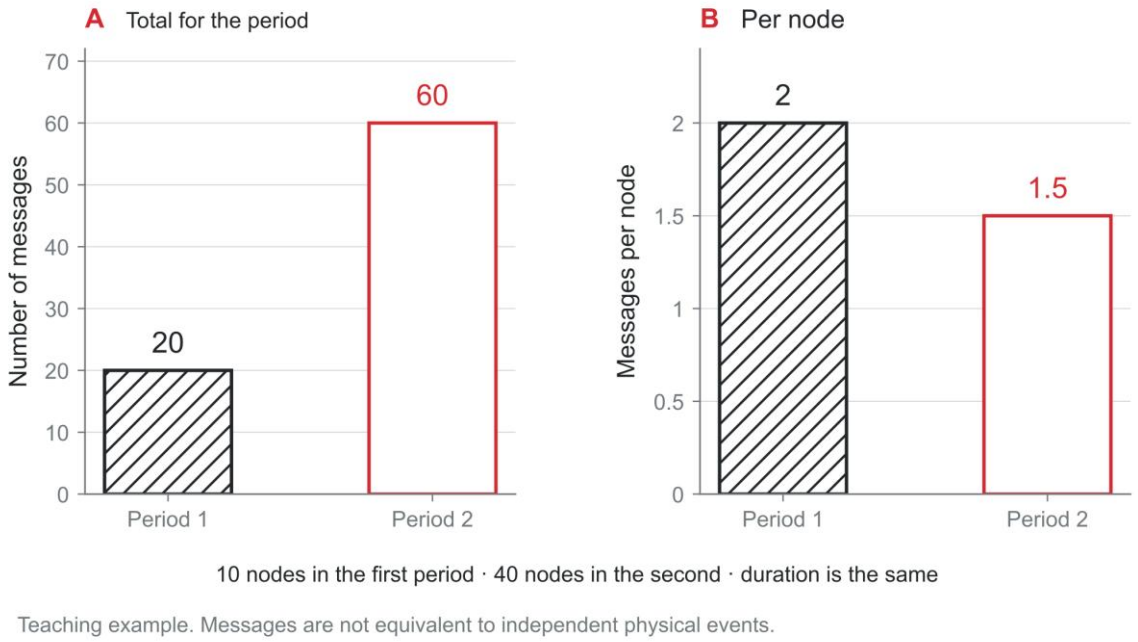



Figure 2. Why more messages don't mean more events. Synthetic training example. The number of messages increased from 20 to 60, and the number of nodes increased from 10 to 40. Over the same period, the load on one node decreased from 2 to 1.5 messages. The frequency of independent physical events cannot be deduced from these numbers.

### Confirmatory series and moment of completion

An exploratory series is used to select a feature and evaluate the feasibility of the next measurement. The confirmatory series begins after fixing the feature, background model, suitability criteria and termination rule. If, based on its data, a new coincidence window or a new subset of people is selected, the result of this selection becomes a search result. The presence of a large number of samples does not return it to a predetermined status.

The simple study plan provides four tests after 100, 200, 300 and 400 eligible attempts. For each, a correct confidence interval is constructed in advance with an error probability of no more than 0.0125 in the accepted model. By the union bound, the probability of at least one non-coverage at these four fixed steps does not exceed 0.05. The independence of the four tests themselves is not required for this reasoning, but each interval must be valid in its own data model. The plan does not allow additional unscripted views with the new decision rule.

More flexible sequential methods are able to maintain their stated properties while updating the result multiple times. In particular, confidence sequences construct intervals with simultaneous coverage in time under the specified premises [58]. Before use, select a specific design and check its conditions. An ordinary confidence interval for a fixed amount of data cannot be automatically declared valid at any stopping point.

The result of the distribution study is formulated through the estimated dependence and the limits of its transfer: the frequency of certain impulses is higher in the specified mode with the given registration rules; or the effect is not detected with the established sensitivity. A change in distribution does not in itself establish an interference with causation, intention, or a new law of nature. It creates the following task: to find out which changes in the source, environment and observation reproduce the found dependence.

Chapter 4

# Causal models and discriminative tests

An explanation becomes a working hypothesis when it can yield an expectation that differs from the expectations of the alternatives. The phrase “an unknown field is at work here” currently gives the name of the possible cause. To check, it is necessary to clarify what the field affects, how the response changes when conditions change, and what observation would be incompatible with the proposal. The more precisely the interaction channel is formulated, the easier it is to select the measurement that will actually change the evaluation of the hypothesis.

## Cause Map

At the beginning of the analysis, it is useful to depict the causal diagram in words or arrows. The intended source affects the environment, the environment affects the object, the object affects the sensor, and processing creates the result. Individual arrows relate external conditions to the sensor and the observer's behavior. This scheme allows us to see alternative causal pathways: one factor can simultaneously change the reading of the device and the sensations of a person, although there is no direct causal connection between them.

The diagram does not have to be complete. Unknown connections are designated as questions. In this case, it is advisable to link each observed variable to a specific record. If a suspected cause cannot be measured directly, its expected effects are considered. Multiple consequences are useful when their co-occurrence is predicted in advance by the model and when known interferences do not produce the same combination.

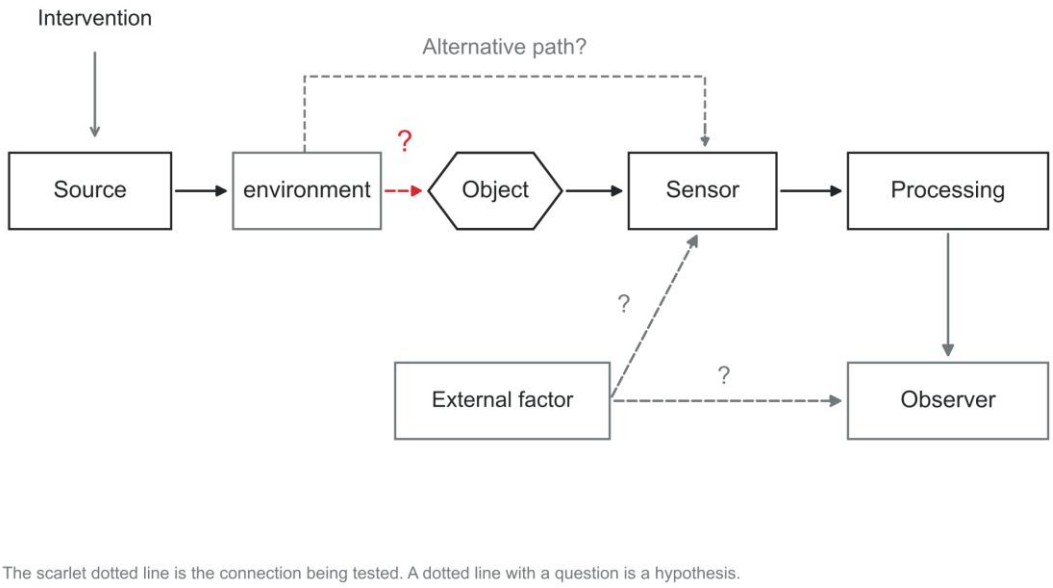



Figure 3. Causal map and alternative causal pathways. Author's causal scheme. Source interference is mapped to the state of the environment, object, sensor, and processing. There may be a workaround to the sensor and a common cause of instrument and observer changes. The scarlet section highlights the connection being tested without establishing its truth.

### Matrix of Competing Explanations

For an unusual time shift, you can consider a change in the local oscillator, a time transfer error, software recalculation of marks, and a physical difference in the tempo of the standards. Each version receives its own predictions: whether the deviation will remain after an autonomous comparison, whether it will appear in the original signal, whether it will be associated with a certain transmission system. Substitution of one version for another is allowed, but must be visible in the history of the study.

| Hypothesis | Discriminating expectation | Useful check |
|---|---|---|
| Time stamp failure | The original generator reading and the mark diverge | Compare independent label generation logs |
| Influence of the environment on the device | The response is related to the design or condition of the sensor | Compare heterogeneous channels and registered environment |
| Changing an Observable | The change is saved when you change a suitable method | Perform an independent measurement under comparable conditions |

The matrix also shows useless repetitions. If all versions predict the same outcome of a proposed experiment, a positive outcome will provide little help in selecting an explanation. Such testing may be necessary to verify the reliability of the recording, but its purpose should be described as such. A discriminating experiment requires a zone in which predictions diverge more than the uncertainty available.

### Prediction to result

Before the experiment, the main indicator, time window, conditions for including data, processing plan and termination rule are recorded. Pre-registration makes the history of research decisions verifiable; it does not in itself guarantee the quality of the selected model or design. [4] Exploratory analysis also has its rightful place: it helps to find patterns, which are then tested on new material.

Changing the plan during the study is sometimes necessary. Then they save the original version, record the reason for the change and indicate the moment after which the new procedure takes effect. Data already seen does not retroactively turn into an independent verification of the idea that arose from it. This is especially important for rare events, where the temptation to use every unusual detail as expected confirmation is great.

### Intervention as a source of new causes

By changing the environment, the researcher adds exposure. Turning off the device changes the heat, noise, electromagnetic environment and team behavior. Moving the robot changes the geometry and sometimes the state being explored itself. Therefore, the experimental variable must be described physically. If multiple conditions change at the same time, the result refers to their aggregate until additional checks separate the contributions.

Interventions that are reversible, observable, and have clear consequences in the chosen environment are preferred. This is the author's rule for organizing experience, and not a promise of safety for an unknown phenomenon. The decision depends on the established channel of influence and the admissibility of a particular operation. If the ability to distinguish between outcomes is lost, the experiment is stopped: continuing in this mode may add risk without adding testable knowledge.

### Training scenario

In a fictional laboratory, a strange impulse occurs when the door is opened. Two versions are proposed: the movement of the door causes a change in the field, or the entering person affects the object. Opening without entering and entering via a different route could distinguish the versions only when controlling for the other conditions. If, along with the door, the lights turn on every time and the ventilation changes, the initial experiment checks a whole set of reasons. The team first describes these relationships, then selects the minimum valid variable.

For a unique event, discriminative checks can be aimed at surviving traces and the compatibility of different channels. Replication of the natural process itself is then not available, but the calibration, geometry reconstruction, and physical consequences of each version can be independently verified. Statements for which such indirect verification is sufficient should be distinguished in advance from statements that require reproducible intervention. Uniqueness limits the method, but does not make all explanations equal.

A result that does not agree with any of the provided versions is retained without forcing a winner to be selected. It may indicate an incomplete list, a measurement failure, or a new question. The causal analysis ends with a specific decision: which connection was limited and which next observation is most meaningful.

### Executable Discrimination Table

Before the confirmatory experiment, it is useful to complete the outcome table, including inconvenient results. For each version, indicate the value, range of the forecast, conditions for its validity and signs of invalidity of the experiment. An empty cell “that will reject the version” means that the version is not yet ready for verification. Incompatibility is established according to a pre-selected rule, taking into account uncertainty, dependence of observations and whether the parameters were adjusted to the tested series.

| Outcome of a valid test | Valid output | Next action |
|---|---|---|
| Model prediction is inconsistent with data | The specified model version is not supported | Save calculation; indicate the changing assumptions of the new version |
| The effect of a given size is excluded | Limited effect size in tested conditions | Specify range and coverage; do not extend the result to other modes |
| Several versions describe the data | Mechanism not identified | Select a configuration with different forecasts |
| Sensitivity is insufficient | The experiment did not distinguish between hypotheses | Change the measurement task or justify a new device |
| Suitability criteria violated | The main hypothesis of this series has not been tested | Analyze the failure; do not consider the series negative |
| Work stopped due to clearance conditions | The study ends at this stage | Save status, responsibility and reasons for stopping |

The tutorial example specifies two versions of the residual signal. Version A predicts a change in sign when the source is rearranged, version B predicts preservation of the sign. When rearranged, the state of

the cable simultaneously changes. Such experience does not distinguish between A and B until the effect of the cable is verified: the planned operation has implemented a package of changes. After the introduction of independent reading, the table is supplemented with version C on mechanical transmission through the base. Expanding the list is acceptable, but new parameters cannot be assessed and tested on the same data without taking into account this procedure.

Completing the program also has a certain meaning. The formulation “available methods do not distinguish between A and B” may be a sufficient result of the stage. The report stores what additional observable attribute would be required to proceed. This allows another researcher to evaluate the usefulness of a new instrument without going through the entire previous journey. The completed analysis of the stable balance is given in case 2.

Chapter 5

# Limits of knowledge and research ethics

Exploring the unknown affects people even before there is a physical explanation. The message could change the reputation of a place, cause alarm, reveal personal information, or lead to interference in someone else's life. Therefore, ethics is included in the design of research along with metrology. It determines what information is permissible to collect, who makes the decision, and what is considered sufficient grounds for proceeding.

## The dignity of an eyewitness

The eyewitness provides a description of the experience, and not the obligation to confirm the picture of the world proposed by the researcher. His story is recorded without pressure to accept a medical, religious or physical interpretation. Uncertainty is formulated in relation to data. The phrase about the impossibility of establishing a cause from the available material does not invalidate the experience and does not automatically turn it into evidence of an external mechanism.

If the study involves a human participant, the purpose, acceptable procedures, methods of termination, and handling of data are determined in advance. Consent relates to an understandable task and can be withdrawn within the limits of the explained rules. It is impossible to obtain the imaginary independence of observations by hiding a significant risk. Decisions about physiological effects and condition assessment require appropriate competence; the research team does not acquire it due to the unusual nature of the item.

## Right to stop

The safety coordinator has the ability to stop work regardless of the manager's interest in the outcome. Such authority must have material content: access to communications, a clear stop command and predetermined actions for operators. Formal law without the ability to implement a decision creates the appearance of control. Restarting requires recording the reason for the shutdown and confirming that clearance conditions have been restored.

The participant's right to terminate his participation is considered separately from the technical stop of the installation. A person can refuse even when the measurements remain standard. Its failure is not interpreted as a sign of an anomaly impact or as a failure of the experiment. The protocol provides in advance how to complete the interaction and save the data already received without putting pressure on the participant.

### Proportionality of the study

The proposed action is evaluated on the expected knowledge, added impact, and available alternatives. While the same issue can be resolved by passive recording or analysis of data already obtained, active intervention requires a separate justification. For an uncertain process, reversibility is especially valuable: the ability to return to observation without continuing to change the environment. At the same time, the reversibility of the control signal itself does not prove the reversibility of all caused consequences.

Preservation of the sample does not have absolute priority over human safety. At the same time, the safety decision should not destroy information unnecessarily: the description, remote data and chain of actions can be preserved. The conflict between research value and risk limitation is addressed openly, including the rationale for the choice. This allows the decision to be assessed later on the information available at the time rather than on knowledge of the subsequent outcome.

### Privacy and Publication

Information about the place, time and features of the experience can identify a person even after removing the name. Before publication, it is determined what level of detail is necessary to verify the scientific conclusion. The source archive and the public set may differ, but the transformations must be described. If, due to the protection of personal data, independent verification is limited, this limitation is reported along with the result.

Names that suggest contamination, danger, or impact can create consequences even before verification. The public description must correspond to the established level of knowledge. The research journal can store alternative versions; When communicating to an external audience, you must not turn a list of suspicions into a list of confirmed threats. Responsibility for such a boundary is assigned in advance.

### Intellectual Honesty

Missing information is not filled in with fictitious precision. If the safe limit is unknown, the basis for the chosen organizational limit and the conditions for its revision should be specified. If the instrument is not tested for this mode, its readings are described with this limitation. The conditional model retains its designation even when its mathematical consequences look convincing. Verifying the calculation and confirming the initial premise remain separate tasks.

When a contradiction appears, the researcher must also consider the error in his own procedure. This does not automatically require that an unusual result be rejected. The productive position simultaneously preserves two possibilities: there is a new effect in the data or the existing explanation was incomplete. The decision is made based on checks available to both versions. Research ethics protects both the individual and the ability to discover what the previous model did not predict.

The environmental implications of the study are also included in the decision. Adding material, changing lighting, or moving equipment may affect the environment outside the area being measured. The proportionality assessment covers these changes, even if the main issue concerns only the device. Preserving a research site means preserving its state within the limits of a reasonable task, and not the right to arbitrarily rearrange conditions for the sake of a more expressive result.

A fictitious case study illustrates this principle. The participant reports severe discomfort only in the experimental area. The team terminates his participation, maintains a neutral description, and reviews the environment. Neither the absence of an immediate instrumental cause nor the coincidence with the area of interest provides a reason to continue the impact for the sake of a more convincing recording. The research problem is transferred to valid independent measurements.

Part II

# Classification and description

Chapter 6

## Multidimensional anomaly classification

The classification should help you choose the next test. If the name of a class immediately suggests a cause, the researcher runs the risk of looking only for evidence of that cause. Therefore, the proposed designations relate primarily to the observed manifestation. One case may have several labels, and some information may remain undefined. This is the author's navigation system intended for this book and allowing for development.

### Main classes of manifestations

| Code | Observation area | Primary Research Question |
|---|---|---|
| TM | Time | Which time value diverges from the expectation? |
| SP | Space | Which geometric relationship is not consistent with the model? |
| GF | Gravity and inertia | What acceleration or field component is measured? |
| MV | Movement and forces | How the position or mechanical interaction changes |
| EM | Electromagnetic fields | Which component and band are measured |
| OP | Optics | What relates to the source and what to the path and registration of light |
| TH | Heat and Energy | How temperature and energy balance boundaries are determined |
| IR | Ionizing radiation | What response is recorded and is the detector suitable? |
| AC | Acoustics and vibration | What frequency and amplitude are measured and how vibration transmission is assessed |
| MT | Substance | How the mass, composition and origin of the sample are confirmed |
| BI | Biology and ecology | How change and comparable background are determined |
| PC | Perception and cognition | What is experienced and what is independently confirmed |
| DI | Digital data | At what stage of recording or processing did the deviation occur? |
| CA | Causal correlations | How the order of events is established and alternatives are tested |
| AG | Apparent agency | What predetermined cues support a meaningful response? |
| UN | Insufficiently defined case | What information is missing to select the first check? |

The GF class differs from MV in its research setting. The movement of an object first refers to mechanical observation. A gravitational deviation label appears when there is a corresponding measurement or an

explicitly testable hypothesis; the trajectory itself does not establish a gravitational mechanism. Similarly, a light object receives an OP label, but its energetic nature is not determined by the color or brightness of the recording.

The AG label means that the apparent meaningfulness of the behavior is being examined. It does not verify the consciousness, intent, or identity of the source. The CA label captures the problem of causal order or unusual dependence and does not confirm reverse causation. The UN label is needed to save cases about which a sufficiently precise question cannot yet be formulated. Its use is preferable to premature selection of a spectacular class.

### Additional axes

To the class of manifestation, spatial character, temporal mode and method of registration are added. The spatial description may include a limited area, a distributed network, a moving source, or an unknown location. Temporary - one-time occurrence, repetition, permanent condition, or connection with a specified condition. The recording method distinguishes between message, single device, multiple channels and controlled experience. These axes do not replace the assessment of reliability, but make the recordings comparable.

The explanatory status is recorded separately. The cause may be established within the model, remain a working hypothesis, or not be proposed at all. A case with a known cause retains the manifestation class: an electromagnetic deviation, after identifying the technical source, remains a useful example for the EM class. It is the explanation and the required action that changes, not the observational history.

### Class assignment rule

The recorder first writes down a minimal statement without a causal interpretation. It then selects classes directly related to the available data and separately notes the classes of hypotheses being tested. For each label, the basis is indicated: file, measurement, evidence or calculation. When a label is revised, the previous version remains in the log with the date of modification. In this way, the classification becomes part of the traceable analysis.

Excessive number of tags is also a nuisance. If at the time of the event there was simply a working radio station, this is not yet a reason to add EM. If the participant felt something, PC relates to the recorded experience, but does not necessarily become the main focus of the study. The main label is chosen on the issue that now determines the method of work. The rest are saved as linked observations.

### Composite tutorial example

In the fictional episode, the camera records the glow, the magnetometer shows the pulse, and the computer clock jumps by one second. The primary description is received by OP, EM and DI. The TM mark remains hypothetical until it is verified whether the independent reference clock rate or just the software mark has changed. If the pulse originates from a common power supply to the equipment, three observations may describe one technical process. If they persist during separate checks, the research program is expanded.

Another fictional case begins with the feeling of an endless corridor. Only the person's narrative is available, so the primary label PC is accompanied by the research hypothesis SP. Measuring the layout and route can create independent spatial survey data. Until this occurs, the hypothetical geometry cannot be treated as an established property of the building. This consistency maintains openness to an unusual explanation and accuracy of the current status.

Classification answers the question about the method, but does not yet determine the danger. Two cases of the same class may require different restrictions, and a subtle phenomenon may be significant for safety. Therefore, the next element of the record is an independent risk profile.

Chapter 7

## Hazard profile and decision boundaries

Danger is determined by the possible consequences of interaction and the conditions under which they arise. The unusual nature of an observation does not in itself determine the degree of risk. A bright light effect can be well explained, but a subtle meter failure can be significant for safety. Therefore, the hazard profile is compiled separately from the class of the anomaly and separately from the confidence in its explanation.

The engineering approach relates risk to scenario, probability and consequences, taking into account the uncertainty of the initial information. This method of setting is presented in the NASA manual on systems engineering. [5] For an insufficiently studied phenomenon, the numerical probability is often not justified. In this case, it is more useful to describe the possible scenario and the dependence of the decision on the missing knowledge than to assign an exact score without a measurement basis.

### Profile axes

| Axis | What is being described | What is required to solve |
|---|---|---|
| Consequences | Possible damage to people, environment and equipment | Specific contact or refusal scenario |
| Contact Availability | Who or what may be affected | Routes, presence and admission conditions |
| Distribution | Source movement or impact transfer | Observable Paths and Undefined Boundaries |
| Duration | Continuation and repeatability of the process | Observation window and conditions for possible return |
| Reversibility | Possibility to restore the previous state | Confirmed Termination Methods |
| Observability | Ability to notice change in time | Eligible Channels, Latency and Detection Limit |
| Controllability | Available actions with predictable results | Proven influence channel and resources |
| Uncertainty | Spaces that change the choice of actions | List of required information and alternatives |

For each axis, it is useful to write down not only the score, but also its basis. The distribution boundary may be measured, inferred by analogy, or not known at all. These conditions cannot be combined into one mark. The presence of an unknown boundary does not prove infinite expansion; it limits confidence in the chosen organizational perimeter and requires revision with new data.

### Decision with incomplete information

The first to consider is an action whose consequences are clear without accepting a controversial hypothesis. Restriction of access to the site of an apparent technical accident may be justified by

observable damage, even if the cause of the damage is unknown. In contrast, expanding the isolation zone based only on the name “spatial anomaly” has no measurement support. Any limitation is associated with a specific scenario, purpose and condition of the revision.

It is useful to determine in advance which additional observation will change the decision. If operation is stopped due to loss of communication control, restoring communication does not in itself eliminate the cause of the failure, but allows you to check other conditions. If the restriction on interaction is due to an unknown material composition, a new optical image usually does not resolve the original issue. This way it becomes clear what information is really valuable for admission.

### Author's evaluation procedure

1. The leader describes the planned activity and its research purpose, including the impacts it will introduce.
2. The safety coordinator identifies plausible harm scenarios based on available data and known properties of the operation.
3. The metrologist indicates what significant changes the team will be able to notice and with what delay.
4. Operators confirm the availability of communications, resources and a method for terminating their own action.
5. The command records the permissible mode, the basis for the tolerance, and the events that require stopping.
6. After the situation changes, the assessment resumes with a new version; the old resolution is not transferred automatically.

The stopping criterion must be observable: loss of a specified control channel, a parameter going beyond a reasonable limit, a barrier state violation, an unexpected process change, or an inability to execute an exit plan. The phrase “stop at danger” is not sufficient if participants have different understandings of danger. At the same time, the list does not limit the right to stop in case of a new significant circumstance.

### Training scenario

A fictional group investigates rare flashes at an abandoned site. The glow itself does not determine the risk, but collapsed decking and loose equipment create known injury scenarios. Passive shooting is chosen from an accessible, stable place; entering the damaged area is not necessary for the primary question of timing of the flares. The uncertainty of the nature of the glow remains, but it does not prevent one from making an informed decision on the known infrastructure.

Later, the signal appears in several devices simultaneously. This changes the research task, but does not automatically give permission for active influence. First, shared dependencies and the ability to control the change are tested. The profile is updated in those axes that are affected by the new data. This step-by-step approach allows us to avoid inaction due to uncertainty and unjustified escalation.

The profile is accompanied by a mandatory review deadline or event. Changes in weather, crew composition, equipment conditions, or source conditions may render the previous basis insufficient. The shift manager must know which of these changes have already occurred. If the transfer of information is not completed, a new action is postponed until the overall picture is restored. The admission decision operates in conjunction with its conditions, and not independently of them.

The result of the evaluation is a record of an acceptable action under given conditions. It accompanies the case record, but does not replace it: scientific data must be preserved even when a decision is made to temporarily not continue the interaction.

### Three layers of dynamic map

The boundary on the working map answers a specific question. The line within which the deviation is registered does not have to coincide with the physical impact limit. It depends on the placement of devices, sensitivity, observation time and the adopted sign. Therefore, the case map contains three separate layers. The common substrate helps to compare them, but does not allow replacing one layer with another.

| Layer | What is marked on it | What does not follow from it |
|---|---|---|
| D - detection | Places, intervals and channels of registration of the selected characteristic; positive and negative results with sensitivity limits. | Everything outside the positive marks is free from influence. |
| N - observability | Really surveyed directions and volumes, blind areas, suitability of channels and spatial reference conditions. | The surveyed area is fully characterized for any mechanism. |
| P - access mode | Allowed actions, positions and routes; the basis of each permit, the person responsible and the condition of review. | The administrative boundary is the measured surface of a physical process. |

Each version is assigned a card identifier and a status record. For the mark, the source of coordinates, the original reference system, the event interval and the moment of receiving the information are stored. If the position is known only relative to the camera, this is what is written down: “frame sector”, and not fictitious geographic coordinates. The empty area is marked with the reason for the void: not observed, temporarily closed, the channel is unsuitable, or the suitable channel did not register the selected sign. These conditions require different solutions.

The update begins with a comparison of two versions of layer N. The appearance of a mark in a new location may be a consequence of the expansion of the view; disappearance is the result of a change in exposure or blocking of the signal path. Only after these changes have been taken into account is a change to Layer D discussed. The Coordinator then revises Layer P for the affected conditions. The old card is retained: it remains evidence of the previous state, although it may no longer be suitable for the current admission.

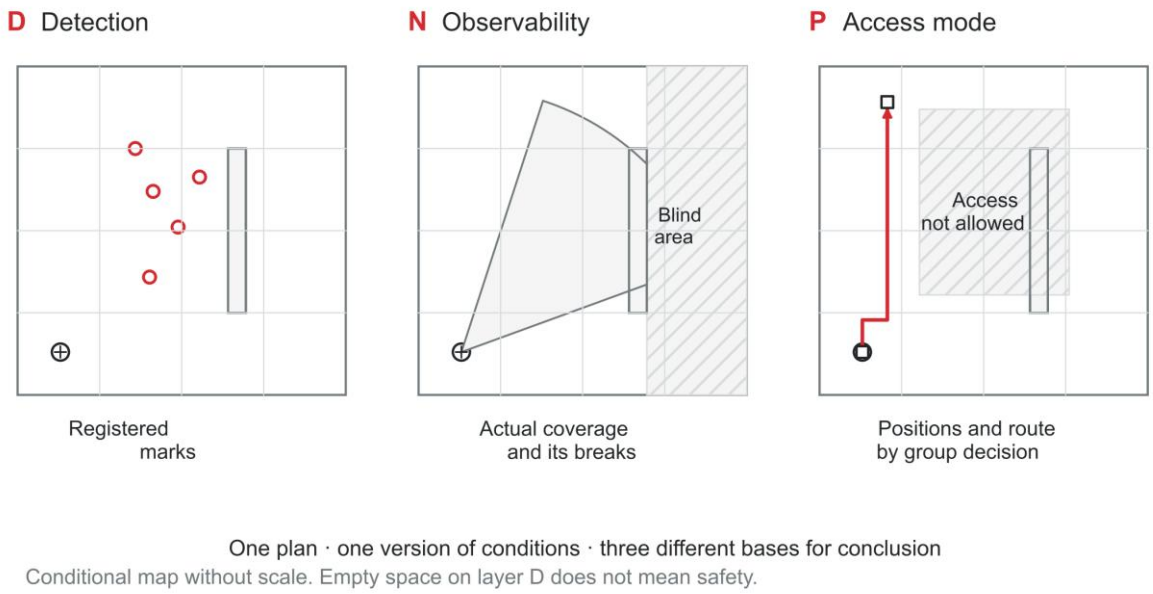



Figure 4. Three maps of one area: detection, observability, access. The author's diagram of three layers of one area. D contains registered marks; N - actual visibility and blind spots; P - allowed positions and route under specified conditions. The geometry is conditional. An empty area of layer D does not automatically receive safe status.

### When the route loses ground

The route is specified not by one line, but by a sequence of tested sections and transition conditions. His card indicates what confirms the position, what protective and observational functions are necessary, what is known about the final position and at what change the permission ceases to be valid. The fact that the previous pass was successful does not confirm the return pass after the environment has changed. This difference is especially significant for the conditional models of unusual connectivity from chapter 18.

1. When changing the map, the operator compares the current position with the last confirmed one; an uncertain position is not replaced by the forecast of the navigation program.
2. The coordinator lists affected areas rather than automatically canceling or saving all routes. The paths of people, equipment and transported materials are checked separately.
3. If further movement is based on a lost condition, new movements on this basis are not allowed. Perform the transition provided for the current configuration; the return itself needs a valid basis.
4. Renewal requires a new version of the map and confirmation of specific route conditions. Visual fading is not sufficient confirmation.

Fictional tutorial example: the mark is first visible only on the west wall. After reconfiguring the second camera, it also appears on the eastern one. In the M02 map, the N layer changes; the physical area extension has not yet been established. Then the connection with the second camera is lost. Version M03 contains a loss of observability of the eastern sector, rather than a record of the disappearance of the effect. Permission to place equipment there that was dependent on this control is suspended. Filling out Form G1 makes each of the three solutions visible without drawing an arbitrary safe circle.

Chapter 8

# Case Record and Data Provenance

The case record combines observations, decisions and the history of their changes. Its purpose is to allow the other group to understand what exactly happened based on the data available, what actions were taken, and what conclusions remain valid. This is a working structure that is filled in as information becomes available. The unknown value is left unknown by specifying the way in which it could be obtained.

## Case ID and boundaries

The identifier must remain the same when the explanation is revised. It should not include the supposed nature of the phenomenon as a mandatory part. The TM, OP or AG marks can be changed separately. For an episode, set a time interval and a rule for combining records; for the territory - surveyed boundaries; for a sample - storage unit and connection with the place of receipt. This prevents different events from being undetected under one name.

If there is reason to split a case, create related records and store the original join in history. Similarly, several cases can be combined into a series based on an explicit criterion. Common external shape, proximity of location, or similar date provide evidence of a connection, but are not necessarily sufficient to infer a common mechanism.

## Contents of the record

| Section | Required content | Common mistake |
|---|---|---|
| Registration | Who, when and in what way provided the information? | Replacing event time with recording time |
| Observation | Minimal statements and Source Materials | Causal explanation in the field of facts |
| Measurements | Devices, modes, units and limitations | Only screenshot saved |
| environment | Geometry, background, infrastructure and change | An unknown background is considered constant |
| Hypotheses | Predictions, alternatives and status | Version added after unmarked result |
| Solutions | Author, reasons, mode and conditions of stopping | There is no reason to continue work |
| Materials | Origin, transmission and condition of samples | Loss of connection between sample and event |
| Versions | Changes in findings and reasons for revision | Latest version erases history |

Each record is associated with the source and time of its creation. Event time, detection time, reporting time, and system entry time may vary. If the exact moment is not known, record the interval or relative order with an explanation of the basis. An artificially precise label creates a false opportunity to compare episodes that in reality cannot be positioned with such precision.

### Origin of material

For a digital recording, the original media, the copying method, the available metadata, and the sequence of transformations are important. For a physical sample, location, circumstances of receipt, packaging, movement, and changes in condition. The general meaning of these requirements is to maintain a connection between the material being studied and the statement about its origin. When part of the chain is lost, this restriction is reflected near the corresponding conclusion.

Storing digital evidence requires considering the integrity and history of files; NIST guidance addresses these issues separately from the overall material acquisition process. [6] In the proposed record, the checksum is associated with a specific version of the file. It helps to compare saved copies, but does not restore the reliability of the event before the moment of recording.

### Access sharing

Not all information is needed by every participant. The operator may need a measurement plan without eyewitness information. It is sometimes useful for the independent analyst to transfer recordings without implied explanation, preserving the necessary instrument information. At the same time, blinding should not deprive the performer of information essential to safety. Access rules are set before transmission and are recorded along with the set version.

A public card may contain abbreviated geographic and personal information. The internal record preserves the basis of the abbreviation and the relationship between versions. If critical data cannot be provided to the reviewer, the conclusion should reflect the limit of independent verification. The presence of a closed archive does not in itself make the statement more reliable.

### Tutorial example of filling

The fictitious case is given the identifier “Case 0042”. The initial recording reports two flashes within approximately five minutes. The camera turned on after the first flash; her watch had not previously been checked. In the record, the first flash remains a witness message, the second is associated with the file. Instead of a general statement of “two recorded events,” two different grounds are retained. Later, an external recording can refine the interval without destroying the original uncertainty.

The decision log indicates why the team chose passive observation and what additional data they expected to obtain. A few days later, a camera calendar time error was detected. The new version of the record corrects the mapping, but the original file and the previous solution remain available. This history allows us to understand what knowledge existed at each stage.

When transmitting a data set, it is useful to keep a list of the objects actually received. The recipient matches it with the content and notes missing elements before starting analysis. This allows one to distinguish between missing recording in the original study and loss in transmission. A later discovered copy is added as a new version with a description of the origin; it should not quietly replace material on which decisions are already based.

The record becomes especially useful when handing off work to another team. The transmitter lists unresolved issues, the status of devices, current restrictions and conditions for the next action. The recipient confirms understanding of these points. On this basis, the initial registration turns into a controlled research effort.

Chapter 9

# Initial registration and mode selection

The initial job is to save the information and determine a valid next step. At this point, there may not yet be a specialist in the supposed class of phenomenon, a proven instrument, or a clear explanation. Therefore, the proposed order relies on available observations and known properties of actions. It does not require immediate determination of the nature of the event.

### First priority

If there are signs of a normal accident, they act according to the appropriate response system and transmit information to the competent service. Scientific registration should not delay necessary actions to protect people. Information about smoke, destruction, damaged infrastructure or deterioration is recorded specifically, without adding an unverified explanation. If the situation does not require an immediate response, you can organize an initial recording without approaching or changing the environment.

Passivity means a lack of intentional research influence, but not a complete lack of influence. Light, sound, heat from equipment, the presence of people and traffic can change conditions. Therefore, even the initial observation is described physically: where the operator is, what device is working and what has changed since its appearance. If possible, already available records are used first.

### Five operating modes

Registration collects the message and stores the material. Remote passive monitoring checks repeatability and background with minimal added impact. A limited study solves a specific measurement problem under specified conditions. A controlled intervention deliberately changes a parameter to test a hypothesis. Stopping stops the selected activity and places the system in the intended state. These modes do not form a mandatory sequence: the study can end after registration or return from experiment to observation.

The transition is justified by the question, measurement suitability and performance conditions. The very fact that the unusual effect persists does not require intervention. Sometimes a long passive recording distinguishes between versions better than a new active operation. Sometimes further observation is meaningless without repairing the measuring path. The decision relates to a specific state of the system and is revised after a significant change.

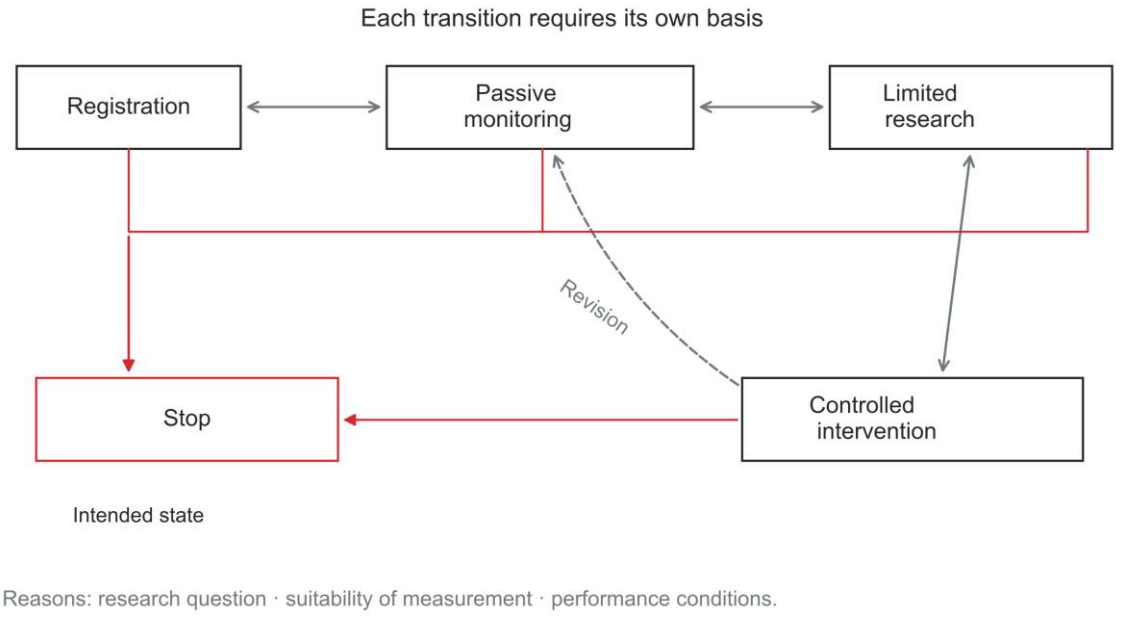



Figure 5. Five modes of exploration and transition grounds. Author's mode map. The transition to the next action requires a separate justification; return, revision and completion are possible. Stopping relates to the selected activity and results in a predetermined installation state. The scheme does not require mandatory intervention or complete power outage.

### Author's operating card for initial admission

1. The recorder records the message, time of receipt and available source; keeps the original wording separate from the refinements.
2. The site manager reports known hazardous conditions, current restrictions, and people present.
3. The Safety Coordinator determines whether it is acceptable to continue the selected surveillance without the added contact.
4. The operator describes the device and mode, checks the available signs of its performance outside the test influence.
5. The metrologist formulates the minimum question that this device is capable of answering and the conditions for an uninterpretable result.
6. The manager assigns the mode and boundaries of the task; The command confirms the connection, termination of the operation and the order of data transfer.
7. After the first series, a suitability assessment is carried out. Only then is a decision made to continue, change the method, or terminate.

If the listed functions are performed by a small group, the role names are stored in the log as responsibility functions. One person may keep multiple records, but should not pretend to independently validate his or her own decision. For actions with significant consequences, it is necessary to determine in advance what external competence and review will be required.

### Stopping Criteria

Work is stopped if the intended connection is lost, a significant protective element fails, an unforeseen change occurs, a clear route to completion is lost, or the participant’s condition deteriorates. Specific

thresholds, if needed, are taken from the applicable requirements and characteristics of the selected operation. The book does not assign universal numbers for unknown environments. In the absence of a reasonable threshold, the action is limited so that its permissibility does not depend on a fictitious value.

The stop command must specify an operator action, not just a word. For one installation, this means stopping the supply of the control signal; for another, it means maintaining power to the recorder when the movement stops. A safe state does not automatically equate to a complete shutdown: the shutdown itself may remove observability or a supporting function. The specific sequence is determined by the system architecture before launch.

### Training scenario

A fictional employee notices an unusual sequence of sounds in a technical room. The employee preserves the available record and reports it to the person in charge of the equipment. The first study compares the timing of sounds with the modes of known systems without changing their operation. Disabling the intended source is allowed only after its functions have been clarified. This way, a scientific question does not lead to the accidental cessation of ventilation or other necessary systems.

After the false alarm stops, a short debriefing is also performed. It turns out what sign caused the decision, what information was available and what helped clarify the situation. If the stop met a predetermined criterion, it should not be declared an error simply because the anticipated harm did not occur. Improving the procedure consists of increasing the discriminative power and understandability of the conditions, rather than prohibiting the reporting of uncertainty.

If the initial record is insufficient, the outcome may be an observation plan with a suitable path rather than a statement of no event. If the cause is established, the conditions for its occurrence are recorded. If a new measured residue occurs, the record and hazard profile are clarified. Initial registration is considered successful when the next step has become more reasonable and verifiable.

### A person is injured or unaccounted for

The transition to help begins based on observable circumstances, even if the mechanism of the event is not determined. A report of an injured person, the absence of a participant in the designated place, or the inability to confirm his condition is not considered a regular research series. The coordinator announces the transition to response, the leader stops scientific activities that could interfere with assistance, and the designated liaison contacts the competent service in accordance with the current local order. Filling out the form should not delay your request.

The organizational basis for separate planning of roles, communication and interaction with external services is available in the US Occupational Safety and Health Administration (OSHA) standard 29 CFR 1910.120, within the scope of work regulated by this document [64]. The map offered below is the author’s adaptation for organizing the study. It does not prescribe medical actions, rescue powers, or methods of entry into an unknown environment.

1. Name the actual event: what is being observed now, by whom and through what channel; separately indicate the unverified message. Do not replace the description with a diagnosis or name of the anomaly.
2. Check the list of participants with direct confirmations. For each, write down: counted in the indicated place; contact has been established, the situation requires clarification; location not confirmed. Loss of radio communications does not in itself prove the disappearance of a person.

3. Provide the service with the known location of the event, the number of people counted and uncounted, observed danger signs and access restrictions. If the coordinates are unreliable, name the last confirmed landmark and method of contacting the informant.
4. Provide up-to-date map layers, recent reliable observations, information about existing barriers and supporting functions. Note what may worsen if the equipment is completely turned off.
5. Agree on the channel for further updates and the person receiving the information. Record the contents of the received message and instructions received; an undelivered notice shall not be considered a completed transmission.
6. Maintain accessible records without delaying assistance. The custodian maintains a time track of responses separate from the research hypotheses; later clarification completes the original entry.

A research position does not create life-saving competence. The possibility of a particular approach or extraction is determined by the prepared response system and actual conditions. Unauthorized entry of the next participant does not become acceptable out of concern for the first. However, the unknown cause does not serve as a reason to refuse available help, which can be provided within the limits of one’s own training and current instructions. Both boundaries are recorded before the expedition: what the group can do and what activities require external capabilities.

If a previously known path is no longer confirmed, the messenger reports this directly. You cannot greet arriving people with an offer to take the “usual path”, hiding the loss of its foundation. Nor should a route be declared physically impossible simply because of a navigation failure. Form G2 distinguishes between a confirmed obstacle, a loss of observability, and an unappreciated opportunity. This allows the profile party to choose their own assessment without an imposed explanation.

The transfer is considered organizationally completed when the receiving party has confirmed receipt of essential information and the further distribution of functions has been determined. Until then, the group maintains an assigned communication channel and an available record of people. The study does not automatically resume after contact is restored: the condition of the participants, space restrictions, serviceability of controls and the basis for new admission are separately considered. A person's refusal to participate further is not considered a technical failure.

Chapter 10

# Combination of effects and development of events

An unusual event can manifest itself in several channels at once. The glow is accompanied by sound, the temperature change coincides with electronic failure, and participants report discomfort. This combination increases the amount of information, but does not provide a single causal story. It is necessary to check whether the observations belong to the same process, have a common external cause, or coincided within the selected time window.

### Three causal structures

In a sequential structure, one process creates the conditions for the next: a change in the environment affects the device, then the data processing. In the structure of a common source, one factor influences several channels in parallel. In an independent coincidence structure, events are not causally related, but are combined by the researcher by time or place. A real system may contain all three structures simultaneously.

A physically meaningful time sequence helps to distinguish them. However, the order of marks is not itself equal to the order of causes. Channels have different delays, recording frequencies and time generation methods. Before building a cascade, the metrologist evaluates which differences in time are generally solvable. If the uncertainty exceeds the expected interval between events, the direction of the relationship remains uncertain.

### Common Cause

Common causes can simultaneously disrupt the operation of backup elements. NASA engineering materials highlight the limits of improving reliability by simply increasing the number of similar systems and the importance of diversity in technology, power sharing, and control. [7] In anomaly research, this logic applies to evidence: multiple records may be different manifestations of the same common vulnerability.

Therefore, next to the effects map, a map of equipment dependencies is drawn up. It includes physical placement, power, synchronization, networking, software library, and general processing stage. For evidence, the possibility of mutual discussion and a common source of information are taken into account. The presence of a dependency does not make a record useless, but it does change the independence of its confirmatory role.

### Process Development

A cascade involves changing conditions over time. After the first event, the system may find itself in a different state: overheated, damaged, overconfigured, or lacking some control. Repeating the same operation in this state does not necessarily reproduce the original experience. The log needs to note changes that could affect subsequent observations, including the actions of the team itself.

It is useful to distinguish between the original state, the transition, the new state, and the return condition. If the return is not confirmed, the next series starts from a new starting point. Such a description prevents the error in which a dozen sequential reactions of one changing set are considered a dozen independent experiments. The series design must be consistent with the physical history of the property.

### Author's protocol of a composite event

1. Save individual source recordings of each channel and describe their timing.
2. Determine which matches are resolvable, taking into account delays and uncertainties.
3. Create a common cause map and overall log of installation and environment changes.
4. Separate the serial link, common source and independent match versions.
5. Select a test that changes one significant section of the circuit with an acceptable added effect.
6. After verification, update the scientific model and hazard profile separately; do not transfer confidence from one to another without reason.

The stopping criterion also takes into account the loss of observability. If the effect has disabled the channel on which the tolerance was based, continuing with the previous operation is no longer consistent with the previous decision. Additional equipment is introduced after assessing its compatibility, since it itself can change the chain of dependencies. A reserve is useful when it is known what kind of failure it can withstand.

### Training scenario

In a fictitious series of experiments, a light pulse, a magnetic channel jump, and the loss of several packets are simultaneously recorded. The first version connects all three signs with a new impact. Checking shows that the camera and network share a common power source, and the magnetometer is located near its wiring. This creates a concrete alternative. Independent power recording and separate recording allow it to be verified without assumptions about the nature of the unknown object.

If, after eliminating the shared dependency, only one channel remains, the original composite event splits into different research tasks. If the agreed sequence is maintained, there is reason to clarify the mechanism and geometry of propagation. In both cases, all the source material is useful, including the channels that were later explained.

The choice of time window changes the number of matches. A very wide window combines processes between which there is no established connection; too narrow may eliminate a physically possible delay. It is justified by the propagation model and channel characteristics before analyzing the main series. If the window was selected from the data, the sequence found becomes a candidate for a separate test. Events that are not included in the selected combination are also saved in the report.

The result of the analysis is a causal diagram with marked uncertain connections and a list of verified dependencies. It links the general methodology to the thematic sections of the book. The next chapter examines the origins and maintenance of the observed regime. The study then moves to temporal processes, where the distinction between event, signal, and time stamp becomes particularly significant.

### Life cycle and state memory

The status record must include sufficient history to compare subsequent actions. The same current readings may hide different internal temperatures, accumulated strain, composition, charge, settings or program status. Hysteresis here is the dependence of the observed response on the path by which the system arrived at the current conditions. Specifying this property does not explain its mechanism or prove unusual physics. It prohibits considering two regimes the same based on only one indicator.

The lifecycle card distinguishes between discovery, condition clarification, allowed change, state hold, termination of active activities, and follow-up. These are statuses of working with a phenomenon, and not mandatory stages of its nature. A case may be reported after the peak; visible subsidence may be replaced by repeated manifestation. Card branching captures such possibilities without assuming that any object will necessarily go through the entire cycle.

| Transition Recording | Required content |
|---|---|
| Initial state $S_i$ | Observed quantities, configuration, map version, previous impacts and unknown intervals. |
| Event or action $T_i$ | What has changed; noticed by whom; command, actual execution and incidental changes. |
| New condition $S_j$ | What is confirmed after the transition; what previous foundations have been preserved or lost. |
| Return | What observable sign would indicate a return; Is verification acceptable? what properties could remain changed. |

| Transition Recording | Required content |
|---|---|
| Next observation | What issue does it solve; comparability conditions; to whom responsibility is transferred. |

A fictitious example: when the control parameter of a training stand is successively decreased, the light response remains where it was not yet present when increased. Both branches, the exposure duration and the state of the measuring path remain in the log. Repeating only a “successful” direction does not confirm a stable boundary. If a reverse pass is unsafe or not allowed, it is not performed for the sake of a symmetrical graph; output is limited to one branch. The missing background is designated as unknown, rather than being filled in with the most convenient reconstruction.

The difference between the branches still needs to be separated from the delay of the measurement itself and the transition regime. To do this, under acceptable conditions, the response is compared for known sequences and exposures, maintaining information about the rate of change. If there is no such comparison, the result is called the dependence of the recorded response on the sequence performed. This is more accurate than attributing a set hysteresis to an object based on a single loop on the graph.

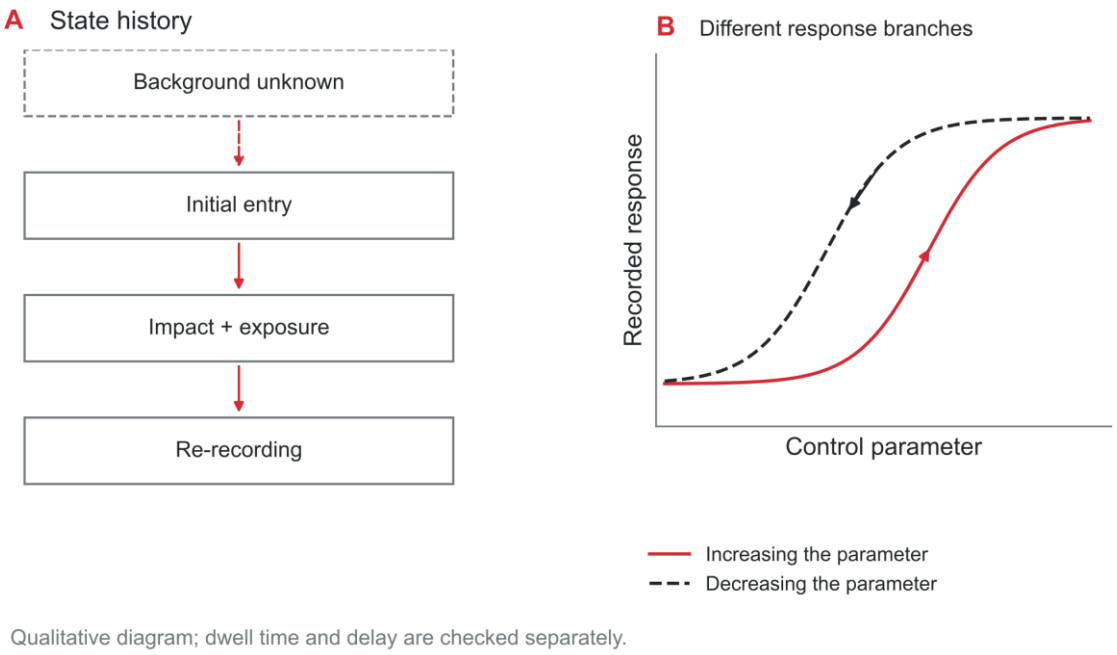



Figure 6. State history and two response branches. Qualitative teaching diagram. The result is associated with the background, sequence of influences and exposure time. The difference between the branches when the parameter increases and decreases is not yet separated from the measurement delay and the transition mode. The curves are arbitrary, the numerical scale is not specified.

### Register of Executable Protocol Prerequisites

Even a careful procedure makes use of the premises: the events are distinguishable, the command has a destination, the record preserves the origin, and the test refers to the desired object. These should be listed before selecting an intervention. The STPA system hazard analysis method examines the relationship between the state of the controlled process, control actions and feedback; delays or incomplete information

may render the action inappropriate for the actual condition of [62]. Here this engineering logic is applied to tolerance limits, without claiming that it covers any conceivable change in the laws of nature.

| Premise | Sign of loss | Which output or tolerance is being limited? |
|---|---|---|
| Local order can be reconstructed | Restart without a connecting record, number conflict, unknown fragment origin. | Sequence of actions across the gap; If individual fragments are preserved, their independent analysis can continue. |
| Essential configuration known | Unaccounted for replacement, mode change, mismatched versions. | Carryover of calibration and resolution from previous configuration. |
| The required spatial relationship has been confirmed | Loss of reference or inconsistent position observations. | Allowing movement along the previous route and inferring propagation. |
| Object and channel distinguishable | It is not possible to distinguish between sample replacement, data replication, or another source. | Comparison “before - after” as the history of one object. |
| Status available for solution | Unknown latency or feedback source, loss of required channel. | Management that requires timely knowledge of this condition. |
| Termination can be confirmed | The command has been sent, but its execution and result are not observed. | Application to stop exposure and subsequent action depending on it. |

For each line, a verification certificate and a loss action are assigned. The prohibition applies to a dependent decision; he is not obliged to prohibit any activity. For example, a local spectrum may remain valid when the global time scale is lost, while the causal order comparison is no longer justified. The acceptable residual regime is selected from actually confirmed possibilities, and not from the general desire to continue.

If a conditional model simultaneously eliminates the distinguishability of states, the preservation of records, and the ability to confirm an action, an executable verifiable protocol is not specified for it. An external camera or mechanical watch does not solve this logical problem by itself. First, the model must name the conserved subsystem and its relationship to the observed process. The register of premises makes it possible to show the exact location of the limitation, rather than promising a universal defense against arbitrary causation.

Chapter 11

## The Emergence and Persistence of Anomalous Regimes

The manifestation class indicates what should be measured. The explanation of the occurrence must additionally show how the system came to the observed state. To do this, it is not enough to name the interaction or suggest a signal shape. It is required to connect the initial conditions, the formation process, the source of maintenance and the observed fate of the object. Such an analysis is useful both for an ordinary phenomenon encountered by the research group for the first time, and for hypothetical new

physics. The confirmation of premises varies, but the requirement to obtain consequences remains common.

The reason for its occurrence does not necessarily coincide with the reason for its continued existence. A short impulse can start a process that then uses up the internal supply; continuous external influence can maintain a state that is impossible after its cessation. The observability condition is also a separate link. Changing lighting can make an existing object visible without creating it. Therefore, the history of a case distinguishes between the appearance of the condition itself, the beginning of available recording, and the moment when the observer recognized the event as unusual.

### Four questions to the origin

First, a state variable is selected. For heating, this can be the reserve of internal energy, for oscillations - amplitude and phase, for composition - the number of certain components. The variable must be related to the observation through the measurement model. The brightness of a pixel is not directly the energy reserve, and the clock reading is not the state of the entire environment. If the variable is currently only indirectly available, additional assumptions necessary to recover it are listed.

Then the system boundary and exchange paths are specified. Energy input, matter transfer, mechanical work and information about external influences receive their own records. The transition mechanism is then described: what changes when triggered, what connections become significant, and why the effect has a given spatial scale. Finally, the preservation and termination conditions are formulated. An explanation that describes only a beautiful stationary pattern does not yet explain its birth or stability.

| Mechanism in working hypothesis | What maintains the condition | Discriminating observation |
|---|---|---|
| Finite internal energy store | Initial resource consumption | Consistent Decay and Limited Integral Output |
| External power | Measurable flow across the border | Changing the output when this flow naturally changes |
| Mode transition | New stable connection configuration | Threshold, delay and history dependence |
| Moving heterogeneity | Transfer of an existing structure | Sequence of responses at spatially separated nodes |

These lines indicate explanatory structures that can be combined. For example, a moving area can receive energy from the outside and simultaneously consume the accumulated resource. In this case, the model must predict speed, duration, and intensity change together. The addition of each mechanism increases the number of conditions that need to be tested. It is useful when it explains a new independent feature, rather than just providing another free parameter.

### From diagram to equation of state

The simplest author's storage model connects the reserve E with the incoming power P and the relaxation time τ. At constant P and τ it has the form given below. E is measured in joules, P in watts, τ in seconds. The term E/τ denotes the chosen model loss law; it is not assigned to any unknown object based on external similarity.

$$\frac{dE}{dt} = P - \frac{E}{\tau}$$

$$E(t) = P\tau + (E_0 - P\tau)e^{-t/\tau}$$

The equation immediately separates several scenarios. With no energy input, the stored energy decreases; with a constant input, it approaches Pτ; after the input changes, it approaches a new level over the characteristic time τ. This already defines an observation program: record a transition curve, estimate the parameters from one portion of the record, and test them on another. If the instrument measures output power only, the initial stored energy must be reconstructed through an additional relation. An arbitrary claim of unknown energy does not independently confirm the model.

Changing regimes requires different dynamics. To illustrate, consider a dimensionless variable x, such as the normalized sign position deviation, and a dimensionless control parameter μ. The following equation is an independent educational model, and not a universal law of anomalies. When μ is less than zero, the only stable state is at zero. When μ is positive, two stable non-zero states arise, and the zero one becomes unstable.

$$\tau \frac{dx}{dt} = \mu x - x^3$$

Indeed, the derivative of the right-hand side with respect to x at a stationary point determines the sign of the small perturbation: at zero it is equal to μ, and at points ±√μ it is equal to −2μ. This results in a verifiable change in stability. Near the threshold, the characteristic response times also change. However, such an equation does not yet name the physical source of energy or the substance that realizes the required coefficients. For a specific object, this is the next required level of explanation. One cannot mistake a mathematical transition of a regime for a ready-made technology for its creation.

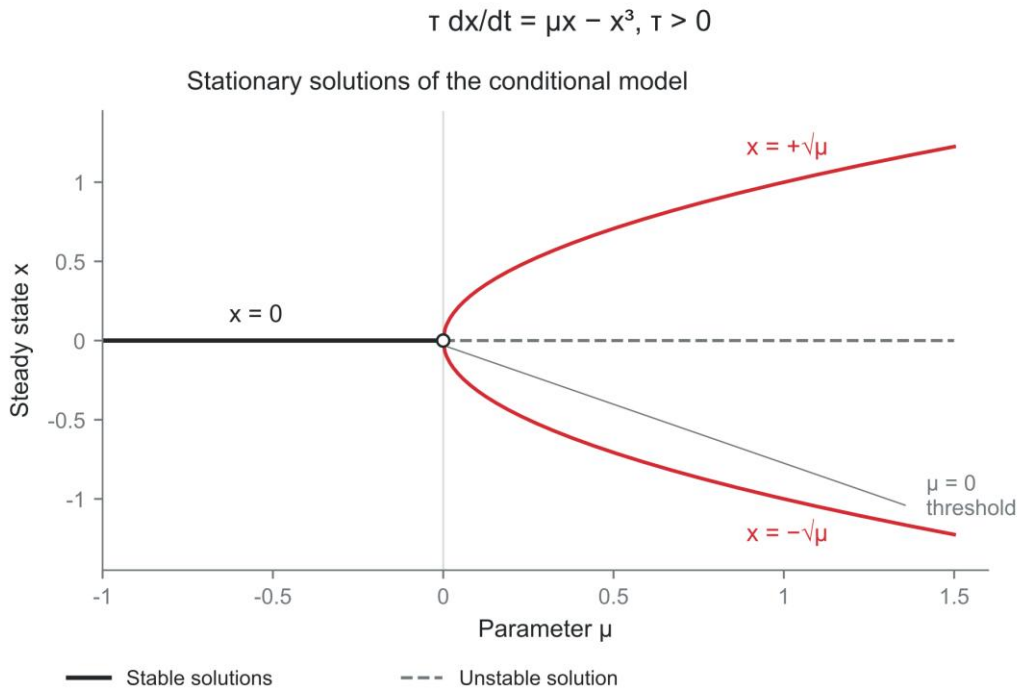



Figure 7. Threshold and change in regime stability. Conditional mathematical model τ dx/dt = μx − x³ for τ > 0. When μ < 0 the state x = 0 is stable. For μ > 0 it is unstable, and the two branches x = ±√μ are stable. Point μ = 0 is the threshold for changing stability; this diagram does not define a hysteresis loop and is not a record of a natural phenomenon.

### Localization and duration

The spatial extent must emerge from the model: from the source distribution, boundary geometry, transport length, or stable field profile. If the size is simply selected from a photograph, as long as a description of the shape is received. To get to the mechanism, it is useful to predict how size will change with duration, intensity, or environmental conditions. Observations of different scales are especially valuable because they can destroy the coincidence obtained by fitting a single episode.

The characteristic time for passing through a region of width L with speed v is of the order of L/v. The decay time and response time of the sensor may vary. If all three quantities are mixed, the short recording will not determine either the size or the speed. The network reconstruction in chapters 13 and 17 shows how these issues are separated. For an unknown phenomenon, let us assume a result in the form of a family of compatible sizes and velocities; the single value emerges only after a sufficient number of independent restrictions.

Existing studies provide examples of this transition from mechanism to prediction. In the Abrahamson and Dinniss model of ball lightning, the supposed glow is associated with the oxidation of the resulting particles; experimental confirmation of individual aggregates did not mean reproduction of the entire object [33]. For hypothetical domain walls, the researchers derived a spatiotemporal clock perturbation pattern and looked for it in satellite data, obtaining constraints instead of finding [65]. Both formulations are useful in that the name of the mechanism is accompanied by separate verifiable consequences.

### Mechanism record and the following experience

The mechanism record complements the case record. It stores the initial state, variables and units, parameters, transition equations, maintenance sources and observed predictions. Separately note which parameters were measured independently, which were estimated from the same event, and which were only hypothesized. This boundary allows us to distinguish a forecast from a re-description of the original data. The protocol must contain at least one result, after which the proposed mechanism will have to be changed or rejected.

The manager selects the next test based on the difference in forecasts. The metrologist assesses whether the expected magnitudes and delays are solvable. A specialized specialist determines which natural changes or safe bench exposures are informative. The operator saves a history of actions, and the safety coordinator stops intervention when leaving the confirmed area. The absence of a valid way to trigger the intended transition does not close the observational program: form, balance, lag, and connections to naturally changing conditions can be checked.

The identified mechanism can only explain part of the life cycle. The group is free to confidently describe the decay, leaving the origin open, or confirm the energy input without a full localization theory. This result becomes the basis for the next model. Scientific development begins where a new version takes on additional obligations to observation: it explains previous data, predicts what has not yet been tested, and shows the area in which it ceases to work.

Part III

# Time and causality

Chapter 12

## Physical time and clock readings

A time violation message may contain three completely different observations: a person does not remember part of the events, the device recorded the wrong date, or two physical standards have accumulated different intervals. Combining these cases with one name hides the reason in advance. The study of the TM class begins with the question of what kind of process served as a clock, who counted its cycles, and how the resulting result was compared with another result. The word “time” in the case report must be accompanied by a description of the observed value.

A clock consists of at least a periodic process, a counter, and a rule for presenting readings. The generator may continue to oscillate while the program loses records; The counter is able to run without interruption while the user interface resets the date. The opposite situation occurs when correcting external synchronization: a jump appears on the screen, although the physical oscillator has not experienced a corresponding frequency jump. Therefore, a photograph of the dial establishes the state of the interface at the time of shooting, but does not itself describe the history of the device’s own time.

### Proper time and ways to compare it

In the theory of relativity, proper time refers to a specific trajectory. Two serviceable standards that have traveled different paths or were in different gravitational conditions may, upon subsequent comparison, show unequal intervals. This is not a defect in timing. The measurement question is whether the difference is consistent with the calculated motion and field model. The use of clocks for comparing gravitational potentials has already been implemented experimentally; it is the possibility of a predicted difference that makes such comparisons a tool of geodesy [8].

For slow motion in a weak field, the standard approximation is:

$$\frac{d\tau}{dt} \approx 1 + \frac{\Phi}{c^2} - \frac{v^2}{2c^2}.$$

Here τ denotes the proper time, t is the consistent coordinate variable, Φ is the Newtonian potential with the usual negative sign, and v is the velocity in the chosen reference frame. The formula describes a limited mode, and not a universal translation of any unusual reading into a characteristic of space. The geodetic potential sometimes already includes the rotation of the Earth; The same amendment cannot be added again.

Frequency and phase also require discrimination. Frequency characterizes the rate of accumulation of cycles, phase - the position within the sequence of oscillations. A constant phase shift can persist after a brief glitch when the frequencies have long been the same. If the relative frequency difference is y and remains constant, the accumulated time difference is approximately equal to yT over the interval T. This simple calculation helps to check whether the reported magnitude and duration of the effect are consistent. A large jump in a mark without a subsequent divergence in the slopes of the time series has a different structure than a steady change in tempo.

Time transmission adds another measuring path. The receiver sees the source clock with a delay that depends on the signal path and equipment. In network designs, estimating this delay requires assumptions

about directional symmetry. In addition, the network time protocol NTP, the precise time protocol PTP and other protocols do not create an independent reference: different services can receive the original time from the same satellite system [9]. The check should go all the way back to the origin of the reference signal and not stop at the name of the application.

### Constructing a Measurement Statement

A full-fledged statement looks concrete: two autonomous generators, previously compared at one point, over a certain interval accumulated such and such a difference with the specified uncertainty; known corrections explain a certain part of it. It lists data omissions, mode changes, and comparison method separately. The formulation “time moves slower indoors” becomes a working hypothesis only after such a description and does not replace it.

A mental example is helpful. The recorder has stored ten thousand consecutive pulses, but the minute is missing from the log. If the hardware counter continues to increase uniformly, missing rows requires checking the record first. If the interval between pulses on the independent meter has changed, the generator and its environment are examined. If the deviation is reproduced for dissimilar standards and is consistent with the field geometry, a third problem arises. These options differ in data, not an impressive name.

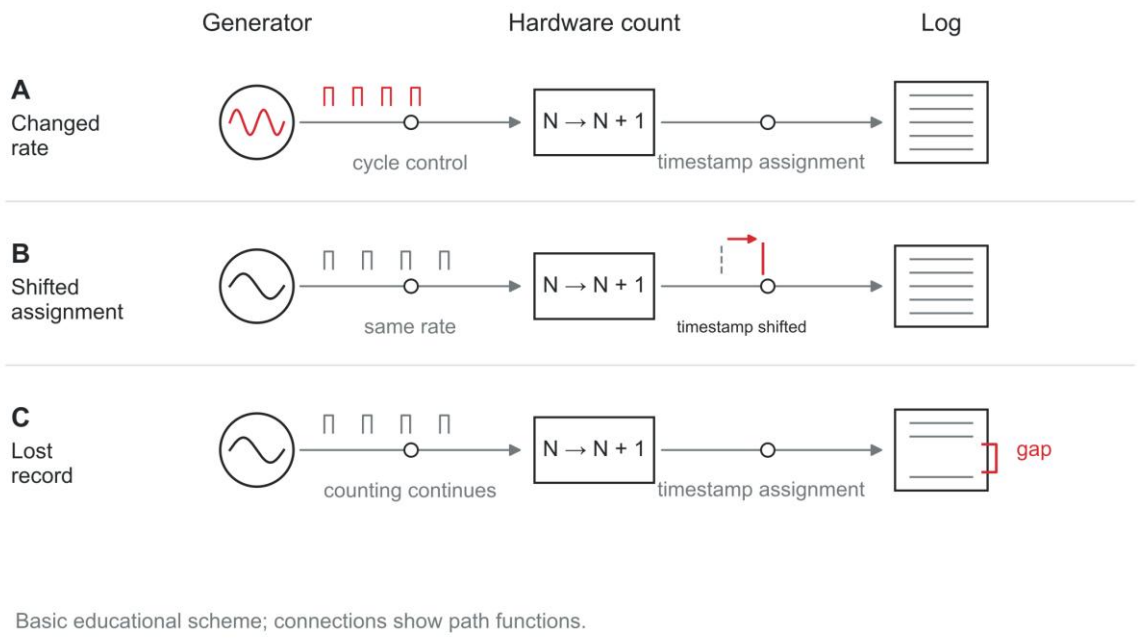



Figure 8. Generator, counter and log: where the discrepancy occurs. A tutorial diagram of three different places where discrepancies occur: the generator, reading binding, and log storage. Continuous hardware counting does not restore missing entries; The path shown is a functional diagram and not installation instructions.

Even an agreed upon change of a few hours does not remove the question of overall impact. Temperature, power, firmware, or a single reference line can link externally different devices. However, an endless list of possible errors is also not an explanation. Each significant alternative must predict an observable difference: dependence on reference material, location, power mode, sampling rate, or transmission method.

### Author's procedure for primary qualification

1. The data custodian preserves the original log, hardware counters, and time correction history; the processed copy receives a separate designation.
2. The metrologist defines the measured quantity and lists the sources of reference time, including hidden dependencies between devices.
3. The operator compares the phase, frequency and completeness of the recording on a common timeline, noting restarts and mode changes.
4. The study director selects the next test based on the discriminating prediction; The safety coordinator confirms that the equipment placement is acceptable.

The basis for continuing is the ability to reconstruct the sequence of measurements and evaluate the uncertainty of the comparison. If the reference scale is unknown, the instrument has been restarted without a log, or the two records cannot be unambiguously compared, the output of the tempo of time is stopped. The message itself is stored in the registry as insufficiently defined. The loss of probative value of a particular measurement does not mean the proven absence of an event.

The boundary of this chapter is between experience, registration and physical comparison. The next task is to construct an observation where these levels stop replacing each other. Only after this does the local temporal discrepancy receive coordinates, duration, measurement meaning and a verifiable connection with surrounding conditions.

Chapter 13

## Checking for local timing discrepancies

The locality of the temporal effect means that the result depends on the location or trajectory, and not simply on the time of day. To check it, it is not enough to bring the watch to the intended area and compare the readings after returning. During transfer, temperature, orientation, mechanical load, and bonding conditions change. The research design must separate the influences of site, specific apparatus, and transfer procedure. Otherwise, the detected residue cannot be confidently attributed to any of these factors.

The basis of the proposed protocol is made up of three positions: the point under study, a control point with comparable normal conditions, and a place for joint comparison of standards. The control is selected according to the model of possible interference. The adjacent corridor may be good temperature control and poor electromagnetic control. The remote laboratory provides an independent background but adds a complex lineage. The reason for choosing each point is recorded before the main series.

### Control before and after transfer

In the joint source recording, the DC offset, drift, and frequency difference spread are assessed. This entry is not required to make the watches exactly the same. Its purpose is to establish the expected behavior of the couple and the limit below which change is indistinguishable. After the main series, the standards are again compared together. If their relative behavior has changed and not recovered, damage, aging, or carryover effects are possible; the data cannot be interpreted as if the original calibration remained unchanged.

When positions are safely accessible, rearranging instruments is useful. If the deviation follows the device, the local hypothesis is weakened. If it follows the place and persists after changing the method of comparison, a more meaningful result arises. However, permutation is not a necessary physical entry into

an uncertain environment. When access is not justified, remote placement is used or the output is limited to an observable external signal.

Optical field clocks show that such a program is not limited to an imaginary device. In the work of Grotti et al., a transported standard was used to compare the potentials of two sites, with local and remote comparisons allowing verification of instrument biases. Reliability difficulties and limited operating time influenced the resulting uncertainty of [8]. This is more important than the advertising characteristics of a separate generator: it is necessary to evaluate the completed campaign.

The deployment of another transportable system after being transported thousands of kilometers has also been demonstrated; in the described experiment, the equipment became operational within two days after the arrival of [10]. This result confirms the possibility of specialized mobile metrology. It does not establish the device's ability to operate continuously while moving, to tolerate any environment, or to provide an instantaneous accurate response when turned on.

### What should remain independent

It is advisable to combine autonomous progress with external comparison. Offline recording helps distinguish the behavior of the oscillator from the behavior of the synchronization channel, and an external reference links the different sites. These functions should not be combined unnoticed: automatic adjustment can eliminate the discrepancy under study and at the same time transfer the error of the external system inside the device. All correction commands are stored along with the raw phase or frequency.

A satellite signal failure does not make the local clock an error-free replacement. After loss of support, the result is determined by its own generator and the [9] holdover algorithm. Ensemble testing of local oscillators can reveal some types of external time substitution, as shown in a separate experimental design [11]. In the proposed complex, such a test serves as a diagnosis of a specific dependency, and not as a certificate of invulnerability.

For each pair, the remainder is constructed between the measured difference and the calculation of known effects. The budget includes uncertainties in position, motion, frequency corrections, transmission, and skips. Adjacent points in a time series are usually related by the behavior of a single generator; Increasing the recording frequency does not create as many independent measurements. The significance of the stable residue is assessed taking into account this dependence, and the result is checked on another series.

### Author's protocol for site comparison

1. The study director specifies in advance the spatial relationship to be tested and the minimum detectable effect; the metrologist confirms that the path is able to distinguish it.
2. The operator performs a joint initial recording, then places the devices in an agreed upon pattern and maintains a separate log of movements, status and corrections.
3. The data custodian maintains raw readings and environmental control, including non-communication intervals; lost intervals are not completed as measured ones.
4. The metrologist calculates the expected corrections and residuals, and then compares the result with the control point and the final joint record.
5. The manager allows repetition with a changed configuration only if the diagnosed condition is maintained; The safety coordinator stops work when an unintended impact occurs.

The test lead stopping criterion is different from the physical hazard criterion. Loss of the timing log makes the series unsuitable for accurate comparison, even in a secure environment. Equipment damage,

unknown heating, or loss of operator communication requires a return to safe mode regardless of the statistical strength of the signal. The device is not left in a more risky position in order to complete a beautiful curve.

Successful completion of such a test does not produce a universal statement about time, but a limited result: the dependence of a certain observed remainder on specified conditions. Particularly valuable for confirming a local effect are the preservation of sign and scale after permutation, the agreement of independent tracts, and the previously predicted change when changing position. It is these features that allow you to move from registration to a model without replacing the model with the name of the territory.

### The moving front as a testable network model

Local divergence may move. Then it is useful to measure the moments of occurrence of one predetermined sign at different nodes. This sign may be the beginning of a frequency shift, and not a jump in the date in the interface. Each channel is first assigned a start selection rule and the delay of the meter itself is estimated. Delay correction is performed using a separate calibration, preserving the original marks. Sharing software time across multiple sensors does not make their physical response latencies the same.

Consider a fully synthetic example of a plane front moving at a constant speed. Spatial coordinates are expressed in meters, times - in seconds of one agreed scale. Four nodes A–D are used for evaluation, and node E is left as a test node in advance. The coordinates here define the design geometry; they do not constitute an instruction to place the equipment at an unknown site.

| Node | Coordinates (x; y; z), m | Response onset, s | Purpose |
|---|---|---|---|
| A | (0; 0; 0) | 100.00 | Model evaluation |
| B | (10; 0; 0) | 102.40 | Model evaluation |
| C | (0; 10; 0) | 103.20 | Model evaluation |
| D | (0; 0; 5) | 101.50 | Model evaluation |
| E | (6; 8; 4) | 105.24 | Checking the forecast |

For a flat front, the moment of arrival is described by the expression below. The vector s has the dimension of seconds per meter. Its direction coincides with the normal movement of the front; the module is equal to the inverse speed in the model under consideration. The parameter $t_0$ specifies the moment of passing the origin of coordinates.

$$t_i = t_0 + \boldsymbol{s} \cdot \boldsymbol{x}_i, v = \frac{1}{|\boldsymbol{s}|}$$

From the first four lines we get $t_0$ = 100.00 s and s = (0.24; 0.32; 0.30) s/m. The modulus s is equal to 0.50 s/m, so the speed is 2.00 m/s, and the unit normal is (0.48; 0.64; 0.60). For E, the model gives in advance 105.20 s. The remainder of the check line is 0.04 s. This sequence separates parameter determination from verification: if E is included in the initial fit, its subsequent agreement is no longer the same independent verification.

Let the standard uncertainty of each moment in the training calculation be equal to 0.02 s, the errors of the nodes are independent, and the uncertainty of the coordinates is still negligible. The prediction for E is expressed through the training labels as −1.2tA + 0.6tB + 0.8tC + 0.8tD. Therefore, the standard uncertainty of the forecast is about 0.035 s, and comparisons with observation E are about 0.040 s. The resulting residue is compatible with the model. These numbers characterize the synthetic problem; real general time corrections would require covariances.

Compatibility does not determine the nature of the front. A change in temperature, a normal propagating effect, and a supposed new field can create a similar order. The next series should test additional differences: response shape, relative sensitivity of heterogeneous nodes, and independent environmental cues. Real network searches also construct a specific spatiotemporal pattern and then constrain its parameters; the existence of such a search does not mean the discovery of its hypothetical object [65].

Before placement, the metrologist verifies that the expected delays exceed the uncertainty of the onset detection and that enough independent nodes will remain. The operator records the loss of a recording as a loss of observability rather than a missing edge. If the testing node fails, the result remains an estimate based on the training data. The geometric limitations of this reconstruction are discussed in chapter 17, and obtaining suitable time records is discussed in project 50.

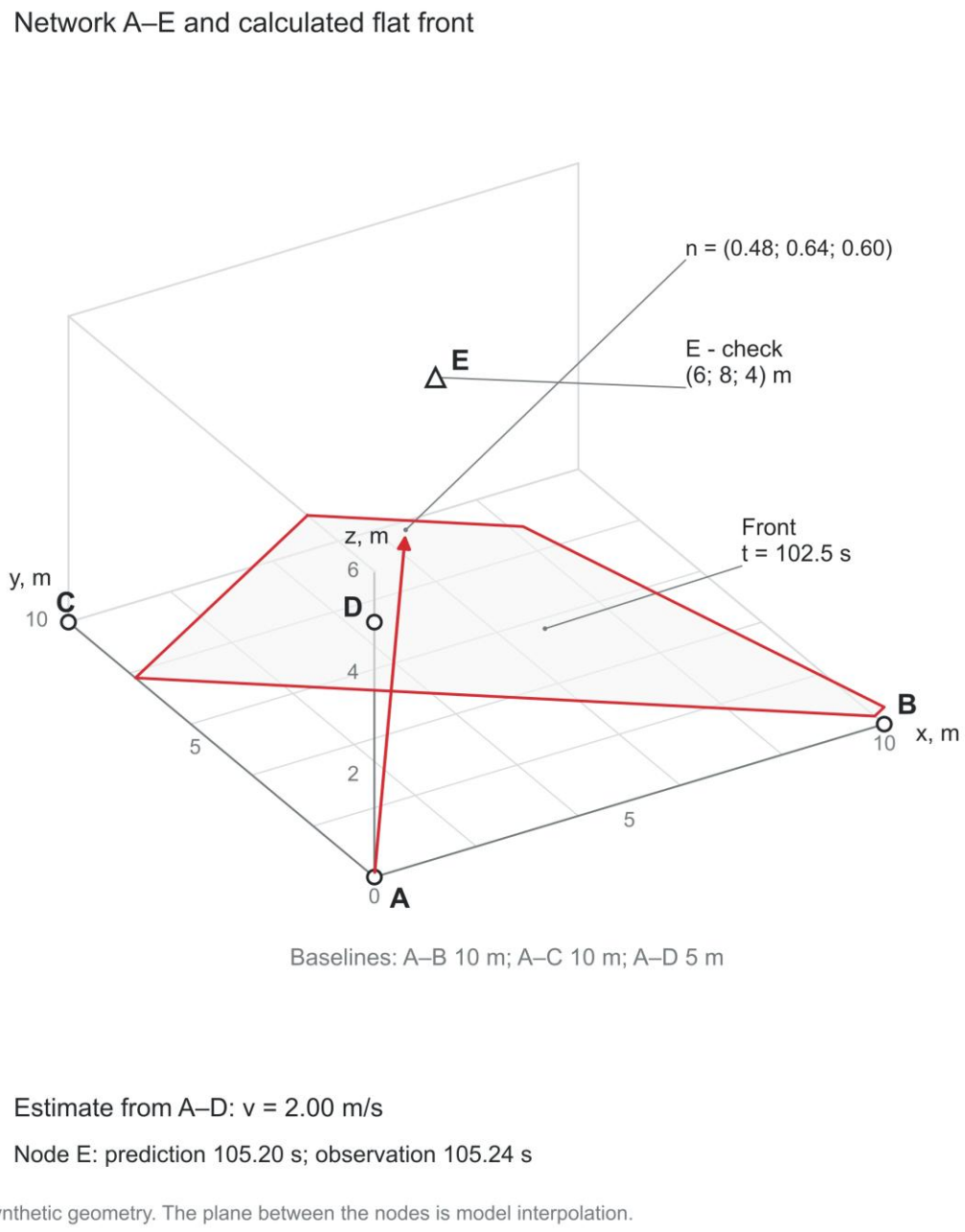



Figure 9. Three-dimensional network and validation node E. Geometry of the synthetic network A–E. Nodes A–D define a three-dimensional model of a planar front; E is held out to test its prediction. The calculated normal and the front's position at t = 102.5 s are shown. The axonometric view depicts the arrangement; the surface between nodes remains a model interpolation.

Chapter 14

# Repetition of events and supposed time loops

Repetition is a property of many common processes: rotation, oscillation, program looping, scheduling, and recording playback. The time loop assumption is much stronger. It asserts not only the similarity of two observations, but also a special connection between the states of the world and the order of events. Therefore, the study begins with determining what exactly was repeated: an image, a sequence of actions, readings from several instruments, or an accessible part of the physical state.

Literally identical files primarily indicate repeated output of the same data. Similar images with different source files may reflect a cyclic scene. The coincidence of several features does not mean the return of the entire system to its previous state. The broader the repetition statement, the more independent quantities it must cover. The word “exactly” is permissible only together with permission, tolerances and a list of compared characteristics.

### Three meanings of repetition

The first option is to repeat the performance. The camera, archive or interface again shows the already recorded fragment. The second is the return of the observed system to a similar configuration: for example, the mechanism completes the cycle. The third is a conditional model in which the trajectory of an event is closed in space-time. Navigating between these options requires additional data. The lost frame number is not intermediate evidence of the third option.

Even in the conditional model of a closed timelike curve, the observer’s own time along his local motion does not have to go backward. The unusualness concerns the global connection of events, and not the obligatory reverse rotation of the clock at each site. Consequently, the film image “all the hands moved backward” sets a separate physical scenario. It must be explained through the dynamics of mechanisms and stored records, and not taken as a definition of a time loop.

A special limitation arises when talking about the complete return of the world to its original state. If the state is indeed fully restored, the observer's memory and the recorder's state should also be restored. The surviving record of the previous cycle means that at least this medium did not return. The model must then explicitly indicate the persisting subsystem and its relationship to the rest of the process. This is a logical requirement for a testable statement, not a proof of the existence or impossibility of a loop.

Real time crystals are useful here as an example of the precise use of an unusual term. In one experimental implementation, a periodically excited ion system produced a stable subharmonic response [12]. The prohibition of certain time crystals in equilibrium refers to other conditions and the specific definition of [13]. None of these statements mean a repetition of an arbitrary historical event. The physical name describes the observed dynamics of the system.

### How to differentiate between versions

The author's verification scheme uses external registration and pre-selected features. External here is a record whose independence is justified by architecture, and not just by distance. If two cameras transmit data to the same server, the server buffer replay is able to play back consistently on both screens. An independent local counter and a separate archive allow you to check this channel, but do not guarantee independence from all environmental influences.

You should compare sequences, not just one spectacular shot. The permissible discrepancy, the duration of the fragment and the characteristics that should change during the normal course of the process are set in

advance. A new mark within the secure control record can help distinguish a replay from a replay of a scene. However, no label serves as a magical proof: you need to check when it was formed, where it was saved, and whether it could have gotten into both sets being compared in the same way.

The proposed training scenario illustrates the difference. Several monitors repeat the same person passing through the door, but the autonomous light recorder shows a continuously changing background. The frame match and the independent physical time series mismatch direct the check to the video path. If only human actions are repeated, and the noise, background and labels are different, the cyclical nature of behavior is investigated. This is fictitious data for test selection and not a report of an observed loop.

### Author's replay recording protocol

1. The data custodian blocks overwriting of the original fragments and preserves their origin, sequence numbers and checksums.
2. The metrologist determines signs of repetition and acceptable discrepancies before viewing new series; the operator captures the physical channels separately from the on-screen presentations.
3. The subject matter expert reviews buffers, schedules, hardware cycles, and common signal sources, articulating the expected differences in each version.
4. The manager compares new series with registered forecasts; changing the definition of repetition is formalized as a new research hypothesis.

A series is no longer used as a confirmatory series if the similarity criterion was selected after reviewing all the data or it is impossible to determine the origin of the record. If archiving fails again, the measuring system is restored, saving its erroneous state for analysis. If the event is accompanied by dangerous movement of objects, loss of orientation or disruption of communication, the safety coordinator stops approaching; The repeatability check continues only from a valid position.

A conditional loop remains a meaningful model only when it predicts differences that a simpler loop cannot and explains the fate of memory and data. An indefinite statement that moves the loop boundary to a new medium with each mismatch prevents the check from being completed. For scientific description, it is more important to maintain stable conditions of refutation than to come up with ever more inventive defenses of the original name.

Chapter 15

## Precognition and Retrocausality

Foresight can be formulated as an information problem: does the answer recorded in advance contain information about an event that has not yet been available to the responder in the usual way? Reverse causation is a stronger assumption about the mechanism. Even unusual predictive success does not automatically establish the direction of causation. It may depend on the pattern of the generator, data leakage, selection order, or analysis features. These capabilities become competing models when discriminative tests are specified for them.

Everyday stories usually do not contain the full range of possible outcomes. The coincident dream is remembered, but not all unfulfilled expectations; the description of the event is clarified after the event has occurred. Such a record may be significant for the history of the experience, but it is difficult to turn it into a quantitative test of the prediction. The research transition consists of recording the content, time, matching rules and the total number of attempts until the result appears.

### What specific tests showed

In the Transparent Psi Project, the protocol agreed upon by supporters and critics was tested in several laboratories. The valid set included 2 115 participants and 37 836 critical samples; the share of correct choices was 49.89% instead of the expected excess of the random level 50% [14]. This result relates to a specific task. It provides a reason not to reproduce the original statement as an established effect, but does not replace the testing of every possible form of premonition.

The 2025 paper examined the procedure in an additional three studies with 26 483 participants. The original prediction of success above chance was not replicated. The deviation below 50% found in the exploratory analysis of the first experiment was confirmed in the second, but was not reproduced in the third [15]. Therefore, the description of this work must maintain a distinction between the original hypothesis, the new direction of effect, and the subsequent test. The word "unusual" does not combine different statistical statements.

These results provide methodological lessons for future research. If the sign of the effect is changed after reviewing the data, a new hypothesis arises that requires a new series. It is impossible to simultaneously consider both a hit and a miss an advantage without a predetermined model. Otherwise, almost any deviation becomes a confirmation, and a coincidence with a random level is declared to be a hidden combination of opposing influences. Such a scheme loses its discriminative ability.

### Time order must be measured

The author's protocol separates the moment of decision, the moment of irreversible fixation of the answer, the time of target generation and the moment of its presentation. These four events cannot be replaced by a single screen animation. The program can show the stimulus later than it was selected, and the log can receive a timestamp after the recording delay. To verify the information order, a diagram of the actual data movement, including intermediate buffers and access rights, is required.

The unpredictability of the goal is also a verifiable property of the procedure. Choosing from a previously known sequence differs from forming after fixing a response. At the same time, cryptographic securing of a record only confirms its immutability relative to the chosen trust system; it does not in itself prove the moment of physical creation or the absence of leakage. A strong protocol combines independent records, access control, and a predetermined audit procedure.




Figure 10. When the target is generated and when it is presented. Two educational sequences of factual events. Late presentation on the screen is compatible both with the formation of the target after fixation of the response, and with the existence of the target before it. Buffer slices represent individual delay; the scheme itself does not establish reverse causation.

The unit of analysis can be a sample, a participant, or a laboratory, and these levels produce different questions. Many answers from one person do not equal as many independent participants. Likewise, different sites with the same program share some of the errors. Therefore, the report shows the distribution of results and the dependency structure, and not just the overall percentage. Particular attention is paid to excluded samples: if their removal is dependent on the response or result, the procedure can create an artificial bias.

### Author's order of confirmatory experiment

1. The manager and the subject specialist fix in advance the only main hypothesis, the direction of the effect, exclusion rules and the criterion for ending the recruitment.
2. The data custodian organizes irreversible recording of responses and a separate log of target generation; the operator does not receive the future target until the response completes.
3. An independent reviewer conducts control runs and audits of information paths without disclosing concealed results to the experimenter.
4. Statistical analysis is performed according to the registered rule; additional findings are labeled as exploratory and tested against new data.
5. The safety coordinator ensures that participation is voluntary and that the load is stopped in case of severe distress; the participant is not asked to make life decisions based on the perceived gift.

The procedure is stopped by violation of target concealment, the possibility of retroactive editing of the answer, ambiguous time order, and failure of inclusion rules. Data from such intervals is not deleted without a trace: it is stored with the reason for the exclusion and the impact of the violation is assessed separately. The interruption is considered neither a success nor a failure of the foresight hypothesis, since the main test under these conditions has failed.

Even a stable new effect would require consistent refinement of the mechanism. First, the reproducible information dependence is checked. Then - its preservation when changing the usual channels, the source of randomness and the procedure. Only then can causal models be compared. Reverse causation must make distinct predictions, such as dependence on time separation and the mode of target generation, that cannot be freely changed after each outcome.

The scientific outcome may be negative and yet meaningful: a certain procedure with known sensitivity did not support the claimed benefit. This conclusion sets the boundary of the further program. It frees the study from the need to defend a particular story and allows it to focus on which observations would actually change the assessment of unusual causation.

### Forecast as a pre-recorded distribution

For the supposed prediction, the space of possible outcomes and the rule for evaluating the forecast are first fixed. A phrase that is suitable for many future events has a different testing power than choosing one of the predetermined options. The protocol stores each forecast, its validity period, all acceptable outcomes and matching criteria. Expiration without an event remains in the set. Changes in interpretation after the outcome are recorded separately and are not included in the confirmatory indicator.

A conditional novel model may predict a small change in the probability of a correct answer, rather than an infallible knowledge of the future. The magnitude of change, reproducibility between new tasks, and procedure dependence are then examined. A distinction is made between transfer between formulations, transfer between participants and transfer between settings. The success of one transfer does not imply the others. The number of trials and stopping rule are set taking into account the expected effect size; the corresponding principles are set out in chapter 3.

The violation of chronology is a separate allegation. Even a reproducible relationship between a prediction record and a subsequent outcome requires verification of timestamps, target generation, leakage, selection, and complete workflow. If the order is unknown, the established statistical relationship in this procedure remains. To state its direction will require additional experience in which the usual routes of transmission are distinguishable and verifiable.

Chapter 16

## An Illustrative Model of a Local Change in the Rate of Time

A meaningful time domain model must relate clock readings to other measurements. The arbitrary assumption “everything is slow here” does not determine what an external observer will see, how the signal will pass through the border and what forces will be required to hold the device. The author's conditional model is introduced below. Its purpose is to obtain consistent, verifiable consequences, and not to describe the detected object or propose a device that creates such an area.

### Geometric Assumption

Let space-time be static and spherically symmetric, and the selected spatial sections have ordinary Euclidean geometry. Let's set the interval:

$$ds^2 = -c^2 N(r)^2 dt^2 + dr^2 + r^2 d\Omega^2.$$

The function N(r) determines the ratio of the proper time of a stationary observer to the general coordinate variable t. The angular part dΩ² describes the directions on the sphere. Flat spatial slices are part of the assumption here: the model isolates one effect and does not claim generality.

Let's choose a smooth profile:

$$N(r) = 1 + \varepsilon\ exp\left(-\frac{r^2}{L^2}\right),$$

where L is positive and ε is greater than −1. Then N does not vanish anywhere, but tends to unity far from the center. For stationary clock $d\tau = N(r)dt$. Positive ε means faster accumulation of proper time at the center relative to the distant standard; negative - slower. The positivity condition preserves the usual Lorentzian signature and eliminates the attempt to quietly obtain a time stop by substituting a forbidden value.

The known ability to compare potentials by clock shows the physical meaning of this rate ratio, but does not confirm the selected profile [8]. Here the parameters ε and L are still variables of the thought experiment. When a model is used to explain data, it is estimated on one set of measurements and then tested on another. Freely changing the width of the region after each unsuccessful observation would deprive the model of its predictive role.

### Implications for clocks, light, and retention

At one point, the same metric change acts on an ideal clock through the same duration of proper time. Therefore, the ratio of two different local atomic transitions with a constant ordinary environment remains the same. Between two fixed points the tempo ratio is $\frac{N(r_1)}{N(r_2)}$. This distinguishes a purely metric hypothesis from an effect that selectively shifts one transition or one type of oscillator. The difference cannot be sought only among devices of the same design.

Light is also included in the model. For a radial ray, the null-interval condition gives the coordinate velocity:

$$\frac{dr}{dt} = \pm cN(r).$$

This is not a change in the locally measured speed of light: in a small region, using a local clock, it remains c. The frequency compared by a stationary sender and receiver varies in the ratio of sender N to receiver N. Therefore, the model simultaneously predicts the clock difference and the corresponding frequency shift of the transmitted signal.

To send a ray from point R to the central reflector and back, the proper round-trip time at point R is:

$$T_R = \frac{2N(R)}{c}\int_0^R \frac{dr}{N(r)}.$$

Both the propagation and the tempo of the receiving clock are present in this recording. If you take into account only one of them, you get an artificial contradiction. In a real comparison, conventional optical media and hardware delays would need to be added to the geometric model; they cannot be declared part of a new effect without separate justification.

Keeping the device stationary also has a cost. In the model, the value of the required proper acceleration is equal to:

$$a = c^2\left|\frac{d\ ln\ N}{dr}\right|.$$

Therefore, the sharp spatial tempo difference is associated with dynamic prediction. For example, with conditional $\varepsilon = 10^{-15}$ and L = 10 m, the central clock per day is ahead of sufficiently distant ones by approximately 86 picoseconds, while the maximum holding acceleration is of the order of 8 m/s². This is a model calculation, not an experimental result. It shows why a small relative temporal effect cannot be assessed separately from its spatial gradient.

### Checking compatibility with observations

The proposed check compares three groups of data at once: comparison of dissimilar clocks, delays and frequencies of signals, mechanical signs of the required retention. Parameters that are suitable for one group should explain the others within the limits of uncertainty. If the clock shows the predicted profile, but the corresponding dynamic effect is excluded by sufficient sensitivity, the model is rejected. This is not a reason to arbitrarily disable an inconvenient consequence or declare it hidden.

1. The metrologist determines the acceptable range of parameters from the source data and calculates distinguishable forecasts for independent channels.
2. The subject matter expert checks the usual mechanical and environmental explanations; The operator receives only tasks for safe remote measurement.
3. The data custodian separates the fitting set from the validation set; The manager fixes in advance the conditions for the incompatibility of the model with observations.
4. The safety coordinator stops the approach if there is unexpected acceleration, movement of the base, or loss of a secure position for the equipment.

Mathematical smoothness does not yet make a region physically feasible. Substituting the metric into the Einstein equations determines the required energy and stress tensor; Below this calculation is brought to the verification of energy conditions. The physical mechanism of formation and the stability of the source remain independent questions. The choice of function N does not itself provide the substance that creates it. Here t preserves the global temporal order; the model does not contain a time loop and does not explain the return of information from the future.

Intervention is limited to testing the implications of the model and eliminating identified instrumental causes. Designing "time alignment" requires a reproducible channel of influence, which is not established here. The value of the model lies in the associated predictions for clocks, light, and holding forces: these can be compared with measurements, constrained, or rejected.

### Source of selected metric

For this model, the question of the source can be taken to a concrete result. Retain the standard equations of general relativity and set the cosmological constant to zero. The specified geometry then determines the full stress-energy tensor required. This concerns the source that would be needed to maintain the profile, rather than a substance that has been discovered. The full calculation appears in Appendix H.

In the local orthonormal frame of a stationary observer, we denote the energy density by ρE, the radial pressure by pr, and the same pressures in two transverse directions by pt. All three quantities have the dimension of energy per volume; for pressure it is pascal. Derivatives of N are taken with respect to the radial coordinate. This results in the following source:

$$\rho_E = 0, p_r = \frac{c^4}{4\pi G}\frac{N'}{rN}, p_t = \frac{c^4}{8\pi G}\frac{N'' + N'/r}{N}$$

Zero energy density here does not mean the absence of a source: non-zero stresses also contribute to Einstein's equations. This result is associated with a particularly stringent assumption of the model—flat spatial geometry on selected static sections. If you allow the spatial part of the metric to change, the requirements for the source will become different. Therefore, the resulting conclusion relates to the entire recorded profile and not to any method of creating a clock difference.

Substituting Gaussian N gives finite pressures at the center. Their common limit is $-c^4\varepsilon/[2\pi G L^2(1+\varepsilon)]$, and far from the center all components of the source tend to zero. For training $\varepsilon = 10^{-15}$ and L = 10 m, the central pressure magnitude is about $1.9 \times 10^{26}$ Pa. The smallness of the relative time shift is therefore not

equivalent to the simplicity of the material source. In the same example, the maximum holding acceleration of about 7.71 m/s² occurs at approximately r = 7.07 m; at the very center it is zero.

The null energy condition requires that the sum of energy density and pressure along each spatial direction be non-negative. For positive ε the radial sum is negative. For negative ε, which remains greater than −1, the transverse sum in the region r greater than L becomes negative. This means that for any non-zero ε, the chosen model requires violation of this condition somewhere. When ε = 0 the source disappears and flat space-time is obtained.

This conclusion limits the physical interpretation, but is not a universal theorem about the impossibility of time domains. Quantum limits on negative energy contributions depend on the field and geometry being considered; the applicability of a particular quantum source would have to be proven separately [27]. A formation model and sustainability analysis would also be required. The conditional metric now receives a more precise status: it coherently relates observations while simultaneously making a strong and explicitly calculated claim on its source.

When checking data, this requirement is added to the connections between clocks, light and mechanics. The proposed region cannot be declared realized just because one frequency curve is similar to a Gaussian one. On the contrary, the disagreement of an independent mechanical channel is already capable of rejecting a given geometry, as in the 3 case, without waiting for the solution of the entire problem of admissible matter. The researcher has two different avenues of verification: observational consistency and theoretical feasibility of the source.

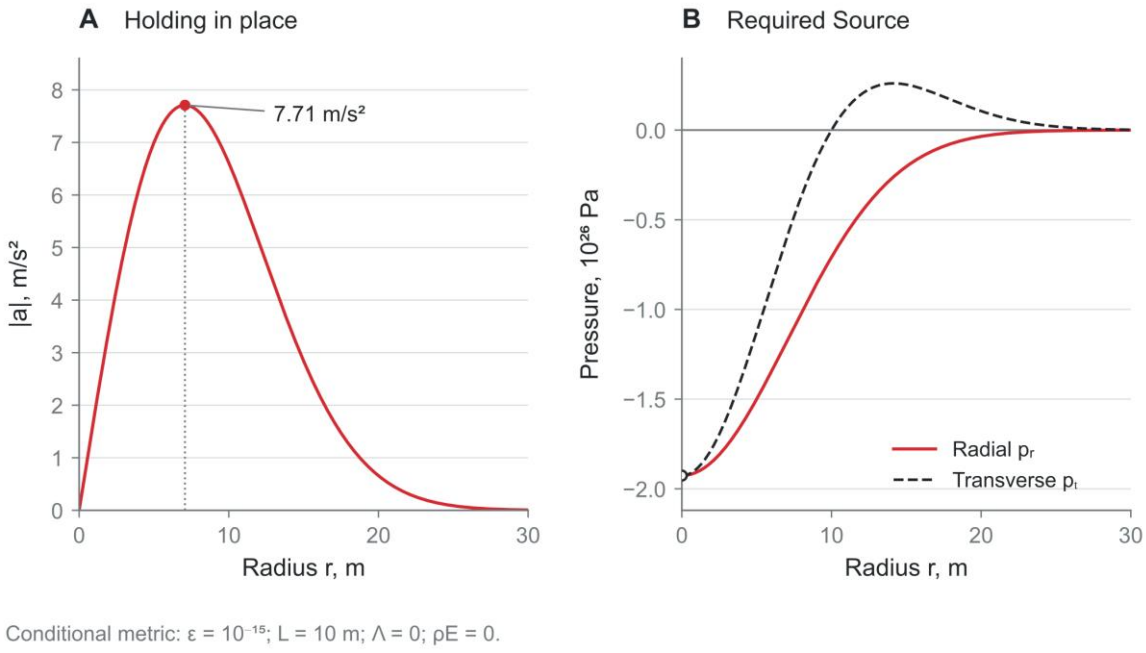



Figure 11. Holding acceleration and required stresses. Calculation of the conditional metric for ε = 10⁻¹⁵ and L = 10 m. The maximum modulus of the holding acceleration is at r ≈ 7.07 m and is about 7.71 m/s²; At the center the acceleration is zero. Radial and transverse pressures have a common finite central limit. The source refers to the selected static geometry of general relativity with Λ = 0 and ρE = 0; This is a calculation within the assumed model, not observational data.

Part IV

# Space and new interactions

Chapter 17

## Geometry of space and optical paths

Spatial discrepancy is detected not directly, but through a trace: image, range, direction, time of arrival or position of an object on the map. Between the object and the final picture are the propagation medium, the sensing element and the reconstruction algorithm. Therefore, the study of the SP class first establishes at which link the discrepancy arose. The changed appearance of a room and the changed distance between its walls are different statements, even if the observer describes them in the same words.

The geometric path length consists of the spatial elements ds. The optical length in a simple stationary medium has the form $\int n(s)ds$, where n is the refractive index. Measuring the phase or propagation time is related to the second quantity and requires knowledge of the properties of the medium; For impulses, the corresponding group response is essential. Equating such a result to geometric length without a propagation model in advance creates the possibility of a false spatial interpretation.

### Different channels show different properties

Mirages provide an established example: the distribution of the refractive index in air changes the paths of light, creating displaced, inverted, or multiple images of real objects [16]. The description of this mechanism does not allow any split image to be declared a mirage. The specific case will require the observer's position, scene geometry, and environmental conditions. A scientific explanation must reproduce observed features, not simply suggest a familiar word.

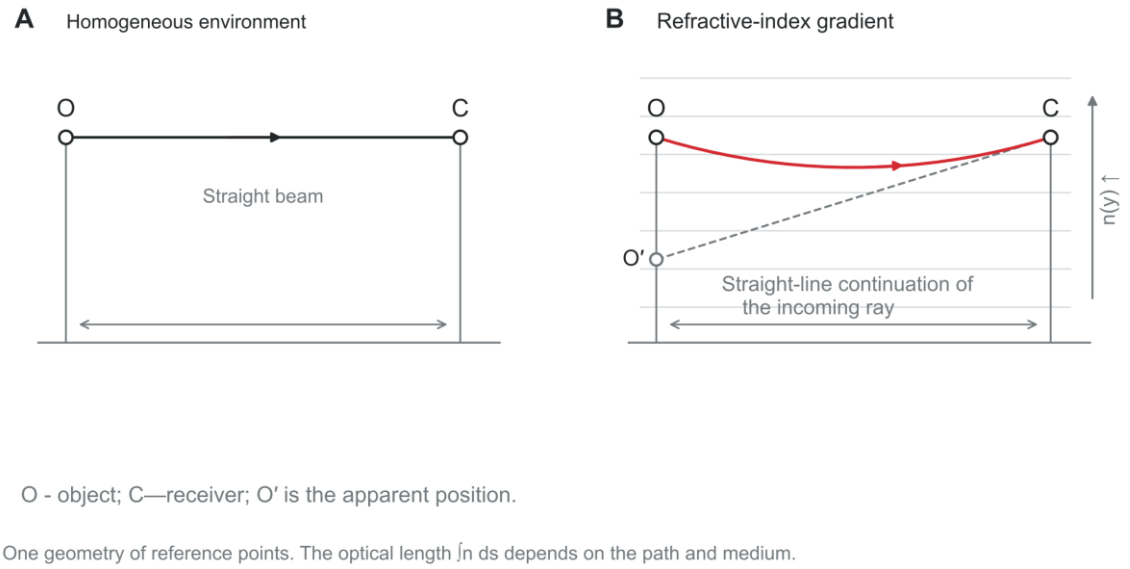



Figure 12. An unchanged scene and a changed path of light. Calculated training scene with constant positions of object O and receiver C. On the right, the beam is calculated for a dimensionless synthetic profile n(y) = 1.2 exp(0.12y); the reverse straight-line continuation gives the apparent position O′. The gradient is chosen for clarity and is not a reconstruction of a real mirage. The distance between the fiducials, the beam length and the optical length ∫n ds are different.

In radar, there are also conditions in which the propagation of the beam creates marks that are falsely similar to the targets being examined [17]. In addition, reflected paths can generate false moving objects; this was considered and tested on data from a specific automotive radar system [18]. Such examples show the diversity of mechanisms. The coincidence of optical and radar unusualness requires a joint model, since both channels interact with the environment, albeit in different ways.

Each spatial result must be associated with a coordinate system. The camera measures directions relative to its own orientation; rangefinder - path to the selected reflection; satellite receiver - solving a problem based on incoming signals. Transferring these results to one map requires transformations, timing coordination, and error assessment. Incorrect camera orientation can create an apparent acceleration of the target, and inconsistent viewing moments can create a false discrepancy in the position of a moving object.

### Closing the measuring circuit

The author's scheme of spatial control is built around stable reference points and redundant connections. The same mutual configuration is measured from several directions and, where possible, by different physical methods. Re-closing the loop helps detect inconsistency. But the remainder of the closure is not a universal indicator of space curvature: it depends on the geometry model, the deformation of the base and the properties of all measuring lines.

The independence of methods is assessed based on general assumptions. Two programs processing the same frames provide a check of the calculations, but not a second observation of the scene. The two optical systems share some of the propagation conditions. A contact standard could provide a different type of comparison, but its use is only permissible on an already accessible safe surface. The opportunity to obtain a more direct measurement is not a reason to cross an unsurveyed border.

It is useful to save three layers of the result: initial readings, geometric reconstruction and visualization. The latter often features anti-aliasing, interpolation and automatically filled surfaces. These operations make the map useful, but can hide gaps. Each constructed surface must have an attribute of origin: directly measured, reconstructed by a model, or added as a graphical guess. An unmeasured span cannot be drawn as a confirmed corridor.

Case study: a cavity appeared in the rangefinder profile that was missing on the building plan. The test must distinguish between a real depression, a reflection from a transparent surface, an incorrect position reference, and a model error. If the cavity disappears after changing direction, this is not an explanation, but it is a useful sign. If it is preserved in an independent geometric survey and confirmed by an available structural survey, the issue moves from optics to structural investigation.

### Author's spatial verification protocol

1. A specialized specialist describes the coordinate system, benchmarks and permissible changes in the foundation; a metrologist evaluates the uncertainty of transformations.
2. The operator stores the original measurements, instrument position and orientation, environmental conditions and operating mode, without being limited to the finished map.
3. The team pre-selects reference lines and repeat views that differentiate hypotheses about geometry and distribution.
4. The data custodian labels the interpolated areas; The manager compares version forecasts with new measurements.
5. The safety coordinator prohibits movement in an area for which the map remains ambiguous; the mode returns to remote monitoring.

The measuring series is stopped when the reference point is lost, the orientation is unclear, or the mode is changed without registration. If the scene changes faster than sequential acquisition, static reconstruction becomes unusable and a temporal model is required. Continuing to accumulate inconsistent points will only increase the apparent detail of the erroneous map. The criterion for quality is the consistency of observations under the disclosed assumptions, not the density of the image.

The transition to the unusual geometry hypothesis is possible after the remainder has been determined relative to a specific model and has survived tests of significant alternatives. This result may still have several explanations. The purpose of the chapter is to provide a language in which these explanations are compared: length, direction, delay, frequency, coordinate relationship, and uncertainty. Without this language, the expression “the space has changed” remains the name of the impression.

### Network geometry and the uncertainty of a moving boundary

In the network example of chapter 13, the four training nodes do not lie in the same plane. This is significant: the moment $t_0$ and the three components s are unknown, so the measurement matrix must have four independent columns. Several nodes at one point give repeatability, but not geometry. If all positions are on the floor, the vertical component s remains undefined. The speed reconstructed in the plane is then not the full speed of the three-dimensional front.

In this example, the matrix has rows $(1; x_i; y_i; z_i)$. For A–D, its spatial part defines three independent bases: 10 m along x, 10 m along y and 5 m along z. Therefore, the components s are found directly from the time differences. Given the same label uncertainty, a short vertical base gives a worse estimate of the corresponding component. Increasing the number of nodes is useful if it adds a new direction or tests a prediction, rather than just densifying an already degenerate configuration.

The common label A is included in all three differences. Therefore, the errors of the found components are correlated, although the original clocks in the training example were considered independent. Taking this connection into account, the standard velocity uncertainty of the four training times is about 0.022 m/s. This is the result of the propagation of specified errors, and not a characteristic of the actual device. Adding coordinate uncertainties, signal extraction delays, and support motion changes the budget and usually degrades the estimate.

$$u^2(t_i) = u_{\mathrm{time,i}}^2 + \boldsymbol{s}^T \boldsymbol{C}_{x,i} \boldsymbol{s}$$

The last entry shows the geometric contribution when position and time errors are independent. The matrix $C_x$ describes the uncertainty of the node coordinates. If the errors are common or the position is estimated from the same signals, the corresponding cross terms are added. The formula also shows why one cannot assign the same allowable distance error to all speeds: the same spatial uncertainty affects a fast and a slow process differently.

Test node E should be selected before viewing the event. Its purpose is to test the front shape, expected delays, and the applicability of the reconstructed geometry. The remainder may arise due to boundary curvature, acceleration, another form of local response, or a specific node error. Therefore, the noticeable discrepancy initially rejects the simple model of plane uniform motion. It does not prove unusual topology and does not automatically introduce a new independent correction for each station.

The physical prototype of the network is first tested on a known, safely produced moving front or on synthetic time series, explicitly separating the two qualifications. The software check tests geometry restoration; the real image additionally tests the sensors and the start selection rule. If placement along the third coordinate is not available, the result is fairly limited to a flat reconstruction. A useful map shows observed front crossings and the area of uncertainty between them; the smooth surface in the illustration retains the status of model interpolation.

Chapter 18

## Checking for unusual connectivity and spatial transitions

The supposed spatial transition represents a stronger statement than image distortion. It concerns the accessibility of a path between regions: can a signal, an object, or an observer end up at another point in a way that is not explained by the known configuration of the environment? Different transfer types cannot be combined. An optical channel does not prove passage for matter, data transmission does not prove movement of a source, and the absence of a visible path does not prove the absence of a hidden conventional path.

In this chapter, spatial transition is considered as a conditional model. The real challenge begins with recording unexpected connections between points. A statement about a portal is not accepted as a ready-made description of an object. The first step is to establish what is being transmitted, where the signal is generated, where it is registered, and what alternative routes remain possible. This allows an unusual case to be examined without having to decide in advance about its ultimate nature.

### Description of connections instead of an image of a door

A useful map is where nodes represent available positions and links represent observed transmission channels. For each connection, the type of signal, direction, delay, conditions of occurrence and confidence in the origin are indicated. Such a map may contain an unexpected edge between two regions,

but the graph of observed connections is not yet the physical topology of the space. A hidden cable, reflection, common transmitter, and computational error are capable of producing a similar recording.

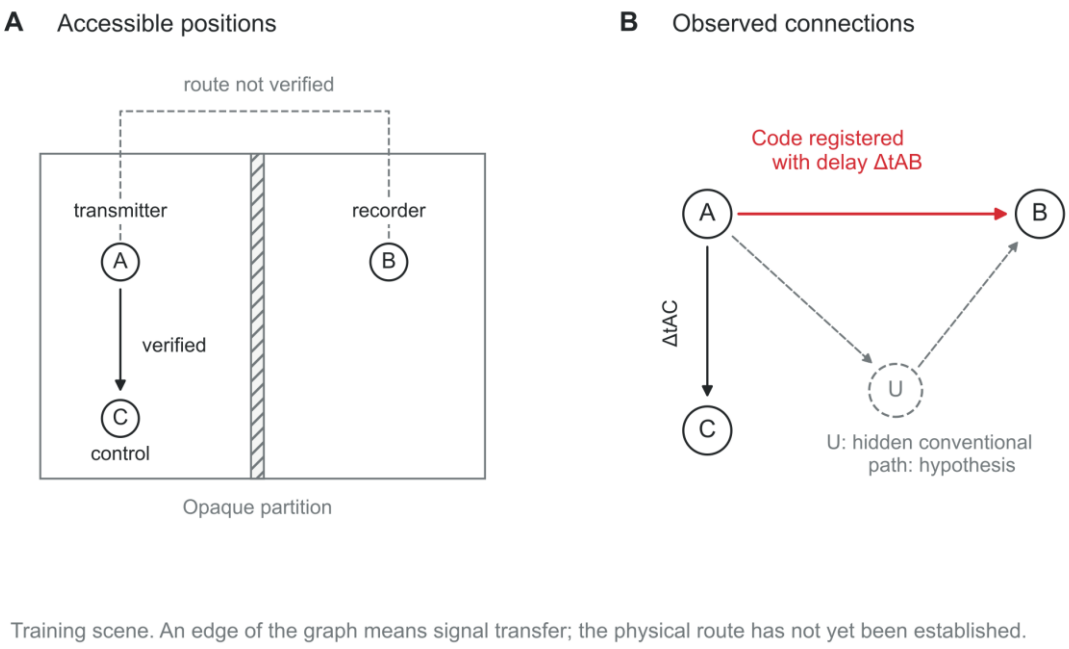



Figure 13. Observation plan and graph of registered connections. Curriculum and graph with general numbering of positions. The solid edge A–C denotes the verified conventional connection, the scarlet A–B the registered code transfer with delay ΔtAB. The dotted route through U remains a version of the hidden regular route; its position on the graph does not define the geometry. Such an entry does not establish a passage for matter or a new topology of space.

The unusual relationship must appear in the properties that are pre-selected for testing. If the protected test code changes, the logged sequence must change consistent with its actual origin. If channel directionality is expected, check it in the permitted configuration. If a shortcut is claimed, the delay is measured regardless of the algorithm that determined the coordinates. Each such check applies to the channel, and not automatically to the entire intended transition.

Particular care must be taken to distinguish between state transfer and object transfer. In the quantum teleportation protocol, the unknown state is reconstructed using entanglement and the classical message [19]. It does not follow from this that the material body moves through a hidden door. A term may be technically correct in its field but misleading when applied to the everyday scene. The case record therefore records the physical content of the operation, and not just its name.

### What can distinguish between the ordinary and the extraordinary path?

External measurements should cover the intended entry, intended exit, and possible normal routes. Complete exclusion of all conceivable paths is practically unattainable; instead, a set of significant versions is generated and the available control sensitivity is estimated. For example, the absence of a signal at an intermediate sensor is only meaningful if that sensor has a proven ability to record the intended normal path. An empty entry without such a check does not close the alternative.

In the training scenario, two points register the same variable light code, although there is an opaque partition between them. The first meaningful conclusion is the presence of an unexplained optical channel under these conditions. It does not yet establish a change in space. Discrimination checks concern

transmitter and recorder independence, reflective surfaces, apertures, program repetition, and time order. This example is fictitious and intended for the logic of the study.

A separate task is changing the channel itself over time. A conditional connection can appear only under a certain orientation or state of the environment. Then you need to determine the observation window in advance and record all unsuccessful attempts. Selecting only lucky coincidences can create the impression of a stable passage of rare random events. The boundary of the intended area should also be the result of a measurement with uncertainty, rather than a line drawn from several impressions.

### Author's connectivity test protocol

1. The study director formulates a minimal transfer statement and prohibits discreet expansion to substance or person transfer.
2. The metrologist and subject specialist build a map of the observed channels and conventional alternatives; the operator maintains synchronous independent registration of available positions.
3. The data custodian stores the origin of the control sequences and all attempts, including failure to register.
4. Control actions are applied only within the limits of the already established safety of equipment and environment; approaching an unknown boundary is not a necessary step.
5. The safety coordinator stops the check if the position of the equipment, communication or observation of an accessible part of the installation is lost.

The loss of registration near the expected boundary does not mean the disappearance of the device. First, a distinction is made between power failure, channel loss, leaving the field of view, and a real change in position. A cable, beacon, or self-contained storage device provides additional information, but may itself introduce communications, load, and the overall cause of failure. Their use is justified as part of the study design and not as a universal defense against unknown geometry.

Some theoretical models allow traversable connections under special conditions [20]. However, the correspondence of one external feature to a mathematical image does not determine the entire model. Meaningful comparisons will require consistent predictions about delays, frequencies, motion, and energy conditions. Until this point, the correct result remains the characteristic of the observed channel. A verified unusual connection would be a significant discovery without the premature promise of an accessible spatial passage.

Chapter 19

## Gravity and inertial deviations

The gravitational anomaly in a measurement sense represents the deviation of the field from the chosen model. Such a deviation may indicate the distribution of normal mass. Inertial disparity refers to the motion and forces in the chosen frame of reference. These two languages are related, but not identical to any accelerometer reading. To investigate the GF class, it is necessary to first establish what is being measured: gravitational acceleration, supporting force, field gradient, or platform motion.

The accelerometer, mounted on a support, responds to the proper acceleration of its sensitive element relative to free movement. During free fall, its reading may approach zero, although the gravitational field has not disappeared. The scale measures the force of interaction with the support; a change in this force also does not determine a single cause. Therefore, the phrase “the device has stopped seeing gravity”

requires clarification of the device and conditions, otherwise mechanical unloading will be mistaken for a change in gravity.

### Field, Gradient and Source

A gradiometer compares the field at separated positions. It is sensitive to spatial changes in acceleration, rather than only its mean value. In one study, a field-deployable atom gradiometer detected a tunnel; the authors reported a statistical uncertainty of 20 E and a signal-to-noise ratio of 8, where E denotes $10^{-9}$ $s^{-2}$ [21]. These quantities characterize that particular demonstration. They do not specify a universal detection range for every cavity or sensitivity under every mode of movement.

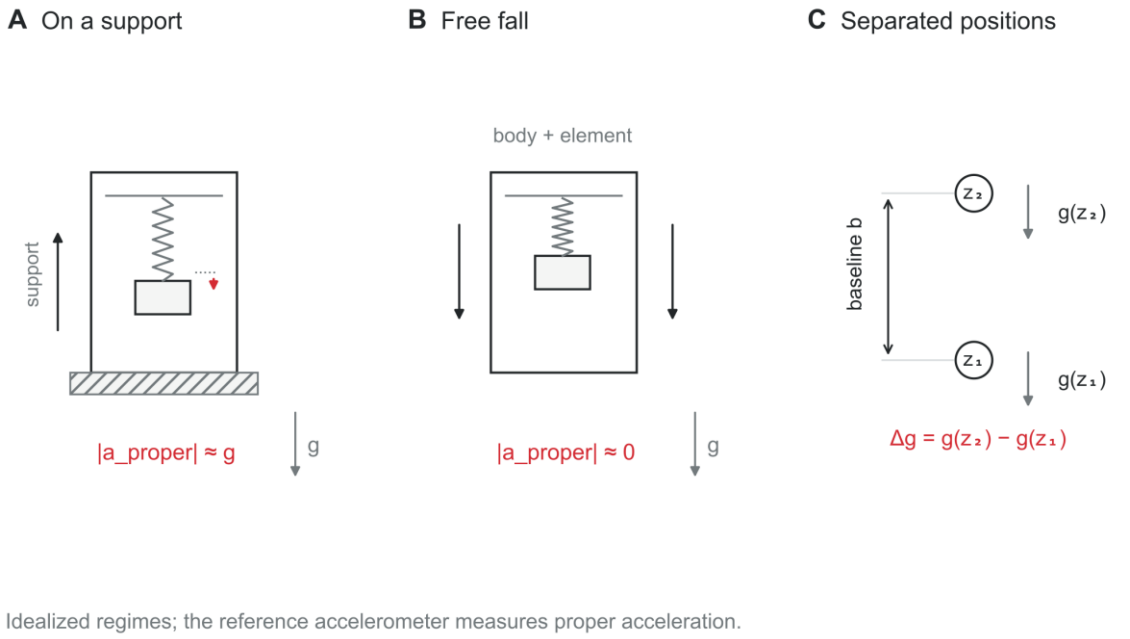



Figure 14. What do the reference accelerometer and gradiometer measure? Three idealized diagrams of the measurement principle. On a fixed support, the sensitive element experiences the action of connection with the body; in a joint free fall, the proper acceleration tends to zero, although the gravitational motion is preserved. The spaced comparison gives Δg based on b and requires taking into account the movement of the platforms. The sketch does not reproduce the design of a specific gradiometer and does not specify its sensitivity.

Even a good field map does not uniquely identify the source. Different density distributions may produce similar external gravity data; geological information and independent methods narrow down the [22] solution set. Therefore, the model of an underground object must include uncertainty in size, depth and density. An overly detailed picture, built without sufficient restrictions, creates a false sense of direct observation.

Gravity measurements also require taking into account changes in surrounding masses, height and movement of the base. In this study, the position of equipment, vehicles and other noticeable sources are recorded if they can affect the expected signal level. Not every small shift is a new interaction. But the mere mention of possible transport does not explain the remainder: it is necessary to check whether a specific source could provide the corresponding sign, scale and temporal form.

### Separation of gravity from other forces

An object held without visible support does not necessarily exhibit a weakening of gravity. For example, the diamagnetic force in a suitable inhomogeneous field is capable of balancing the gravity of [23]. A general principle is important for research: equilibrium means a balance of acting forces, and not the disappearance of one of them. In an unknown scene, electromagnetic, mechanical and aerodynamic connections are first established without reproducing a potentially dangerous configuration using our own means.

The discriminative program can compare the response of several control objects, but only in a validated safe test bench. Dependence on conductivity, magnetic properties, shape or surface area helps to identify common interactions. The gravitational interpretation, on the contrary, must be consistent with the corresponding model of motion for different bodies after taking into account other forces. A single match is not considered a definitive test: material and geometry can change multiple properties at once.

If the source is unknown and cannot be safely placed on the bench, observation and monitoring of natural variations is preferred. Determine whether the signal is related to the movement of the object, the tilt of the device, or environmental conditions. Unreasonably introducing heavy masses, powerful fields or vibrations can change the scene itself and create new risks. Research management here is about selecting discernible passive cues rather than increasing exposure for the sake of response.

### Author's protocol for comparing forces

1. The metrologist describes the physical response of each instrument and converts the readings into comparable quantities without confounding acceleration, force, and gradient.
2. The profile specialist builds a model of known masses and motion; the operator records the tilt, vibration and configuration of the installation along with the main row.
3. The team repeats the available profile and control line, checking whether the remainder follows the location, instrument, or source condition.
4. The manager selects the next test based on the difference in forecasts; The data custodian stores all amendment versions and excluded intervals.
5. The safety coordinator stops working if there is unexplained movement of the support, loss of stability, or the device goes beyond the diagnostic range.

A numerical result requires a budget that distinguishes between repeatability and bias. A small spread of multiple measurements does not eliminate a constant bias, shared temperature drift, or incorrect height. In addition, adjacent spatial profile points may share the same geolocation error. Increasing the number of points improves the description of the shape only to the extent that their dependencies and real spatial resolutions are known.

The author's limit for accepting the result is formulated in advance. The residual must exceed a reasonable range of uncertainty, persist in the reconfiguration, and not disappear after the identified normal cause has been corrected. If only the first conditions are met, the case remains open. It does not automatically receive a geological or fundamental explanation. A useful report shows which versions are limited by the data and which have not yet been discerned.

The chapter on gravity thus completes the transition from impressive movement to physical comparison. The observed rise, fall, or change in weight becomes a problem of forces and trajectories; the spatial remainder is a problem about field sources. Only on this basis can a new interaction be discussed, which will be discussed further through measurable parameters and coordinated responses of various systems.

Chapter 20

# New fields and changes in fundamental parameters

A new field becomes the subject of measurement when its connection with the observed system is proposed. The field name itself does not determine the instrument readings. It is necessary to indicate what is changing: transition energy, strength, decay rate, optical property, or other measurable relationship. Then you need to associate the change with the magnitude of the field and separate it from the normal environment. Without this, the “detector of the unknown” registers only its own deviations, which have not yet been given a physical interpretation.

The fundamental parameter also cannot be discussed separately from the comparison procedure. The numerical value of a dimensional quantity depends on the units. Therefore, a statement about a change in a constant requires operational content: what dimensionless ratio has changed and what elements of the measuring system are accepted as unchanged. This difference is highlighted by Duff's theoretical work [24]. The practical implication is that relationships need to be measured and patterns revealed, rather than prohibited from examining any possible changes to the laws.

### Differential response

The ratio of the frequencies of two transitions is convenient because different transitions may depend differently on the assumed parameter. In the linear approximation, a small relative change in the ratio is represented by the sum of the relative changes in the parameters multiplied by the sensitivity coefficients. These coefficients relate to a specific physical model. If both systems respond in the same way, the relationship will not change: lack of response then limits the mode of observation chosen, and not necessarily all forms of influence.

The BACON optical clock network compared the frequencies of different atomic systems and used the data to constrain a specific ultra-light field model, [25]. In another work, a quartz oscillator was compared with rubidium and dysprosium transitions, obtaining constraints on specified interactions [26]. These studies provide a sample problem formulation: first the sensitive systems and coupling model are known, then the data are converted into parameter constraints. They do not imply the existence of a universal sensor of all unknown fields.

The main difficulty is distinguishability. If one observed relationship depends on three unknown parameters, an infinite number of combinations can produce the same result. Adding a second device only helps when its dependence is truly different. Two identical sensors with the same temperature sensitivity can confirm the repeatability of the signal while maintaining an unresolved ambiguity between the new field and the overall heating.

### Forecast matrix

The author's program builds a table of expected responses. The rows correspond to the measuring channels, the columns - to significant hypotheses: a certain field, temperature, magnetic influence, mechanical deformation, reference oscillator error. For each column, the sign, relative scale, and characteristic time dependence are specified where they are derived from the model. An empty cell represents unknown rather than zero response. The new configuration is chosen to distinguish between the most similar columns.

The actual frequency band must be included in the forecast. Slow drift, short pulse and steady oscillation pass through averaging, servo and recording differently. If the expected effect is shorter than the integration interval, the instrument may show only a weakened average trace. If the frequency lies outside

the operating band, the lack of detection does not give the expected limitation. Therefore, the sensitivity limit is indicated along with the shape and duration of the signal being tested.

Correlations require separate analysis. The A/B and C/B ratios contain a common denominator, so a fluctuation in B will create a consistent change in both series. Such agreement is not two independent evidence of a new field. It is useful to add test links and preserve the original frequencies whenever technically possible. The processing architecture is also important: the general correction algorithm is capable of transferring one artifact to all resulting channels at once.

### Author's interaction search protocol

1. The study director records the attitude being measured and the specific pattern of association; a specialized specialist sets the coefficients and scope of applicability.
2. The metrologist compares the forecast with the actual band, noise and systematic shifts; indistinguishable parameters are combined or excluded from the declared result.
3. The operator maintains the master and environment records, and the data custodian stores the raw channels and correction history.
4. The analysis is checked on synthetic signals separately from the calibration of physical sensors; the final prediction is tested on a held-out series.
5. When changing the model after reviewing the data, the manager puts the result into exploratory mode and assigns a new confirmatory test.

The reason for the stop is loss of sensitivity in the desired band, saturation, unknown mode change or destruction of channel independence. It is impossible to continue calculating the parameter boundary using such a series: the beautiful number will refer to non-existent measurement conditions. Safety is determined by the identified physical impacts, not by the intended field name. An unexplained signal is not a reason to increase the energy of impact on the object.

If the predicted signal is not found, the result is formulated conditionally: for a given model, frequency range and analysis rules, parameters above a certain limit are incompatible with observations at the accepted level of confidence. If a signal is found, its robustness to the independent configuration is first checked. Only the combination of correct timing behavior, relative responses, and reproducibility allows discussion of a specific new mechanism.

Control of a new field does not automatically follow from its discovery. An intervention requires a distinct relationship between the regulated intervention and the measured outcome, including reversibility and possible side channels. Sometimes only observation is available. This is a full-fledged scientific result: the device can set limits and help build theory long before the advent of technology capable of changing the process under study.

### Explicit additional force model

It is convenient to build a specific search program on the additional interaction of the Yukawa form. For two point masses, we introduce the potential below. α is the dimensionless relative strength of the additional interaction, λ is the positive length of its action, and r is the distance between the masses. This is a family of testable alternatives, rather than a statement that a selected interaction has been found. When α = 0 Newton's law returns.

$$U(r) = -\frac{G m_1 m_2}{r}\left(1 + \alpha e^{-r/\lambda}\right)$$

The radial force is obtained by differentiating the potential. The additional factor 1 + r/λ is significant: multiplying the Newtonian force only by the exponential would give a different law. For positive α, the additional interaction is attractive; the sign of the radial component below is assumed to be positive from the source.

$$F_r = -\frac{G m_1 m_2}{r^2}\left[1 + \alpha\left(1 + \frac{r}{\lambda}\right)e^{-r/\lambda}\right]$$

The form of the law determines the choice of distances. At distances significantly greater than λ, the additional interaction is suppressed. At a narrow set of small distances, it may be difficult to distinguish as the force scale changes. Therefore, a series covering the area of expected shape change is useful. Independent knowledge of masses and distances is included in the test along with the measurement of force. If the position of the source is allowed to change arbitrarily each time, the accuracy of the sensor itself will not restore the distinguishability of α and λ.

### Extended bodies and measured torque

A real installation contains volumes of matter. For them, the potential is added up over pairs of mass elements. In the model below, the densities and integration regions are specified by the measured geometry; the distance R refers to a pair of elements within different bodies. For a torsion device, the observed torque is obtained by changing this energy when turning through an angle φ.

$$U = -G\int_{V_1}\int_{V_2}\frac{\rho_1(\boldsymbol{x})\rho_2(\boldsymbol{x}')}{R}\left(1 + \alpha e^{-R/\lambda}\right)d^3x\,d^3x'$$

$$M_\varphi = -\frac{\partial U}{\partial \varphi}$$

The distance between surfaces cannot be substituted for r in the point-mass model without transformation. The distribution of density, the shape of the suspension and the movement of the center of mass when turning are also significant. Numerical calculations are checked on simple geometries and when refining the partition. This is an independent part of the measurement model. In the actual work of Lee et al., the observed torques were compared with the geometry calculation and constrained the additional interaction; agreement with ordinary gravity became the quantitative result of [66].

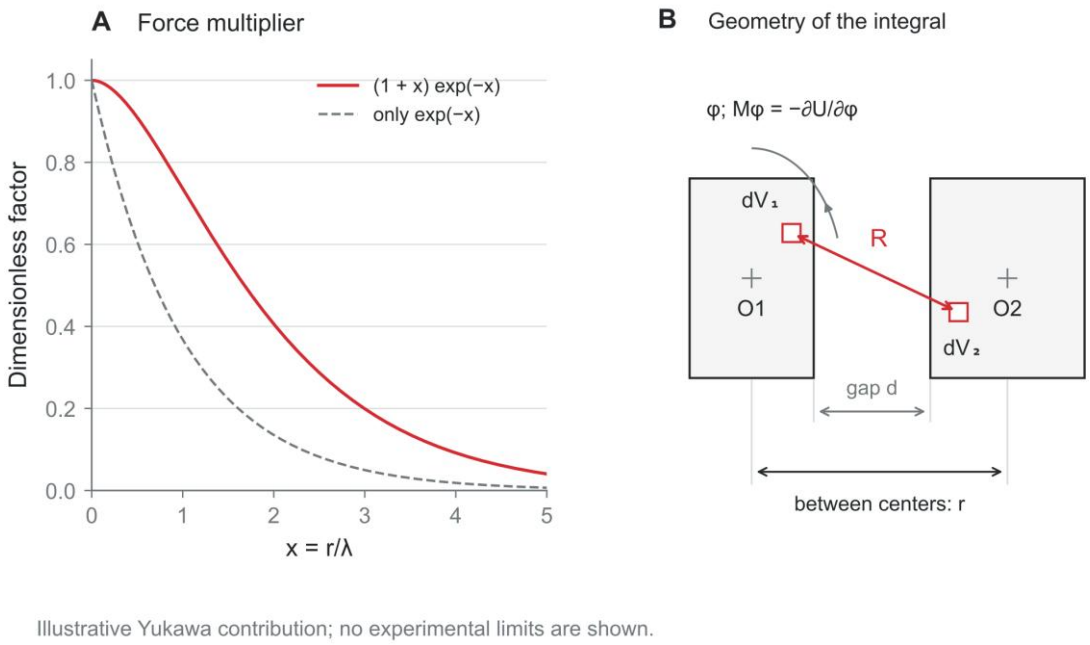



Figure 15. The form of additional force and the geometry of extended bodies. On the left, the factor (1 + r/λ) exp(−r/λ) arising in the additional force when differentiating the Yukawa potential is calculated; one exponential is shown for comparison. On the right, the training section is distinguished by the surface gap d, the distance between centers r and the variable distance R between volume elements. For extended bodies, an integral over geometry is required; the observed torque is related to the derivative of the energy with respect to the angle φ. The graph is not an experimental exclusion curve.

### Tutorial calculation of sensitivity

Let in the training limit of point masses $m_1$ = 0.010 kg, $m_2$ = 1.0 kg, r = 0.10 m and λ = 0.050 m. These values specify the scale calculation; a real stand would require a three-dimensional model. The Newtonian force is approximately 0.0667 nN. At α = 0.10 the additional force is only 0.00271 nN, that is, 2.71 pN. A project with uncertainty 0.30 nH is not able to test such an additional interaction. Improving the graph or the number of characters on the display does not change this limitation.

If the measured residual is zero, λ is fixed in advance, and the only error in the simplified calculation is normal with the standard uncertainty 0.30 nH, the two-sided 95% band gives the constraint |α| approximately 22. This is a weak but meaningful boundary in the given model. To verify an α of order 0.10 with the same geometry would require an uncertainty of about 1.4 pN or better. The stated range of the 51 design cannot therefore be passed off as performance in advanced short-range gravity tests.

For a series of distances at a fixed λ, the additional-interaction model is linear in α: the vector of residuals is described as αK, where K is calculated for a unit-strength additional interaction. Given a known covariance matrix C, the estimate and its standard uncertainty have the following form. Uncertainties in geometry and conventional forces are either included in the coupled model or accounted for by separate parameters; they cannot be hidden away in one convenient sensor error.

$$\hat{\alpha} = \frac{\boldsymbol{K}^T \boldsymbol{C}^{-1} \Delta \boldsymbol{F}}{\boldsymbol{K}^T \boldsymbol{C}^{-1} \boldsymbol{K}}, u_\alpha = \left(\boldsymbol{K}^T \boldsymbol{C}^{-1} \boldsymbol{K}\right)^{-1/2}$$

If λ is also fitted, the result is a parameter domain and a separate test of the selected form on new data. The discovered dependence, similar to the inverse square of the distance, does not yet establish a gravitational origin. Case 2 retains precisely this limited positive outcome. A strong model must predict the next

experience, given constant parameters, and be able to distinguish itself from ordinary forces that have available channels of influence.

Chapter 21

# Wormholes and the limits of physical models

A wormhole is a concept in a geometric model of space-time, not a general name for any unexplained passage. To compare such a concept with observation, one must know which regions are connected, how the causal curves run, what sources support the geometry, and how it might have arisen. A single unusual image does not define these properties. The scientific value of a model lies in the associated consequences and limitations that can be tested or at least calculated.

### Four levels of feasibility

The first level is mathematical correctness. The metric must have the required properties, and the selected fields must satisfy the corresponding equations. The second level is source acceptability: the specified energies, pressures and states must be compatible with the applied physical theory. The third is the possibility of formation and sustainable existence. The fourth is agreement with the observed limitations. Success at one level does not replace others.

A special model by Gao, Jafferis and Wall shows the traversability of a bridge in a certain black hole configuration in three-dimensional spacetime (BTZ) after introducing a connection between the boundaries; Negative averaged null energy plays a significant role. The authors separately note that this design does not allow causality to be violated [20]. The substantive result consists in establishing the possibility within the specified prerequisites. Transferring it to an earthly object would require justification for why exactly these prerequisites are realized.

Negative energy in quantum theory also does not mean a freely available material with any properties. Ford and Roman considered constraints on the magnitude and duration of negative energy density and applied them to certain static traversable geometries. The resulting conditions significantly narrow the permissible scales and distributions of [27]. This is a strong limitation of a particular class of models, but not a universal theorem about all possible theories of spacetime.

Similar care is needed when discussing time. Hawking's arguments for chronology protection connect attempts to form closed timelike curves with energy conditions and quantum backreaction [28]. Subsequent mathematical work by Kay, Radzikowski, and Wald identifies difficulties with a standard quantum description at a particular class of horizons, where the relevant quantities become singular or undefined [29]. A limit of an approximation cannot automatically be turned into a calculation of a specific explosion or the guaranteed destruction of an object.

### The model must survive uncomfortable questions

For any proposed geometry, it is useful to draw up a record of prerequisites. It includes dimensionality, asymptotic behavior, boundary conditions, field types, and how the source is described. If the model requires an external connection between distant boundaries, this connection should not disappear from the popular retelling. If stability is tested only for certain disturbances, it cannot be confirmed that it is robust to all influences. Accurately describing the boundaries makes the theory stronger because it shows where testing is actually possible.

A numerical or quantum simulation can reproduce the individual dynamics of a mathematical model. However, the similarity of equations does not establish the identity of all physical properties. A system

simulating signal propagation may have a completely ordinary geometry and a different energy balance. To draw a conclusion about spatial passage, a separate justification for this particular property is needed. The description indicates which quantity is modeled and which observation is directly available.

The hypothesis being tested about a spatial object must reconcile geometry and dynamics. Signal path calculations must accommodate delays and frequency variations; the source of geometry is mechanical and energy observations; change of state - to the intended control mechanism. If a model explains only one aspect at the cost of the free choice of all others, its predictive power is low. This can be assessed before discussing the engineering implementation.

### Author's procedure for expert assessment

1. The profile theorist formulates minimal premises and separates exact results from approximations; The manager fixes the area of the proposed conclusion.
2. The metrologist translates predictions into observable quantities and checks that the required accuracy, duration, and independence are available.
3. An independent specialist looks for conventional models that produce the same available observations; discriminative checks are ranked according to their informativeness and admissibility.
4. The data custodian saves the model version, parameters and original calculations; changes in premises after verification are clearly noted.
5. The transition to intervention is considered separately and requires a confirmed control channel; The theoretical possibility in itself does not permit such a transition.

The criterion for stopping theoretical derivation occurs when the applicability of the equations is exceeded, the parameters are unjustified, or there is no measurable difference between the versions. In this case, the result “the model is not yet distinguishable” is acceptable, rather than an arbitrary choice of the most impressive explanation. A practical study may continue as data collection if it maintains its intrinsic value and established safety.

Neutralizing hypothetical geometry requires special care in language. One cannot conclude that a change in the electromagnetic field will close the passage just because a model contains the word “quantum.” It is necessary to equation the connection between the controlled parameter and the state of the object and check side effects. While such a channel does not exist, limiting contact, monitoring, and eliminating known associated hazards are available. These are real ways to control the situation, although they do not change the intended topology.

A physical model is also valuable when it shows the high cost of assumption. It may require an unavailable source, predict a missing dynamic effect, or detect its own instability. These results narrow the explanatory space. Therefore, the chapter on wormholes concludes not a catalog of possibilities, but a discipline of comparison: each expansion of the worldview must bring additional obligations to observation.

Part V

# Physical processes in the environment

Chapter 22

## Electromagnetic deviations

### Quantity before name

The message about a “strong field” does not yet specify the subject of measurement. Electric field, magnetic induction, radio frequency radiation and voltage on a conductor are described by different quantities. They differ in spatial structure, time course and methods of registration. Therefore, a case is assigned an EM class by the observed deviation of a specific channel, and not by the feeling of the researcher or the inscription on a universal indicator. The primary record should make it possible to restore what exactly the sensor converted, in what units the result is expressed, and what processes remained beyond the limits of its sensitivity.

An established example of a common anomaly is provided by geophysics: the global grid EMAG2v3 combines magnetic measurements of different origins. This product shows large-scale structure of the field, but does not replace the survey of a single room or small area [30]. The word "anomaly" here means a deviation from the selected background representation. If you compare a local measurement with a map of a different height and resolution, a difference may already arise in the comparison procedure. The absence of a detail on the general map does not make the found detail a violation of physical laws.

### Measurement model and observation network

The author's proposed protocol begins with three questions: does the value change over time, does it depend on position, and does the result follow the instrument. To answer, the coordinates and orientation of the sensor, its band, averaging mode, temperature, power state and nearby operating devices are recorded. The scalar reading and vector components do not mix. Rotating the sensor can change one component while the field remains unchanged; such a change cannot automatically be described as the appearance or disappearance of a source.

An observational network is built around a testable difference. One channel remains at the reference location, the second passes through predetermined available positions, and the third, if necessary, uses a different conversion principle. Simultaneous recordings help separate changes in time from changes in position. Rearranging devices is permissible only after evaluating the operation itself and is accompanied by a note about the new position. The metrologist determines in advance how much the difference should exceed the uncertainty of comparison. The measurement model includes significant influencing quantities and dependencies, and not just the nominal accuracy of the [2] sensor.

Records are saved before filtering. Along with the amplitude graph, a time scale, frequency representation, and overload indications are needed. The narrow peak may correspond to the real source, the instrument's internal oscillator, or frequency conversion during processing. The discriminating test consists of comparing an independent channel and documented equipment modes, and not in sequentially including more and more powerful influences. If disconnecting a device is permitted by its normal procedure and does not affect protective functions, record the expected change and associated environmental changes in advance.

### Forks of explanation

If the deviation moves with the sensor, its own materials, power supply and processing must be checked. If it remains in place but follows the equipment schedule, a man-made connection is investigated. If the spatial profile is maintained under different devices and modes, a model of the external source is formed. These branches can be combined: the real background can interact with the device error. Multiple source distributions can fit a single magnetic map; geological and structural information helps limit such non-uniqueness [22].

Training scenario: near a closed door, the magnetometer regularly shows a jump, and the camera simultaneously loses frames. The first explanation combines events into one unusual field. However, the building log detects the actuator's operation; The standalone camera stores the image, whereas the previous camera and recorder shared power. This fictitious example does not prove the specific cause of a real case. It makes the necessary distinction between physical disturbance, hardware susceptibility and general infrastructure failure.

### Tolerance and result

The study director approves the question and available positions. The metrologist is responsible for the suitability of ranges; a specialized specialist assesses the electrical installation and the compatibility of the equipment with the environment; The safety coordinator determines the termination conditions. The meter itself must be suitable for the conditions of use: the presence of a measuring function does not confirm the permissibility of the device in a hazardous atmosphere [31]. People with medical devices are not used as field indicators. The person's tolerance and the suitability of his technique are considered separately from the interest in observation.

It is useful in the operational record to separately show the reliability of the scientific conclusion and the admissibility of the next action. The mechanism may remain unclear, although the established profile already allows one to reasonably limit a specific contact. The opposite situation is also possible: the source is well understood, but the existing equipment is unsuitable for safe work near it. These two assessments cannot be reduced to one mark. The metrologist reports that he is able to confirm the channel, and the safety coordinator reports what action remains acceptable given this quality of information.

Operation is stopped when the channel leaves the confirmed range, the permitted access boundary is violated, the protective function is lost, or the setting is changed outside the considered scenario. Stopping the study does not mean randomly de-energizing the object. The outcome is formulated as an established field profile, an instrument effect, an explained anthropogenic source, or a remaining deviation with the listed uncertainties. The hypothesis of a new interaction will require an additional prediction: what quantity will change, in what comparison, and why known models do not assume this. One unusual card is not enough for such a transition.

Chapter 23

## Unusual Luminous Objects

### Glowing area and material object

The light spot on the recording is not identical to a separate body. The camera records the distribution of radiation after passing through the medium, optics and electronic processing. The visible boundary may belong to the source, an illuminated surface, scattering in the air, or a saturated area of the matrix. The study begins by separating these possibilities. The word “object” is acceptable as a convenient designation

for the image area being monitored while its material independence is still being verified. Size, speed, and distance cannot be inferred from angular dimension without additional geometric data.

Instrumental studies of rare luminescences exist. Cen, Yuan and Xue recorded an episode interpreted as ball lightning after a cloud-to-ground discharge; observation by two slitless spectrographs contained signatures of soil elements [32]. This is a narrow result of one event. In the Abrahamson and Dinniss model, the energy source is the oxidation of nanoparticle networks. Their laboratory experiments revealed chain aggregates, but the luminous ball in the described experiments did not turn out [33]. Supporting part of a mechanism and reproducing the entire phenomenon are different levels of evidence.

Another scale is represented by the observation of the ASIM instrument - the atmosphere-space interaction monitor on the International Space Station: a thunderstorm gamma-ray flash was compared with ultraviolet elve-type glow in the lower ionosphere and other registration channels [34]. This result does not mean a common origin for all luminous events. For a close spherical glow and a high-altitude brief event, different geometric models and instrument ranges are needed. The external similarity of color images does not unite processes separated by the conditions of occurrence and the method of signal transmission.

## Registration that preserves differences

The author's observation scheme includes a general view of the scene, a channel with a known angular scale and, when justified by the question, spectral registration. The positions of the platforms, the direction of the optical axes and time stamps are checked independently of the event itself. Before observation, safe control scenes are recorded to establish saturation, highlights, and automatic exposure features. Settings that can change automatically are saved along with the frames. If it is impossible to obtain the original camera data, this limitation is included in the case record.

For geometry, spaced viewpoints with overlapping fields of view are especially useful. However, two images do not guarantee triangulation: it is necessary to prove that they are matching the same detail and the same time interval. With a rapidly changing glow, different observers can see different parts of the distributed source. In the journal, therefore, the coordinate of the bright maximum is separated from the boundary of the region and from the supposed center of the material body. The geometry mismatch is preserved without being corrected by selecting a convenient trajectory.

The spectrum is checked for background, sensitivity, saturation and relationship with the image. The presence of a line helps discuss the emitting component, but does not automatically determine the overall composition and energy source. The absence of a line only makes sense within the limits of the recorded bandwidth and sensitivity. The time sequence of the spectra sometimes distinguishes between cooling, compositional change, and movement relative to the background; if the timing accuracy is insufficient, these versions remain compatible. The spectrum obtained after the disappearance of the glow from the supposed trace is formalized as a separate measurement with its own chain of origin.

## Competing explanations and security

For each version, a distinctive feature is specified. The reflection must be consistent with the position of the possible source and surface. Instrument flare is associated with the optical system and its orientation. Atmospheric refraction allows for displaced and multiple images of real objects, but a specific mirage requires checking the geometry and air conditions [16]. The self-emitting process must explain not only the visibility, but also the duration, spectrum, and change in brightness. The absence of a ready explanation leaves the case open; it does not select the most unusual version for the researcher.

The default mode for an unpredictable light event is accessible passive observation rather than zooming in for the best shot. A thunderstorm, an unknown electrical installation or suspicion of ionizing radiation are

considered by specialized specialists as independent grounds for restricting work. The spectrograph does not serve as a protective device. The operator stops guidance or movement if the task requires moving beyond the agreed position, and the safety coordinator stops the study if observation conditions are violated. This protocol does not propose to initiate a discharge to test for similarity with a rare phenomenon.

### Conditional model and result limit

If autonomous glow is confirmed, but known versions do not explain its duration, a conditional model of a hidden energy storage device is acceptable. The model should specify the state variable, the path of energy entry or release, and the observed consequence of depletion. The researcher compares the calculated brightness progression with the new series, maintaining the alternative of external power supply. A model is considered useful when it distinguishes possible outcomes in advance. The name “ball lightning” in itself does not specify either the design of the source or the method of its safe suppression.

The conclusion shares the reliably recorded glow, the reconstructed geometry, and the hypothesis of the mechanism. It lists saturation intervals, lost frames, available spectral region, and reasons for eliminating alternatives. Unsuccessful reproduction is recorded with the same attention as a successful match of features. As a result, even a non-repeated episode can produce a meaningful scientific result: limit the distance, rule out a specific optical artifact, or formulate a test that the next observational setup can actually perform.

### Worked model of a finite energy reservoir

Let us expand the conditional hypothesis of the accumulator into a verifiable calculation. Let there be no external power after moment t = 0, the entire model loss of reserve E turns into radiation and its power is equal to E/τ. Let us also assume that a constant fraction b of the total power comes out in the selected spectral band. These are three independent assumptions. They must be checked for dynamics and spectrum; neither follows simply from the fact that the camera shows a glowing ball.

$$E(t) = E_0 e^{-t/\tau},\; P_{\mathrm{rad}}(t) = \frac{E_0}{\tau} e^{-t/\tau},\; P_{\mathrm{band}} = b P_{\mathrm{rad}}$$

In the full tutorial example, $E_0$ = 12 J, τ = 4 s and b = 0.20. Then the initial total radiated power is 3 W, and the power in the observed band is 0.60 W. The table shows a calculation, not a record of a natural event. These values are available for comparison only after establishing the radiation geometry and radiometric calibration. The signal from one receiver at an unknown distance does not yet determine the power of the entire object.

| Time, s | Remaining stock, J | Band power, W |
|---|---|---|
| 0 | 12.000 | 0.6000 |
| 4 | 4.415 | 0.2207 |
| 8 | 1.624 | 0.0812 |
| 12 | 0.597 | 0.0299 |

The total power integral from zero to infinity is 12 J, and the in-band energy integral is 2.4 J. These two consequences must be consistent with one set of parameters. If τ is estimated from the first four seconds, the remaining section checks the decay shape. A separate series of spectra checks the consistency of b. Changing the color or opacity of a path can disrupt the band prediction while preserving the original energy law; therefore, the light curve cannot be considered outside of the propagation model.

The competing version adds constant power supply 3 W. With the same initial margin and τ = 4 s, the margin remains equal to 12 J, and the in-band power is 0.60 W. If the power then stops, a calculated decline will begin. Such switching can be observed during a natural change in an installed conventional source or at a qualified safe stand. Experiments with discharges or arbitrary influence on an unknown glow do not follow from these equations.

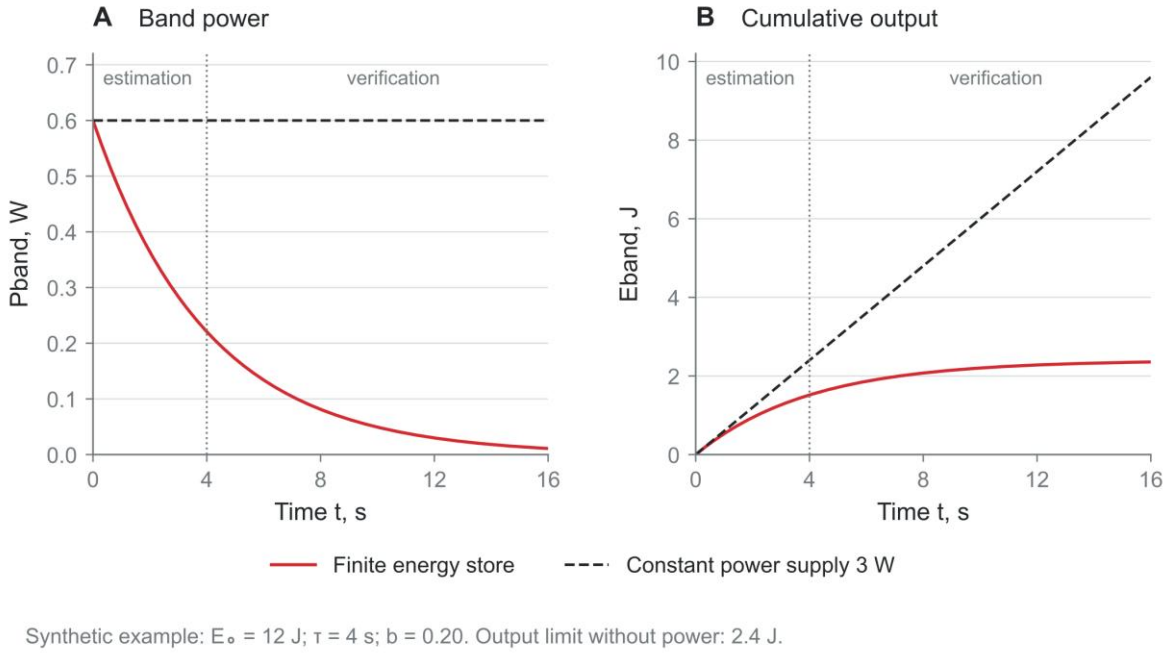



Figure 16. Finite supply and maintained glow. Synthetic energy-balance example: $E_0$ = 12 J, τ = 4 s, b = 0.20. Without power, the band power is 0.60 exp(−t/4) W, and the accumulated output is 2.4[1 − exp(−t/4)] J. With constant power supply 3 W, the reserve remains 12 J: the power in the band is 0.60 W, the output is 0.60t J. The first four seconds are allocated for parameter estimation, the subsequent interval is for checking the discriminative prediction. Measurement errors are not modeled.

A stable glow in itself does not disprove the finite supply: one can propose a very large $E_0$ and a different τ. Therefore, the limitation of the initial resource must have an independent basis, and the loss law must be checked separately. In the absence of such a basis, the conclusion becomes narrower: this exponential model with the estimated parameters does not describe the record. This is a complete result, after which one chooses between changing the loss law, external power supply, and a different interpretation of the measured light.

The custodian stores the original radiometric readings, spectral band, geometry and all saturated intervals. The metrologist evaluates the uncertainty of the integral output and its relationship to power calibration. The supervisor fixes the fit area before checking the later section. If the observation does not cover the beginning of the event, $E_0$ refers to the beginning of the available series, not the moment of birth of the object. This refinement preserves the usefulness of the model even for incomplete recording.

Chapter 24

# Acoustics and mechanical vibrations

### Two pathways behind one report

Humming, trembling of objects and sensations of pressure can refer to different physical channels. The microphone measures changes in air pressure in a specific band; the accelerometer measures the proper acceleration of the sensing element associated with the attachment point; a complaint record characterizes a person's experience. These data can be compared, but one cannot be replaced by another. An acoustic case is classified as AC based on an identified signal or a reasonable hypothesis of its presence. As long as only the experience is recorded, the physical channel remains a research question, even if the description seems very specific.

The main difficulty of low-frequency observation is that the usual recording of sound may not preserve the desired value. The band is determined by the entire path: the sensitive element, amplifier, filters, converter and program. The noise amplified during playback does not prove the existence of the same pressure in the original environment. In contrast, an empty trace of a consumer device does not exclude a signal outside its range. Therefore, the metrologist describes the tested frequency response and the limits of applicability, including the relationships between the significant influencing quantities [2].

### Registration plan

The proposed protocol separates the air and structural channels. A sound pressure meter is installed at an accessible support position, and suitable motion sensors are installed on permitted structures. The method of attachment is recorded by photography and recording, since the movement of a specific point in a specific direction is measured. A time reference and a log of equipment operation are also needed. If the source is suspected of moving, first check the movement of the measurement platform itself. Wind, touching the sensor and operator actions are noted as events that can change the recording.

Frequency analysis is accompanied by viewing the original time series. Short beats, a steady tone, and a slow background change may produce a similar average, although they require different explanations. For each calculation, the interval, window and averaging method are indicated. Changing the method after identifying an interesting peak is allowed as an exploratory analysis, but the new result is checked on a different record. Collection parameters are selected based on the expected duration and frequency; a detected form that the path could not correctly register does not become evidence due to the detailed graph.

The control position is selected along the expected transmission path. An adjacent room may share the same foundation and therefore not be an independent control of mechanical vibration. A street point may have a different air background. It is useful to explain in advance what distinctions between positions should be maintained in each version of the source. Simultaneous observations protect against confusion of the spatial effect with a changed machine mode. Repeated recordings over different periods check the stability of the connection, but are not considered independent just because they are stored in separate files.

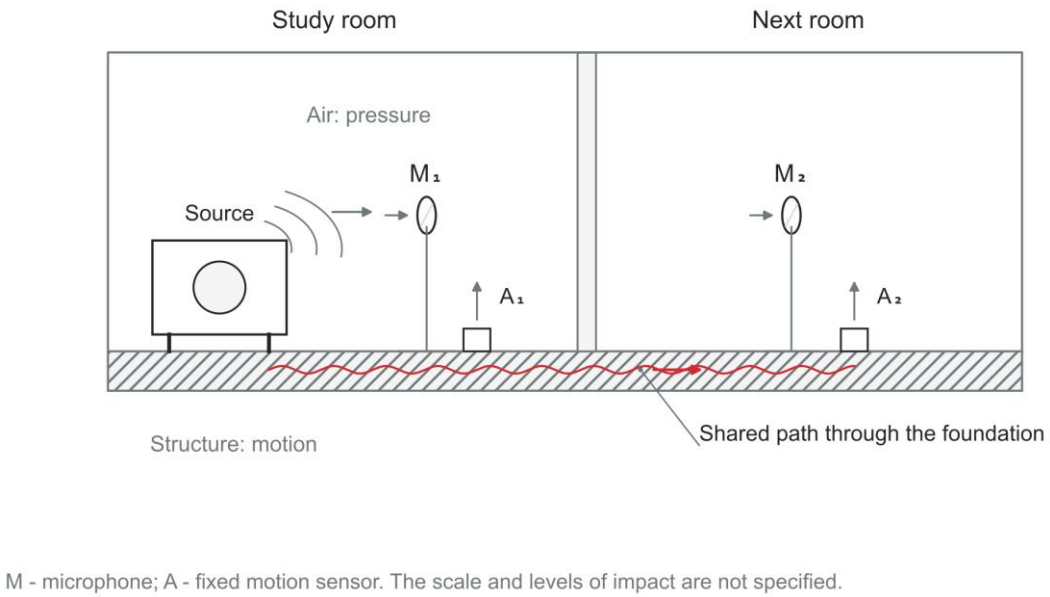



Figure 17. Airborne and structural transmission routes. Study section of premises with a common base. Microphones $M_1$ and $M_2$ observe air pressure, fixed sensors $A_1$ and $A_2$ monitor the movement of the structure in the shown direction. The scarlet path highlights a common mechanical connection through the base: the adjacent room therefore does not become an independent vibration control. The geometry does not specify safety distances, frequency response or insulation design.

### Sensations and Causal Inference

Reports from people are placed on a separate timeline without suggesting a list of symptoms. Their relationship to the physical channel is assessed after the initial descriptions have been recorded. A negative finding in one study cannot invalidate every subjective experience. In a double-blind crossover study by Marshall and colleagues, the tested simulated-infrasound exposure did not worsen the measured outcomes relative to sham exposure; the conclusion is limited to the participants, exposure, and selected outcomes [35]. It neither defines a universally safe level nor explains every situation involving low-frequency noise.

If the experience coincides with turning on the equipment, several causal pathways remain: sound, vibration, accompanying room changes, and the participant's knowledge of the operation of the machine. They are differentiated by suitable observations and, if necessary, approved human subjects testing rather than home-based amplification. Clinical assessment of the condition is performed separately from physical reconstruction. The lack of an acoustic explanation does not invalidate the message, but it does not confirm an external source with unusual properties.

### Forks and termination

When the signal is present in the microphone and is associated with the source mode, the air path is specified. When the structural channel changes more strongly, the mechanical connection is examined. When only the processed track is changed, the original recording and settings are returned. When different sensors produce inconsistent results, ranges, orientation, and timing are first checked. At each stage, the leader formulates the following question; the operator does not select a new stimulation based on the impression of the sound. Determining the cause and reducing the impact can proceed at different speeds.

The Safety Coordinator will terminate the research intervention if approved conditions are exceeded, people react unexpectedly, the stability of the structure is compromised, or source control is lost. Numerical limits are taken from the applicable estimate for the specific environment and task. The stop must maintain the necessary protective functions of the building. If the installed source can be routinely transferred to safe mode, the subject matter expert specifies the transition, and the team verifies that both physical channels change and the meters return to normal operation.

The training scenario completes the logic: periodic movement of a light object is noticed on the floor and a hum is heard. Simultaneous recording shows that the movement follows the mechanical impulses while the tone is maintained continuously. The general signature “acoustic anomaly” would hide two processes. Split analysis allows you to address the mechanical transmission and continue to study airborne noise separately. Even if the movement is successfully eliminated, the conclusion does not promise the disappearance of all sensations: it names the verified result, the remaining channels and the conditions for subsequent observation.

Chapter 25

# Thermal processes and energy balance

### Temperature, flow and energy reserve

The cold area of the image, the rapid heating of the object and the expected excess energy form three different problems. Temperature describes the thermal state within the chosen model; flow characterizes the transfer of energy; energy balance requires taking into account changes in supply and exchange across system boundaries. Low temperature in itself does not prove energy extraction by an unknown mechanism. High temperature does not set the power of the source. The first decision of the chapter is to select the statement to be tested and the system scale to which it applies.

In a thermal imager, between the object and the number on the screen there is a radiometric conversion model. The NIST thermal camera calibration report specifically addresses measurement procedures and uncertainty, including spatial blurring of the [36] signal. Research practice therefore retains radiometric data and processing information when available. Changing the palette only rearranges the display. The appearance of an expressive blue spot on an automatically extended scale is not equivalent to the appearance of a new physical cold.

### Thermal Observation Check

The author's scheme begins with an accessible, still view. It indicates the surface under study, stable landmarks and control areas. The observation direction, distance within the established geometry, air conditions and surface features are recorded. Reflected radiation and changes in emissivity are considered competing explanations for signal changes. A contact sensor, if its use is permissible, provides a different comparison channel, but itself changes the conditions of local heat exchange. The disagreement between two measurement methods is analyzed through their physical models, and not by voting of instruments.

For repeated observation, the camera position is restored and identical areas are compared. The time series are combined taking into account the response delay: the camera and the installed sensor can smooth out the fast process in different ways. If the surface material, humidity or geometry changes, the previous signal conversion is checked again. The signal at the boundary of a small object may include adjacent background; Enlarging the screen image does not restore lost spatial resolution. The protocol explicitly marks areas for which the numerical temperature estimate is not confirmed.

### Balance with designated boundaries

To test the energy hypothesis, draw the boundary of the system and list the flows crossing it. Heat exchange, the operation of external devices, and energy transfer with the substance are taken into account if the substance enters or exits. A convenient entry looks like: $R = \Delta E - E_{in} + E_{out}$. Here ΔE is an estimate of the change in energy reserves within the boundary for a selected interval, Ein and Eout are the total inflow and outflow, R is the remainder of the accepted balance. The sign and definitions of all terms are fixed before analysis; different types of transfer do not include twice.

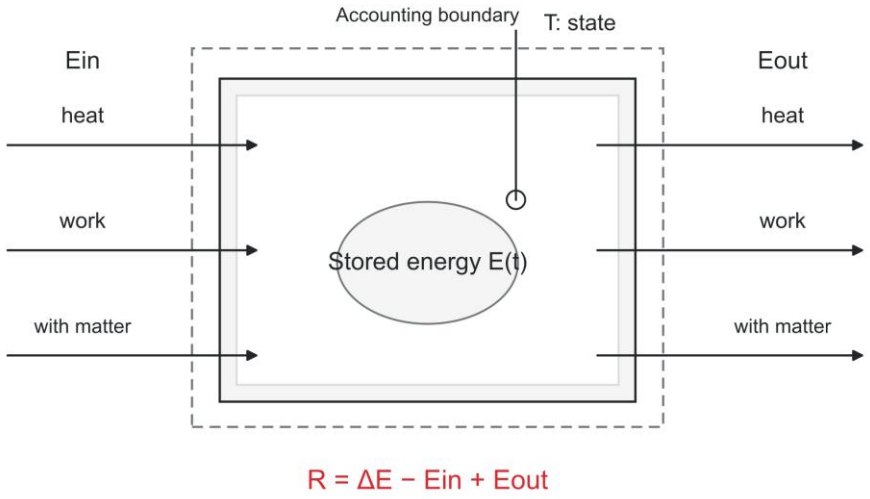



Figure 18. Control volume and energy balance balance. Accounting scheme for conditional control volume. Heat, work and energy transferred by the substance enter into Ein and Eout over the same interval; each transfer is included once in the matched model. The temperature channel observes the condition. The scarlet remainder R = ΔE − Ein + Eout is moved out of bounds as a result of the calculation and is not depicted as a new energy source. A set of arrows shows metering categories rather than already measured flows.

A non-zero R first characterizes the inconsistency between the data and the model. To discuss a new source, it is necessary to show that the remainder is conserved when the boundary, measurements, and known transport pathways are refined. The uncertainty of the remainder is not obtained by simply listing the accuracies: common sensors, corrections and background are able to relate the estimates of the terms [2]. If the significant flux is not measured at all, the beautiful numerical value of R does not have the status of a closed-loop energy proof. The report leaves an unfinished balance rather than a detected energy of unknown origin.

A calorimetric test project is drawn up for a material that has already been approved for the corresponding laboratory procedure. The manager determines the expected difference between the hypotheses; the heating engineer sets the model of accumulation and losses; the metrologist prescribes control measurements; the operator records each mode transition. Before an unknown object, the system itself is checked against an authorized reference process. Installation parameters are selected according to the required sensitivity and properties of the task. Transferring an object into a closed chamber is not considered a neutral action: it can change heat dissipation, gas exchange and the state of the material.

### Intervention forks

If an independent measurement confirms the temperature change, but the balance is explained by normal heat exchange, the control is directed to the established path. If only the radiometric assessment changes, the surface and recording path are examined. If both channels are confirmed and the balance is incomplete, the flows are first clarified. Only after this is the residual hypothesis formulated quantitatively: under what change in admissible conditions does it predict a different result than the known models. Neither branch requires random heating of an unknown substance or testing the effects on humans.

A shutdown is declared when there is a loss of plant temperature control, an unintended change in material, damage to the containment system, or loss of a critical measurement. It means moving to a predetermined safe mode while maintaining the necessary cooling and monitoring. The return of readings to background is checked after the channel is restored to serviceability. If the surface has become optically different, the disappearance of the spot may reflect a change in observation rather than the cessation of the source. Therefore, confirmation of the result is based on the path of influence for which the decision was made.

### Educational analysis

In a fictitious experiment, a closed case heats up slowly even though the visible load is turned off. The first estimate takes into account only the wall temperature and concludes that there is excess energy. The extended log detects continued power to the internal logger; the control case shows a different heat dissipation due to a different tabletop installation. After accounting for these differences, the remainder disappears within the limits of uncertainty. This outcome is not a failure of the study: an explanatory model has been obtained and requirements for the next trial have been established. If the remainder holds, it is these requirements that will make the new result meaningful.

Chapter 26

## Movement of objects and apparent levitation

### From image to mechanics

The observed motion requires the indication of a reference frame. An object can change position relative to the camera, table, building or earth's surface; These are different statements. The camera, mounted on an oscillating support, is able to attribute its own movement to the surrounding scene. Therefore, the first measurement of the MV class relates to coordinates and time, and the conclusion about force appears only after analyzing the geometry, mass and interactions. Apparent immobility in the air also needs to be verified: maintaining a position does not yet indicate how the acting forces are balanced.

Non-contact retention is known to physics. Berry and Geim consider diamagnetic levitation, in which magnetic interaction in a suitable non-uniform field can balance the gravity of [23]. This example is important as a test of the logic of the conclusion: the absence of a visible support does not establish gravity shielding. The conditions described do not constitute a proposal to build a field installation with a strong magnetic field. The unknown case requires its own reconstruction; external similarity with the published experiment does not prove the coincidence of the mechanism.

### Trajectory and scene completeness

The author's protocol begins with an unalterable, general-view record that includes the subject, intended supports, and surrounding landmarks. The close-up complements it, but does not replace it: the lost

periphery can hide the movement of the platform or external contact. With multiple cameras, time and geometry are confirmed separately. For each trajectory, the original image coordinates, object selection rules, and position uncertainty estimates are stored. Smoothing and calculation of acceleration are formalized as derivative operations; a sharp acceleration peak may arise from a small localization error.

If radar is used, it is useful to remember the independent branch of instrument explanation. In a study of automotive radar with multiple transmit and receive channels (MIMO), reflected multipaths created false moving targets; recognition depended on the scene model, and some filtering methods also removed real direct signals [18]. Therefore, the trajectory remaining after algorithmic cleaning is compared with the original data. The agreement between camera and radar strengthens the argument only after checking that both channels refer to the same object and do not share an erroneous time reference.

Force measurements are planned separately. A sensor on a support evaluates the interaction with that support; accelerometer—proper acceleration of the sensing element; coordinate motion is restored taking into account orientation and gravity; none of them alone describes all the forces on the body. For static holding, an estimated balance is drawn up, for movement - a model of the change in momentum in the designated reference system. Air flows, electrical and magnetic interactions, mechanical connections and support inclination are considered as channels to be tested. The entry “no forces detected” is replaced with a list of measured channels with sensitivity limits.

### What follows the effect

If the study allows limited variation in conditions, select in advance which feature will distinguish between site, material, apparatus, and source. Rearranging an available inert reference object can test the observation geometry; changing the camera position - optical version. Any movement of an unknown object is considered as a separate intervention, and not as the usual preparation of an experiment. For field maps, non-uniqueness also remains: different distributions of sources can be consistent with the same measurements of the [22] field. One card does not replace a mechanical balance.

Dependence on the observer is treated especially carefully. The operator simultaneously changes lighting, body position, air flow, floor load and the moment the recording starts. If the effect disappeared when the person was removed, the involvement of consciousness has not yet been established. First, the changed physical conditions and launch method are examined. Blind processing of recordings helps to separate knowledge of the condition from the extraction of the trajectory, but does not correct poor shooting. The study of human participation requires a separate ethical basis and does not involve the presence of a person in the area of moving objects.

### Acceptable Experience Limit

Before intervention, a specialized specialist considers possible falls, capture, rotation and load transfer to adjacent structures. The manager records the measurement goal, the safety coordinator records the access boundaries and termination signs, and the operator records the sequence of permitted actions. Observation is terminated when there is unplanned movement, loss of control over the source of force, change in the support system, or loss of a channel on which safety depends. Conditions are selected for a specific mass, geometry and environment; the same “distance from levitation” for all cases is not physically justified.

Exposure management is associated with a validated mechanism. If the movement is created by a standard drive, its engineered safe transition is used. If the source is unknown, the absence of a movement command is not considered a fixation. Turning off the camera or suppressing the signal by the algorithm means losing surveillance, not stopping the subject. After any restriction, the actual position, the condition

of the restraints and the new mechanical loads are checked. The reversibility of the control command does not guarantee the reversibility of damage that may have occurred during the transition.

### What remains established

Training scenario: A light plate appears stationary above the surface, but a side view reveals regular touches that are indistinguishable from an overhead angle. The former free-hold model is replaced by a contact-based movement model; The research question shifts to the periodicity mechanism. If contacts and known fields are excluded only within limited ranges, the conclusion preserves these boundaries. A working hypothesis for a new interaction must predict a dependence on an available parameter and withstand independent replication. The strong impression of movement does not negate the need for such a prediction.

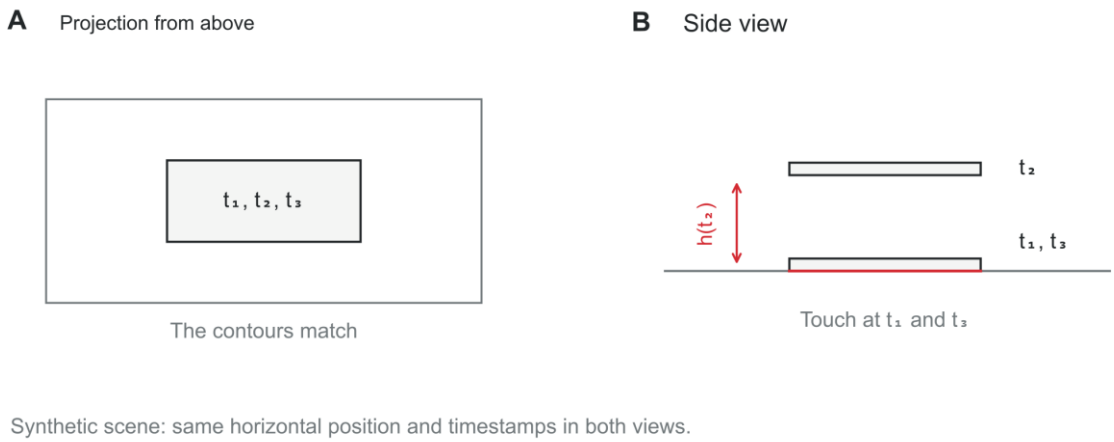



Figure 19. One plate from two viewpoints. Two software-generated projections of one synthetic scene. The plate maintains its horizontal position, so its contour from above coincides at $t_1$, $t_2$ and $t_3$. The side projection detects clearance at $t_2$ and contact at $t_1$ and $t_3$. The positions are schematic and do not set the amplitude of actual experiments; the drawing clarifies the completeness of observation without establishing the mechanism of movement.

Part VI

# Matter and living systems

Chapter 27

## Changes in mass and composition

### What has really changed

The reading on the scale is not a direct record of the quantity of the substance. The measurement relates the interaction with the support, environmental conditions and the device model. Even when the result is expressed in mass units, it is necessary to establish what exactly was compared and what corrections were applied. The NIST Mass Calibration Guide covers air buoyancy, standards, and measurement conditions [37]. These foundations are especially relevant for a claim about the disappearance or reappearance of a substance: such a claim is much stronger than observing a change in the reading of a single device.

In the author’s protocol, the accounting object is first specified: a separate item, the contents of a vessel, or a system of “vessel, contents and closing elements.” The history of this border is being recorded. If a lid was opened, a tag was added, or an object was moved with a wet instrument between measurements, the sequence already contains a possible exchange of substance. Changes in mass, chemical composition and spatial distribution are studied separately. The coincidence of one indicator does not prove the immutability of the other two, and the difference between different parts of heterogeneous material does not necessarily mean a transformation over time.

### Mass comparison

The plan includes the object under study, acceptable control containers and a suitable standard of comparison. The order of measurements is chosen so that the drift of the instrument does not automatically coincide with the difference in conditions. For each record, the time, object ID, container configuration, environmental conditions and installation status are stored. All valid duplicate measurements are also saved, not just the most unusual pair. The result is expressed as a change relative to a certain initial configuration; the unknown moment of loss of material is not replaced by the assumption of instantaneous disappearance.

If the reference changes, checking the measuring system becomes a priority. If the container and sample are changed in a similar way, the common factor is examined. If the difference is stable only in the sample, the available exchange paths with the environment and the condition of its surface are checked. The closed system assumption is tested by actual design and history, not by the word “closed.” The sealed or hermetic envelope is also part of the object and its own engineering task; unknown material cannot be enclosed in it without assessing the conditions that arise.

### Composition and spectral features

The composition is determined by methods that answer a specific question: about chemical elements, compounds, phases or structure. Elemental spectrometry does not automatically answer all these questions. The description of energy dispersive X-ray spectrometry (EDS) published by NIST identifies the need for standards and matrix corrections, as well as spectral artifacts including output peaks and [38] hits. Therefore, one unrecognized peak does not receive the name of a new element. First, the calibration, background, response model, and consistency of the entire group of expected features are checked.

To test for compositional changes, comparable sites or a reasonable sampling scheme are needed. The sample keeper notes the position of each portion relative to the original object and all stages of preparation. Destructive analysis can provide qualitative data about its portion, but exclude subsequent measurement of its previous condition. If re-examination is allowed, the remainder is distributed among predetermined tasks. The independent method is chosen for its different physical basis and different set of errors, and not simply for the name of the second device.

Control materials undergo a comparable path whenever possible without additional risk. Empty containers help reveal the container's contribution; process control - changes made by preparation; repeated measurement of a verified standard—the state of the analytical channel. Their functions differ. If contamination is detected only after delivery, the entire chain to the laboratory is reconstructed. If the origin of the composition is uncertain, it cannot be confidently attributed to the place of discovery, even if the spectrum itself was obtained flawlessly.

### Saving and limiting actions

Before analysis, a specialized specialist determines the admissibility of storage, transportation and the chosen research method. The appearance, absence of odor or absence of signal from one sensor does not provide general permission to handle the material. Treatment for safety may alter the characteristics being tested; World Health Organization (WHO) recommendations emphasize the dependence of decontamination on the material, conditions and validated process [39]. Therefore, the initial observation and the condition after treatment are recorded separately in the record. The scientific value of a sample is not a reason to keep a dangerous operation outside the laboratory's capabilities.

Stop work if there is an unexpected change to the container, signs of containment failure, actual material not meeting tolerance conditions, or loss of sample provenance rendering the next step pointless. The latter case does not always require emergency action, but does require stopping the interpretation. The manager can order re-registration or refuse the destructive analysis. The decision to renew is confirmed by a specialized specialist together with the safety coordinator; the specimen keeper conveys information about what remains unknown.

### How an unusual result is formulated

Training scenario: two samples from the same stone give different elemental compositions, and the mass of the residue decreases after a series of operations. First there is a version of the transformation of matter. The selection map shows that the samples belonged to different inclusions; the log reveals an unaccounted portion consumed during preparation. The resulting balance explains observation without transformation of elements. If similar versions are verified and the remainder remains, a working hypothesis is formulated predicting a new independent comparison. An unusual composition in itself does not establish either the process by which the material appeared or its origin.

The conclusion contains the magnitude and uncertainty of the change, the definition of the accounting system, the distribution of the analyzed areas and a list of the transformations performed. They separately indicate which initial properties can no longer be verified. Such a report may retain the status of an open case without a dramatic title. The scientific result is reproducible differentiation and limitation of explanations; the words “materialization” or “transmutation” become valid only when substantially stronger requirements are met than a change in mass or an unexpected line in the spectrum.

### Evidence-based ladder of substance change

A stronger claim requires new observations, not just a more confident description of the previous result. Changing the mass of a particular system, changing chemical bonds, and changing the composition of nuclei relate to different physical issues. Therefore, transitions between them are formalized explicitly. The table defines the author's research ladder; it does not constitute permission to analyze material for which an acceptable route of circulation has not been established.

| Statement | Additional base | What has not yet been established |
|---|---|---|
| The scale reading has changed | Saved initial reading and device status | System mass and reason for change |
| The mass of the given system has changed | Comparable boundary; reference; amendments; uncertainty | Transfer or conversion path |
| The distribution of components has changed | Representative selection and spatial map | Change in bulk composition |
| Bonds or phases have changed | Method sensitive to the corresponding structure | Change of chemical elements |
| Changed elemental or isotopic composition | Independent methods; sample balance; control of impurities and preparation | Mechanism of nuclear change |
| Specific nuclear process model supported | Consensus products, balance and predicted additional features | Other processes outside the scope of inspection |

The first transition is well illustrated by a numerical example. Let synthetic measurements of one system give 100.0000 g and 99.9996 g, each with a standard uncertainty of 0.0002 g. If the errors are independent, the difference is equal to −0.0004 g, and its standard uncertainty is about 0.00028 g. Such a pair does not provide a convincing basis for discussing the disappearance of matter. If the errors are correlated, the difference budget must be recalculated based on their origin; the number of repetitions does not replace this work.

Even a significant loss of mass of the open part does not mean a loss of mass of the entire installation. Condensation on the wall, a separated portion, or transfer to another phase changes the local distribution. Therefore, in parallel, they keep records of the object, container, separated fractions and consumed samples. The same circuit is drawn up for the initial and final states. If part of the material cannot be safely taken into account, the result is limited to an open balance, maintaining a quantitative assessment of the missing link.

The following steps require methods with different tasks. Elemental composition, molecular bonds, crystalline phases, and isotope ratios are not four names for one analysis. Already the EDS description links the reliability of the elemental result with standards, matrix corrections and verification of spectral artifacts [38]. For a stronger conclusion, choose an additional method that is truly sensitive to the desired difference, and find out in advance which preparation transformations can change this difference.

The isotopic difference also needs causal testing. Comparison of different inclusions of a heterogeneous sample or a changed fraction ratio may change the measured ratio without the proposed nuclear transformation. Therefore, the model must predict changes in the abundance of specific components in the

designated system and be consistent with the history of selection. Analysis of two portions of the same material is a test of heterogeneity and procedure, but is not automatically an independent repetition of the event.

If a certain nuclear mechanism is proposed, the expected products, the energy contribution, and the types of radiation that it actually provides are deduced from it. The universal requirement “there must be any radiation signal” does not exist in this research scheme: the prediction of the selected reaction is checked. The required sensitivity and recording time are calculated before the result is analyzed. The absence of a channel capable of noticing the predicted feature means that the test is incomplete, not confirmation of an unusual way to hide it.

A positive outcome may remain at an intermediate stage. For example, independent analyzes confirm a change in a certain phase after an observed event, while the elemental composition remains compatible with the original. This is a meaningful physical result with its own program for studying the conditions of formation. A premature transition to the word "transmutation" would make the conclusion less precise. The stage is stored along with what needs to be measured for the next transition, and the materials for safe and traceable handling are transferred to chapter 31.

Chapter 28

# Ionizing radiation and detector failure

### Indication and danger

The radiation case begins with the exact name of the quantity being measured. The number of recorded events, activity estimate, spectrum and dosimetric indicator are not interchangeable. The device converts the interactions available to its design and may not respond to a different type or energy range of radiation. Therefore, the IR class is assigned based on confirmed data or reasonable suspicion, and the decision on safety is made by a specialized specialist taking into account the entire situation. The inscription “radiation not detected” without the range, conditions and serviceability of the measuring instrument does not define a safe mode.

A particularly dangerous mistake is one in which the absence of evidence is perceived as an improvement. International Atomic Energy Agency (IAEA) guidance SSG-8 warns that some Geiger-Müller (GM) meters, especially older ones, may show zero [40] when saturated. This is a characteristic of certain devices and modes, and not of all modern dosimeters. The practical implication is that knowledge of the behavior of a particular channel under congestion is essential. A sudden drop in readings after they have increased requires diagnosis and a safe solution, rather than zooming in to confirm the suspected disappearance of the source.

### Measuring channel qualification

The author's protocol begins before entering the site. The metrologist and radiation protection specialist agree on the measured quantity, type of device, range, observation geometry and signs of an unreliable result. The record includes an identifier, information about confirmation of characteristics, acceptable conditions, power status and malfunction signals provided by the manufacturer. The performance is checked using standard safe means in a competent organization. Such verification should not turn into an independent search or the use of unknown sources to test the device.

When recording, not only the average number is saved, but also the accumulation interval, position, timestamp and all warnings. A change in result may reflect a change in source, geometry, shielding

objects, or sensor condition. If the operator moves at the same time as the band switch, the two influences are already mixed. The research record identifies areas of stable configuration, transitions and intervals for which interpretation is impossible. Data gaps are not filled with an assumption about the background level.

A reliable comparison requires a model of background fluctuations and alarm errors. NIST considers false alarm testing separate from detection performance; the statistical models used require their own premises [3]. Therefore, a series without alarms does not give the right to consider the probability of missing out to be zero. The test plan is formulated for a specific function and conditions. An artificially cleaned series, from which unusual readings are removed, is not suitable for an independent assessment of exactly those events for which the observation was carried out.

### Three branches of the solution

The first branch - the reading in the confirmed range is consistent with an independent suitable channel. Then a specialist in the field interprets the value and determines measures for a real radiation problem. The second branch - the channels diverge, the device reports an overload or behaves in an unexpected way. Then the result is considered unreliable for access permission, the research step is stopped and the previously justified protective mode is maintained. Third branch - the readings are compatible with the background if the equipment is in working order. The conclusion is limited to the sensitivity, location, interval, and those types of radiation that were actually monitored.

The independence of devices is checked by the design of the entire system. Different enclosures can share power, software calculations, or the same time scale. A common cause can disrupt multiple backup links, so the number of devices is not equal to the number of independent acknowledgments [7]. If all loggers are losing data at the same time, this is a separate DI event that requires its own review. The radiation explanation for the electronic failure is also not automatically accepted: NASA distinguishes between single and cumulative effects in electronics, but the description of space systems does not establish the cause of a terrestrial device failure [41].

### Exploration without dangerous escalation

The signal from the radiation device is not an invitation to find the item manually. The research director passes the assessment to the relevant service and limits the scientific task to the available data. The safety coordinator has the right to stop work if there is a loss of control, a change in the situation or insufficient equipment. Relocation, opening, shielding and processing of a suspected source are considered special activities with assigned responsibilities. The universal radius, shielding material, or approach order are not inferred from the IR class name.

If the phenomenon under study has disappeared, first confirm the operability of the tract and the preservation of the comparison conditions. The source could leave the field of observation, become obscured by an obstacle, or change mode. Neither of these outcomes by itself equals the removal of the hazard. Checking for possible contamination is a different task than measuring the external field; it requires an appropriate professional plan. Scientific uncertainty about the mechanism does not override organizational restrictions based on an already established risk category.

Training scenario: after an increase in readings, one device displays zero, and the log simultaneously records a sign of an unacceptable mode. An erroneous interpretation would declare neutralization. A correct entry highlights the measurement failure, pauses the next step, and maintains the limitations until independent evaluation. If a real field decline is later confirmed, this will become a separate output with its own time boundary. The final report distinguishes between the measurements taken, the intervals that were not available, the protective decisions made, and what questions remain open.

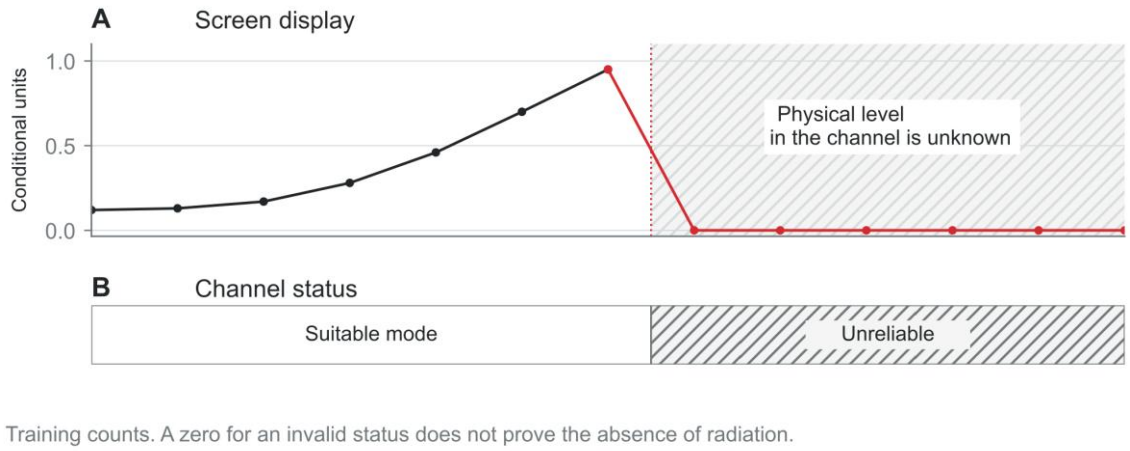



Figure 20. Zero reading when the channel becomes unusable. Synthetic readings of one conditional channel and a separate band of its suitability. After the invalid mode flag, the displayed number drops to zero and physical layer interpretation on that channel becomes unavailable. The hidden dose is not completed; The example does not specify the general saturation characteristics of the detectors and does not establish a tolerance threshold.

Chapter 29

# Biological and environmental deviations

### Levels of a living system

Unusual plant coloration, mass mortality of organisms, shifts in animal behavior, and an unknown laboratory result refer to different levels of organization. The BI class unifies the subject area, but does not specify a single reason. An observation is described in terms of an organism, population, community or ecosystem and a specific indicator: abundance, distribution, damage, activity or composition. External unusualness does not establish infectivity, and the absence of familiar signs does not provide a general conclusion about safety. The first task is to distinguish between a biological event, a state of the environment, and a recording error.

The work is based on known terrestrial mechanisms: changes in water and power supply, temperature, chemical influences, diseases, natural dynamics and human influence. The list is turned into testable alternatives, choosing measurements for each. Detection of a form not identified by the observer means a limitation of identification. It does not support extraterrestrial origin, special life basis, or intelligent behavior. Such hypotheses will require additional features that cannot be obtained by simply renaming an unknown organism.

### Environmental surveillance plan

The author's scheme begins with a map of observations, site history and comparable control sites. The recording unit, area or duration of observation, season, weather and detection rules are recorded. The same area may appear deserted due to changes in shooting time or visibility. Therefore, zero observations and search effort are also stored. The control area is selected based on the similarity of significant conditions, and not just on remoteness. If water regimes or vegetation composition differ, simple comparisons of abundance may confound several causes.

In the U.S. Environmental Protection Agency's (EPA) wetland monitoring guidance, the BACI (before-after/control-impact) framework compares changes before and after exposure at the study and control sites. Repeated observations are needed to account for natural variability; the lack of baseline period and

site differences limit the causal inference of [42]. Transferring this logic to an unknown case is the author's adaptation. If the event has already occurred, previous photographs and journals are assessed as historical data with a different completeness. They cannot be declared as equivalent replacements for the pre-planned original series.

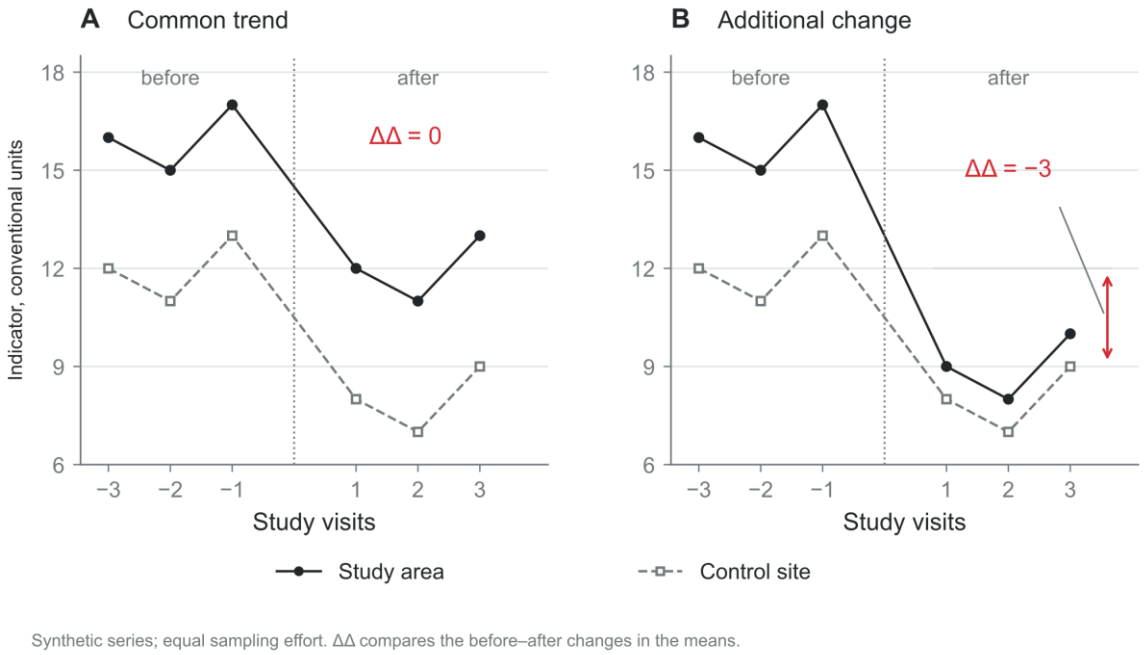



Figure 21. General trend and change in the study area only. Two synthetic comparisons of repeated observations with equal accounting training effort. On the left, the average decreases by four units in both sections: the difference in changes ΔΔ is equal to zero. On the right, the control is reduced by four, the studied area by seven: ΔΔ = −3. This is an illustration of a calculation, not an EPA data or proof of cause. The conclusion depends on the comparability of the sites and the reference period; without pre-exposure observations, these comparisons are not available.

It is useful to separate the response rate from the suspected cause. For example, changes in vegetation cover are recorded independently of measurements of water, light, and physical properties of the environment. Time course helps to choose a model: instantaneous visible change, gradual damage and recovery after changing conditions require different explanations. However, a delayed response does not prove a hidden agent. The plan specifies in advance which comparisons will support a particular version, which ones will weaken it, and which results will remain ambiguous.

### From observation to sample

Selection is not a necessary first step. First, it is determined whether the proposed analysis will change the decision and whether a competent laboratory can accept the material in a known configuration. WHO relates biological risk assessment to the agent, procedure, equipment, environment and personnel competence; gaps in information affect the selection of measures [43]. Therefore, the unknown cannot be eliminated by prescribing an arbitrary universal protection kit. The issue of the admissibility of selection is decided before it is carried out, together with waste management and possible changes in the environment itself.

The Biosafety in Microbiology and Biomedical Laboratories (BMBL) guideline, prepared by the US Centers for Disease Control and Prevention (CDC) and the US National Institutes of Health (NIH), addresses risk assessment as the basis of laboratory work and the shared responsibilities of managers,

biosafety specialists and participants in the procedure. Recommendations are advisory in nature; they do not list all possible combinations of threats and measures [44]. This principle provides the rationale for requiring a separate determination from the receiving laboratory rather than assigning a fictitious level of “abnormal protection” to any biological material. Known professional requirements remain regardless of the unusual nature of the find's history.

If sampling is permitted, the custodian records the location, time, observed condition, connection to the photograph, and any changes prior to transfer. Control samples and background observations are assigned according to the research question. Processing required for safe handling may change the characteristics intended to be analyzed; this is reflected in the choice of method and conclusion. Independent cultivation of unknown material, test infection of organisms and testing on humans are not included in the research route. They are not a necessary condition for obtaining useful field data.

### Forks and boundaries of intervention

When the deviation matches the measured environmental change, the mechanism and independent alternatives are evaluated. When a general time trend is found across all sites, the regional factor is examined. When the effect is stable only in a separate zone, the local pathways of influence and the quality of the control comparison are clarified. If the laboratory result diverges from the field, the representativeness and preservation of the material are checked. A negative result from a particular test limits the trait tested; it does not prove the absence of any biological hazard.

Work is stopped if there are signs of unintended transfer of material, a violation of retention, a sample that does not meet the reception conditions, or a threat to people and the environment. The safety coordinator initiates the planned response, and specialized services solve the practical problem. The destruction of organisms or the cultivation of an area is not prescribed for the sake of testing a beautiful hypothesis. Even an action that reduces one type of impact can change a community and prevent the cause from being restored. Interventions require ecological and biological justification separate from scientific curiosity.

Training scenario: An unusual bloom appears near one shore, and then decreases a week later after a change in weather. Without control, this would appear to be a successful neutralization by the group's last action. Comparable observations show a simultaneous change in the area where no one intervened. The correct inference limits the causal role of the intervention and preserves the task of studying the conditions. The completed biological protocol describes the state of the system, possible transfer, the validity of the comparison and who is responsible for further monitoring; it does not replace this information with the name of an unknown creature.

Chapter 30

## Mixed processes and cascading changes

### Multiple classes in one case

The event may be simultaneously accompanied by light, temperature changes, movement of objects and recording failures. The list of classes OP, TH, MV and DI describes the manifestations, but does not yet explain their relationship. A single source with several pathways of influence, a chain of sequential changes, or independent processes that coincided accidentally in time are possible. Research must distinguish between these structures. Assigning many classes to one case does not mean the discovery of many new interactions and does not give the right to combine uncertainties into one expressive story.

The author's model represents the process as a network of causal assumptions. Nodes represent measurable states: device mode, field, temperature, air flow, object position, data channel state. The arrow indicates a specific expected impact and is accompanied by the expected direction of change or lag. Individual nodes describe the actions of the group. Such a scheme does not have to be completely correct; its task is to show which connections have been verified, which are only assumed, and where the measurements are not enough to choose between versions.

### Common cause and sequence

Synchronicity does not always mean direct transmission of impact. Three sensors can simultaneously change readings due to a common power supply, a common time, or a common processing algorithm. NASA is separately considering a common-cause failure that could overcome the [7] redundancy. Therefore, the research design includes the instrumentation infrastructure, including environmental conditions. Dependencies between channels are clarified before acknowledgments are counted. Unless a common cause has yet been verified, the consistency of multiple screens receives less evidentiary value than independent measurements of different physical quantities.

The sequence of events also requires caution. The measured latency includes sensor response, data acquisition, transmission, and timestamping. An early signal in the log may be a late physics process if another channel reports the result after averaging. First, the order is estimated taking into account these uncertainties, then causation is discussed. If the possible start intervals overlap, the report retains the indeterminate order. It cannot be corrected by selecting those peaks that better fit the desired cascade model.

### Research System Intervention

Distance reduces some contacts, but does not make observation physically absent. In a study of a pollution measurement system on an unmanned platform, the propellers changed the plume distribution and readings; the impact depended on the configuration and mode of [45]. Therefore, robot movement, lighting, fan operation and radio signal transmission are included in the impact log. A device that simultaneously observes and changes its environment can create positive feedback: a change in its mode triggers a new signal, and a new signal triggers another change in mode.

To distinguish between versions, an observable relationship is selected in advance, which can be verified without dangerous escalation. The passive stage is able to show a stable sequence. The permitted control mode of the equipment helps to verify its participation. A comparison with a stand-alone logger evaluates the role of the shared infrastructure. You should not change multiple conditions at once if their causal contribution is the issue. However, for the sake of the experimental purity, the protective function cannot be turned off: the inaccessibility of such a comparison honestly limits the conclusion, and does not justify the risk.

The mixed case especially requires a test of the usual hazards. Field gas sensors have limited selectivity and are application dependent; some types may give erroneously low readings in unfavorable [31] atmospheres. This means that the coincidence of unusual light with the normal reading of one device does not cancel the assessment of the environment. The UN class is retained for the insufficiently defined remainder, and the established factors are considered according to their professional rules. An unknown cause should not displace a practical risk that has already been identified.

### Cascade control

For each connection, the consequences of breaking are specified. Stopping the drive may reduce vibration but stop the necessary heat dissipation; Closing the transport pathway can alter the accumulation of the substance. The study director and subject matter expert select the action for the entire design, and the safety coordinator checks that critical conditions remain observable. Preference is given to a change with a clear mechanism and a verifiable result. If the expected benefit depends on several unconfirmed connections at once, the intervention remains insufficiently justified, even when its name sounds like neutralization.

Stop signs are not limited to just one channel. These include an unintended combination of processes, acceleration of change, spread beyond the agreed boundary, loss of independent control and deviation of the protective system from the permitted mode. The operator transfers the installation to the intended state, preserving the necessary functions. The data custodian records the last valid configuration and moment of each command. After stopping, they check whether another branch of the cascade has arisen, which the previous circuit considered unimportant.

### Educational reconstruction

In a fictitious room, the indicator light flashes, the light tape moves, the camera stops recording, and the body temperature rises. First, events are associated with a single unknown field. The log shows changes in the ventilation mode and the shared electrical line; a self-contained camera stores the recording, and the movement of the tape follows the air flow. The temperature delay is consistent with the heat transfer of the housing. This reconstruction does not require the claim that all mixed events are common. It demonstrates how a single testable network replaces an uncertain feature union.

If some manifestations remain unexplained, the scheme reduces the problem space. Established connections are saved, unconfirmed ones are marked, and the next series is sent to the most discriminating node. The result may be multiple mechanisms with varying confidence, rather than a single answer. Such a structure is also useful for management: limiting a confirmed path of influence is possible before the final theory, if the own risks of the limitation are assessed. Scientific explanation and practical control are related, but do not have to be completed simultaneously.

Chapter 31

## Samples and preservation of the state under study

### What exactly is saved

A sample is part of a process transferred to another research situation. Removal from a site changes the environment, support, lighting, temperature, gas exchange or other connections. Therefore, the expression “keep an object unchanged” is not sufficiently specific. It is necessary to name the properties that are important for the following conclusion: composition, structure, distribution of components, surface shape or time dynamics. If it is not known which link supports the observed state, in-situ logging within a valid mode is preferable first. Transfer is not considered the default way to deliver an anomaly to a more convenient laboratory.

The author's protocol shares three objectives: limiting the impact on people and the environment, preserving scientifically significant properties and proving the origin of the material. These tasks may conflict. Safe processing can destroy the trait being studied; Optimal analytical storage may not meet retention conditions. The decision is made by the competent group before selection. Rejection of a sample

while maintaining quality observations is a complete outcome if a safe and scientifically meaningful handling route is not established.

### Admission conditions

The manager formulates the analysis question and explains why it cannot be solved by the existing data. A specialized specialist evaluates the expected properties and hazards, the receiving laboratory confirms the available procedures, and the safety coordinator checks the application at all stages. In a biological context, BMBL relates risk to the agent, the material, and the activity itself; changing the methodology can change the necessary measures [44]. This principle does not provide universal permission to handle any unknown substance: it requires a specific description of the task and capabilities of the institution.

Before dispatch, the identifiers, expected state, valid container, and responsible recipient are agreed upon. Conditions of transportation and mandatory requirements are determined by competent specialists for the actual category of material and the applicable jurisdiction. In the book they are not replaced by the conventional label “anomalous sample.” If the initial data is insufficient to assign an acceptable treatment, further selection is suspended. The uncertainty does not disappear once the item is placed in a closed box; it is simply transferred to another person if not explicitly described.

### Chain of origin and transformation

On site, each sample is assigned a persistent identifier and linked to the overall site record. The time, position, orientation, observed state, performer and the basis for choosing this particular part are recorded. The image must show a connection to the original object where such registration is possible without additional risk. Chunking creates child identifiers with a preserved relationship. Renaming a file or laboratory internal numbering should not interrupt this story.

For each transfer, the sender, recipient, time and actual condition of the package are noted. The discrepancy is not silently corrected: it is described as a separate event. The log includes storage changes, processing, opening, separating, and material consumption. The sequence of transformations is important, not just the list of owners. If the measurement was taken after treatment, the result refers to the treated condition; the assumption about the state before it requires a separate basis.

The control regimen is selected based on the possible source of the impurity or change. Container control shows the contribution of the container, transfer control shows part of the path events, and preparation control shows the impact of the laboratory procedure. Replicates are useful for checking for heterogeneity, but are not independent inputs. The content and number of controls are justified by the task and the admissibility of actions. A large number of samples does not compensate for the lack of a record of where they came from and how they were modified.

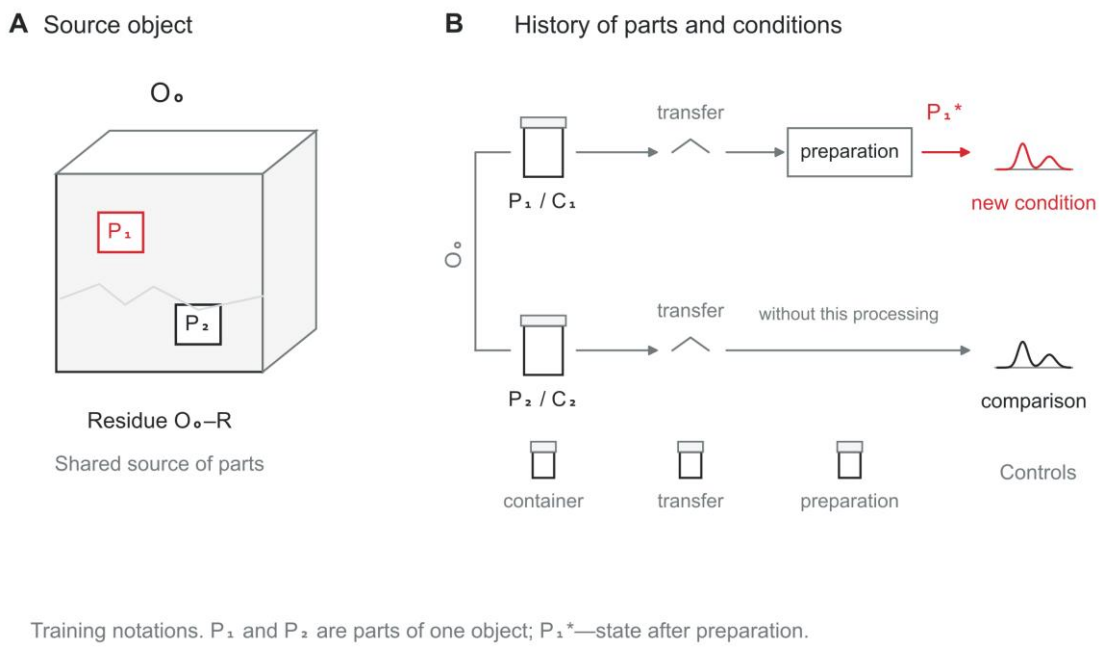



Figure 22. Sample map, child parts and state changes. A training map of one parent object $O_0$, its children $P_1$ and $P_2$, and the remainder $O_0$–R. The history preserves the connection of each part with the container, the transfer, and the subsequent state. $P_1$* denotes the portion after preparation, and the schematic response icons are not spectral data. Containing, transfer and preparation controls belong to different stages. Two parts of the same object do not become independent original objects; the method of handling an unknown material is not specified by the design.

### Safe processing and preservation of features

WHO emphasizes the need to select and validate the decontamination process for specific conditions; material properties and actual execution influence the result [39]. The research chain therefore distinguishes between a specified process, evidence of its implementation and verification of effectiveness. External cleanliness does not replace the latter. At the same time, it is documented which analytical properties the treatment may have changed. Preserving evidence does not require sacrificing essential security; it requires an honest identification of lost inferential possibilities.

If the hypothesis relates to a transitional state, a synchronous recording design before selection, during permitted transfer, and after acceptance is useful. Time stamps describe not only the clock, but also the actual events: change of support, closing of the container, start of measurement. This sequence makes it possible to distinguish the disappearance of the effect during transfer from its natural attenuation, if there is enough data. The disappearance itself does not prove the attachment of the phenomenon to the place: the cause could be changed conditions or a loss of sensitivity of observation.

### Stop and summary of the material

The operation is stopped if the hold is broken, the sample changes unexpectedly, does not meet the agreed conditions, or the possibility of safe acceptance is lost. If the problem is one of identification, the material is not renamed a guess, but is stored as an object with broken traceability to a solution. If continuation creates a threat, the established response plan determines action. The data custodian records which records remain valid; the manager does not demand that the transfer be continued just to complete the series.

Case scenario: An unusual coating loses color after delivery, but laboratory analysis reveals only normal components. Without history, this outcome appears to be a refutation of the original observation. The

complete chain shows changes in illumination, surface condition and treatment before analysis. A correct conclusion says that the condition being examined does not reproduce the original symptom and lists possible causes. Checking the original color is saved as a separate task; the laboratory result does not gain strength that the chosen path of circulation could not provide.

The final status of the sample includes location, conditions for further circulation, remainder, permitted research, and custodian. Destruction, transfer or long-term storage are independent decisions with a documented basis. A data archive can retain scientific value even after the loss of material if it allows the limits of inference to be restored. A good chain of custody does not make an unknown sample safe by itself; it makes visible changes, responsibility and those questions that can still be answered.

### Register of Outgoing Items

The accounting boundary is wider than the list of scientific samples. After work, the test site can be left by the holder, sensor body, packaging, control material, removable storage and the rest of the preparation. Their meaning is determined by the possible transfer path and state, and not by whether the item is called a sample. The G5 register includes all items for which the contact history is significant in the case profile. This is not a reason to declare any equipment contaminated: established contact, suspected transfer and lack of assessment have different statuses.

Before moving, the custodian compares the inventory item with the original record: identifier, completeness, location of use, and observed changes. The subject matter expert determines what status information is needed for the next call. The recipient confirms the ability to accept this particular item in the specified configuration. Laboratory approval for a single sample does not apply to holder, remnant, or altered packaging. Electronic transmission of data is considered separately from the transport of media.

1. For each outgoing unit, record the source, associated patterns, and transactions; new parts receive child identifiers.
2. Compare the intended route with the current map and reception conditions. Separately note operations that have already changed the condition under study.
3. If the recipient refuses, do not send the item to an impromptu alternative address. Review further communication with the person responsible for the current configuration.
4. If there is a missing unit, set the last confirmed entry and possible directions of movement. Do not substitute a lack of accounting for a statement that the substance has disappeared.
5. Close the line only with a specific status: transferred with confirmation, remains under assigned responsibility, processed according to a reasonable procedure, or the location has not been established and transferred for analysis.

Fictional case study: sample P1 was accepted by the laboratory, but its holder D1 was used in a different mode and is not described in the application. A positive entry about P1 does not allow packing D1 together with a regular tool. On the register, the holder remains a separate entity with an unvalued state and a designated custodian. If its further verification is not necessary for the scientific question, this still does not change the decision on acceptable treatment. Accounting ends with responsibility for the subject, not with the end of data analysis.

Part VII

# Perception and information

Chapter 32

## Missing Time and Gaps in Memory

A report that "twenty minutes disappeared" may contain several different claims. A person may not remember what happened, judge an interval to have been shorter, discover a gap in a video recording, or find that clocks disagree. These events require different checks. Grouping them prematurely under the name of a temporal anomaly creates a spurious common cause before data are available. The first task is to reconstruct the question precisely: what quantity changed, who noticed it, and what was it compared with? The experience itself deserves to be recorded regardless of whether its proposed explanation can be confirmed.

Physiological conditions may be accompanied by a combination of lucid experience, unusual sensations, and limited control of the body. In a laboratory study by Takeuchi et al, sixteen participants had six episodes of isolated sleep paralysis; polysomnographic data made it possible to associate them with the characteristics of the transition between sleep and wakefulness [46]. This is a narrow experimental support. It does not provide any basis for explaining the report of a long-term absence of memories by any sleepy state, much less considering the disappearance of a section of physical time as proven.

Other work correlated behavioral microsleeps with simultaneous recordings of brain activity, eye movements, and task performance. The observed brief cessations of the response had measurable physiological correspondences [47]. For a research protocol, the way in which data is divided is essential: the participant's report, the observed action and the physiological recording are compared, but do not replace each other. Stillness on video does not establish sleep, no response does not measure memory, and a memory gap does not indicate the amount of clock divergence.

### Four independent reconstruction lines

The author's protocol begins after providing assistance to the person and stopping actions that could worsen his condition. The study director determines whether routine recording of circumstances is available without additional burden on the participant. The Safety Coordinator has the right to stop the interview; a specialized specialist resolves health issues within his competence. The operator records the situation, the data custodian takes the original records. The exploratory conversation should not delay needed help or become a test of the person's ability to tolerate a recurrence of the episode.

The first line describes the memory: the last confidently remembered moment, the first subsequent one, the source of the duration estimate and the degree of confidence in each detail. The second reconstructs observed actions from independent records. The third concerns the condition of the participant and the available physiological data obtained with consent. The fourth checks device timelines. For each line, intervals of reliable observation, intervals of uncertainty, and information that appeared later are noted. Alignment of gap boundaries is interesting, but requires checking the common source first, such as turning off power to all recorders.

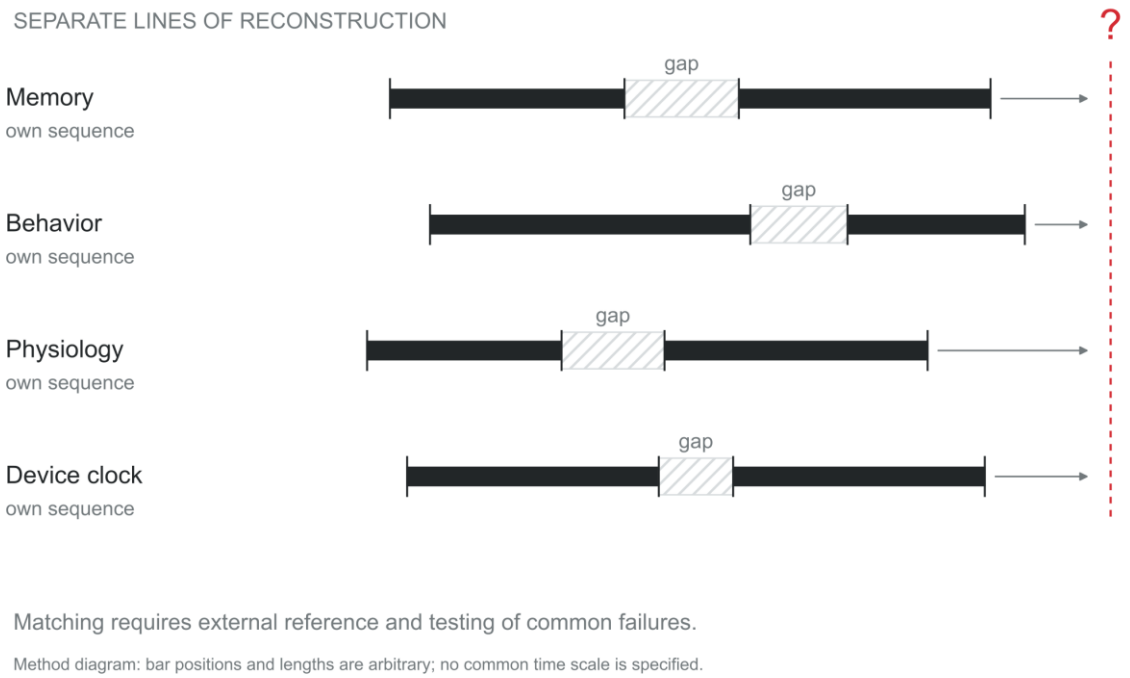



Figure 23. Four lines of reconstruction of one episode. Method diagram. Memory, observed behavior, physiological recording, and device clocks have their own scope. The position and length of the stripes are arbitrary: the drawing does not specify the duration of the spaces and does not establish their simultaneity. The red dotted line marks the issue of external binding and common source of failure, rather than a confirmed link.

1. Write down an initial free description without prompting a suspected reason; preserve the date and circumstances of the story.
2. Accept the originals of available records, figure out ways to create timestamps and identify missing fragments.
3. Create a general chronology with separate tracks for memory, behavior, physiology and instrument time.
4. Pass discrepancies to relevant specialists; complete registration if continuation creates a burden or requires unprepared intervention.

Several eyewitnesses are interviewed in such a way as to preserve the original individual versions. Experimental memory studies show that discussing an event can change participants' subsequent reports [1]. Therefore, in the protocol, not only the content of the message and the number of narrators are important, but also the history of the exchange of information. Repeating someone else's details can be sincere. The investigative intonation gets in the way here: the origin of the information is being investigated, and not the moral assessment of the person. A later clarification is not deleted from the archive, but is added indicating the time and reason for the change.

### Educational analysis

Fictional training scenario: An employee reports that after a short rest, he unexpectedly found himself seventeen minutes behind the expected time. The indoor camera also contains a gap. The first assumption connects both facts with one impact. Checking shows that the application displays the creation time of the exported fragment, and not a continuous shooting timeline. The turnstile log and independent lighting recorder continue without skipping. However, they do not capture the employee's internal state, so explaining the video gap does not automatically explain the employee's experience.

The result of such analysis is formulated separately. The gap in the provided video has a technical explanation; the literal loss of time is not confirmed by available instruments; the circumstances of the subjective interval remain insufficiently defined. Additional research is only permissible with a clear question and voluntary participation. It is impossible to suggest that a person disturb his sleep again in order to obtain a more convincing case. If the available materials are insufficient, the final result is a map of limitations, rather than an artificially selected diagnosis or a fantasy version.

The physical time hypothesis requires a positive instrumental result that withstands the tests described in the time section. To study the experience, it is sufficient to correctly pose another question: what conditions accompanied the change in the subjective sequence. These directions can develop in parallel. Separating them preserves the dignity of the evidence and prevents it from carrying an evidentiary burden that it does not have. The outcome of the case analysis should show what has been directly established, what has been reconstructed, and what new material can actually change the conclusion.

### Matrix of inconsistent evidence

When stories diverge, first break each piece of evidence into separate statements. For each, the object, action, place, interval and source of knowledge are written down. “I saw the door open” and “I was informed that the door was open” occupy different lines. The witness's confidence persists as a characteristic of the story; it is not a replacement for surveillance coverage testing. Primary versions are recorded before joint discussion, and subsequent changes are associated with the history of obtaining new information.

| Approval in a study case | Available material | Scope and limitation | Intermediate output |
|---|---|---|---|
| Witness A saw a man enter | Primary recording of the story | Time estimated from memory; witness indicates an interval of several minutes, its accuracy has not been independently verified | Evidence of entry is retained; exact moment unknown |
| The camera does not show the entrance | Video of the entrance area | There is no recording between the 40th and 55th seconds of the selected fragment | Lack of entry in the pass is not established |
| The door sensor gave two pulses | Sensor local sequence | There is no confirmed connection with the common time scale; possible contact bounce | Two counts are set, the number of passes is not defined |
| Witness B clarified the time after viewing | Two versions of the story | Latest version depends on video shown | Clarification is not independent confirmation |

The next measurement is selected for a specific gap. If the key issue is the number of passes, check the sensitivity and rules for combining sensor pulses. If order is required relative to an external event, an independent temporal relationship is sought. Repeated questioning after all materials have been shown may help to understand the interpretation, but does not replicate the original independent observation. The contradiction is not resolved by voting on the number of stories.

A conditional history change model must specify which records or states are saved and why. By completely randomly changing all possible traces, no observable difference between versions is determined. With a limited change, the task arises: compare the affected and preserved channels, check their real independence and calculate the discriminative prediction. Such a postulate is noted as conditional; The very fact that the stories do not match does not confirm it.

Chapter 33

## A Sensed Presence and Out-of-Body Experiences

The feeling of someone's presence can be definite even when a person does not see a figure or hear a voice. An out-of-body experience, on the contrary, changes the position from which one's own body is perceived. In both cases, the initial subject of registration is the organization of experience: where the observer is felt, what the action is attributed to, what signs allow us to talk about another being. A detailed description aids research more than immediately assigning a name to a putative source. The certainty of an experience and the establishment of its external cause refer to different issues.

Ehrsson's experimental work demonstrated the possibility of changing the experienced position of one's own body through the coordinated manipulation of visual perspective and body signals [48]. This result provides a way to study the components of self-position. It does not measure the separation of consciousness from the organism and does not prove the identity of the laboratory illusion with all spontaneous cases. The practical value of the model lies in the fact that individual conditions of experience become controllable and allow comparison with a control condition.

Robotic studies of sense of presence exploit the incoherence between human movement and returned bodily signals. In work by Bernasconi et al, the procedure was associated with sensorimotor processing characteristics, including in patients with Parkinson's disease; additional data were obtained from a separate clinical sample [49]. Published in 2026, the pooled analysis covered twenty-five experiments conducted by the authors, with a total of 561 [50] participants. This extends the empirical basis of a particular model, while maintaining the need for independent external validation and careful generalization to other situations.

### Description without premature diagnosis

The author's procedure of primary description separates three layers. The first is the immediate qualities of experience: direction, distance, movement, duration, bodily location. The second is observable external events, including instrument readings. The third is interpretation: “observed”, “warned”, “managed”. The last layer is not excluded from the recording because it is important for understanding the situation, but is labeled as the participant's conclusion. A clarifying question concerns the basis of this conclusion: what kind of event would be expected if it were true and what would not be expected.

The initial interview is conducted by a trained professional who does not promise to confirm the entity or prove the disease. The data custodian ensures a consistent mode of access: personal experiences cannot be published along with identifying details by default. In case of pronounced distress, the scientific program gives way to assistance along the specialized route. Resumption of the study requires a separate decision, and consent to the conversation does not mean consent to the experimental induction of sensations. This boundary is especially important when the participant is also a member of the expedition and may feel job pressure.

A controlled study is acceptable if there is a specific hypothesis, proven safety of the procedure, and the ability to stop at the request of the participant. The metrologist records real delays, movements and

stimulation modes, and not just software commands. The operator carries out the assigned sequence without, if possible, knowing the expected response. The assessor receives reports without condition information. The main indicator is determined in advance: for example, the frequency of a previously described experience, and not an arbitrarily chosen most striking phrase. The result is a relationship between the condition and the indicator within the tested limits.

### What does the equipment really measure?

The physiological channel is useful when it answers a specific question about the state of the body. It does not become a sensor of the external subject only because it reacts simultaneously with the experience. In the same way, the camera confirms the change in the image, but not the origin of the sensation, and the robotic stand verifies the sensorimotor model, not the existence of the invisible interlocutor. For each entry, you must specify the subject of the output. If one channel characterizes the movement, the other the participant's report, their agreement confirms a specific relationship between the movement and the report, and not an arbitrary third entity.

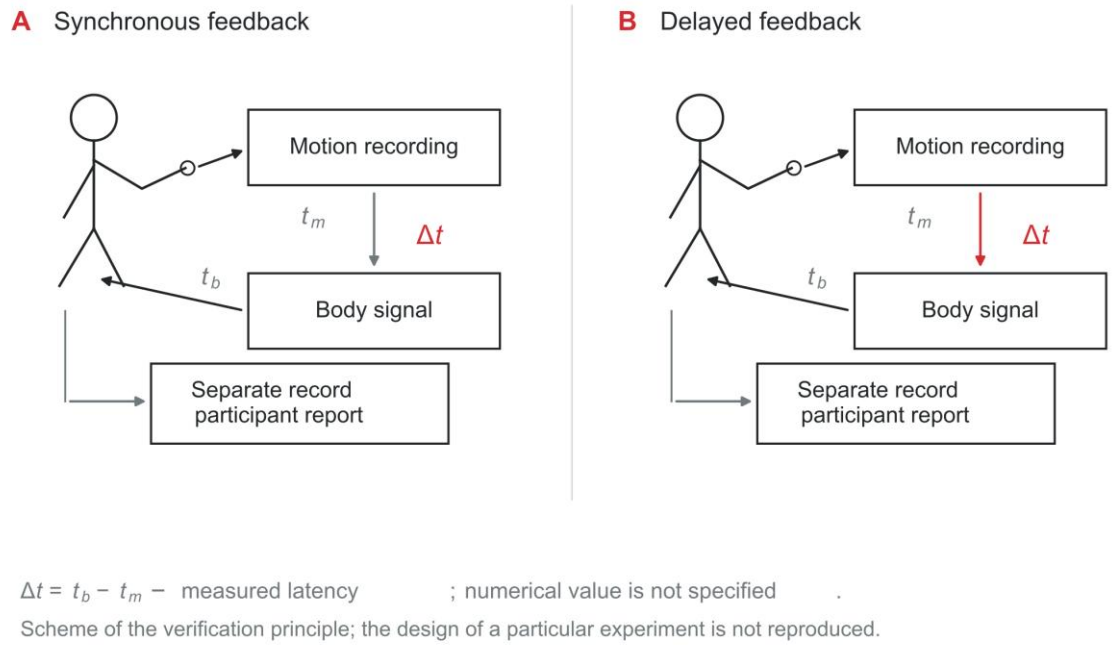



Figure 24. Sensorimotor connectivity and individual participant report. Scheme of the method: coordinated and delayed return of the body signal. Δt is the actual measured delay between movement and return, not the number specified here. The participant's report is registered in a separate channel. The figure illustrates the principle of sensorimotor verification and does not reproduce the construction of a specific experience or the external cause of the experience.

A useful additional check is to separate the presence of the operator, the state of the apparatus and the availability of the result to the observer. However, the “observer effect” cannot be introduced as a ready-made explanation for any difference. First, they describe what changed physically: the sound, the waiting time, the experimenter's movements, the sequence of questions, or the processing of the recording. If a difference remains after control, it requires new experiment. Replacing a specific variable with the word “consciousness” does not reduce uncertainty and does not allow the selection of a device for further research.

### Training scenario and output limit

A fictitious training scenario: test participants sense a person approaching behind them when a certain module of the robotic system operates with a delay. An independent recorder confirms the delay, and hidden control sessions weaken the initial connection between the sensation and the name of the mode. It turns out that some of the participants were guided by the characteristic sound of switching. After acoustic equalization, the effect decreases, but persists in some conditions. There are now two testable components: the available cue and the possible influence of sensorimotor mismatch. None of them allow you to diagnose a person based on his story.

The report must preserve both stages, including the initial overestimate. If the final experiment is insufficiently sensitive, the conclusion is limited to uncertainty, rather than a claim that experience is absent. If the association is reproduced, it is described with its conditions, range, and exceptions. Moving to the question of agency requires a different program: an external response, predefined information content, and controls for ordinary channels. This keeps inquiry open to the unusual while distinguishing a description of inner experience from evidence of an independent acting source.

Chapter 34

## Unusual Sensations Indoors

The room brings together many influences and expectations. Light, sound, temperature, the location of passages, the operation of equipment and the story of the past of a place are included in one situation, although they do not have to have a common cause. Therefore, a complaint about a “heavy atmosphere” becomes the beginning of several checks. One relates to known hazards, another to the quality of perception, and the third to specific recorded deviations. The change in impression after leaving the room does not in itself determine which of these lines explains the observation.

In Project Haunt, seventy-nine participants were placed in a specially designed room under different combinations of tested electromagnetic fields and infrasound. The authors did not find the expected dependence of the number of unusual sensations on these conditions; the experimenters knew the assigned regimen, so the study was not completely double-blind [51]. In a separate double-blind test of weak complex magnetic fields, the expected presence effect was also not confirmed [52]. These results limit specific explanations without establishing the universal harmlessness of all physical effects.

### Initial inspection of the premises

The proposed author's protocol begins with determining the availability of the survey. The safety coordinator assesses what common hazards need to be eliminated before inviting people. A specialized specialist selects devices for specific factors; the absence of a suitable meter is not replaced by a household device with unknown sensitivity. Field Guides for Contaminant Measurement emphasize the importance of calibration, selectivity, and operating conditions for [31] sensors. Therefore, a low reading only makes sense in conjunction with confirmation of the suitability of the entire measuring path for the given issue.

Before turning on additional equipment, the state of the room is recorded: operating installations, door position, lighting, available ventilation information and observation time. This list is not an attempt to collect everything that exists. It describes the variables that can affect the selected measurements or safety. Then a map of observation points is created with stable designations. Rearranging the sensor is registered as a change in conditions, and not a subtle attempt to obtain a more expressive graph. Unoccupied periods are also useful if the equipment can operate without human intervention.

The manager selects the main connection to be verified. For example, pressure messages are assumed to coincide with a specific low-frequency signal. Then, before viewing the joint data, the coincidence time window, the message registration method, and the acoustic event evaluation rule are specified. Expanding the window after failure is acceptable as an exploratory analysis, but the result receives a different status. Otherwise, any sensation can be associated with the nearest fluctuation, and the absence of a predetermined boundary makes the hypothesis practically invulnerable to verification.

### Control of the situation and expectations

Comparing two rooms requires more than a “control” sign. If one is darker, colder, and has a humming sound, the difference in reports does not highlight a single cause. Control is built under question: they compare periods of one room, agreed upon safe modes, or rooms with the described differences. When conditions cannot be equalized, this constraint is included in the output. A strong correlation in a complex natural environment may suggest a useful hypothesis, but does not become a controlled experiment due to the large number of visitors.

Research on expectations requires an ethically acceptable design. Neutral instructions reduce the number of imposed images, but do not eliminate prior awareness. It is clarified separately, without turning the question into an examination of correct beliefs. The open story is supplemented with pre-established scales, preserving the possibility of the answer “nothing unusual.” You cannot measure the success of a procedure by the number of bright stories. Quiet sessions, refusal to participate, and cases when an instrument signal appears without a subjective event are no less informative.

Actively changing the environment is the new mode of operation. It requires a limited question, a proven installation, and an independent safety justification; the book does not involve self-made radiation or intense acoustic exposure to people. The operator terminates the procedure if conditions go beyond the agreed limits, loss of control or demand of the participant. If a physical factor can be studied on a safe technical analogue without a person, this path is used first. Avoiding unnecessary exposure both reduces risk and simplifies the measurement task.

### Training scenario

Fictional training scenario: In the archive room, visitors regularly feel movement over their shoulder. In the initial recordings, the experience coincides with the hum of a fan. After installing an independent recorder, it is discovered that the messages occur more often after turning to a bright screen, and the hum continues during quiet periods. The evidence suggests different explanations: visual conditions, anticipation, and mechanical cues. None have yet been identified causally. Safe lighting comparison changes the frequency of reporting but maintains differences between participants.

The completed report of such a study describes the discovered relationship and its limits. He does not declare the premises fully explored and does not evaluate the sincerity of previous visitors. For an operational solution, it is specifically stated which known hazards have been verified by competent personnel, which conditions are acceptable and who is responsible for re-examination after changes. The scientific result may turn out to be more modest than the original story, but more useful for action: it becomes clear what to change, what to measure next, and what conclusions the available data do not yet allow.

Chapter 35

# Digital anomalies and the limits of automatic analysis

An unusual fragment of a file appears at the last section of a long chain: an event affects the sensor, the signal is converted, transmitted, stored and analyzed. An error in any area can become a convincing picture on the screen. Therefore, a digital anomaly initially means a deviation in the data. To transfer a statement to the outside world, it is necessary to reconstruct the origin of the record. Particular care should be taken when working with a result that exists only after complex processing and disappears when accessing the original signal.

The detection algorithm compares the data to a given model of expected behavior. It can be useful without knowing the reason for the deviation, but that is why a high oddity score does not mean new physics. The NIST AI Risk Management Framework requires assessing quality under the intended use conditions, documenting generalization limitations, and monitoring the system after implementation [53]. For anomaly research, this turns into a specific question: what background was the algorithm tested against and why does this background match the current record.

### Two different levels of verification

The first level relates to the algorithm: whether the program reproduces the calculation, whether the input conforms to the specified format, whether model versions and parameters are saved. The second relates to the measurement: whether the signal exists on the original channel, whether it is consistent with independent observations, and whether saturation, gaps and incorrect time scales are excluded. The correctness of the calculation does not confirm the correctness of the measurement. Conversely, a real change in the environment may be missed by a functioning program if its representation of the normal state does not include the desired class of events.

The proposed author's protocol assigns the data custodian to maintaining the original version, the metrologist to check the chain of custody, and the analysis specialist to perform reproducible computational analysis. The manager formulates the purpose of the system: ranking records, issuing a signal to the operator, or supporting a specific decision. These functions cannot be changed unnoticed. An algorithm that is suitable for selecting interesting videos does not automatically have the right to initiate an intervention. A dangerous decision requires self-confirmation and a predetermined procedure for human verification.

The test set includes normal recordings, known artifacts, safely introduced control signals, and conditions other than training. The artificial example must be labeled and separated from the real observation. It tests the ability to recognize a given change rather than the existence of an unknown phenomenon. It is advisable to separate the setup and the final evaluation: after selecting the parameters, the test set is no longer considered unknown to the developer. Repeated improvement of the result on the same materials does not create new independent confirmation.

### Number of alarms and meaning of accuracy

Fictional training scenario: ten control events are included in ten thousand fragments of a secure test array. The program finds nine of them and produces an additional hundred false alarms. Sensitivity to inserted events appears to be high, but among 109 messages, only nine relate to test targets. The operator has to view many common fragments. This example shows why overall correct response rates alone are not enough: separate rates of detection, false alarms, and follow-up costs are needed.

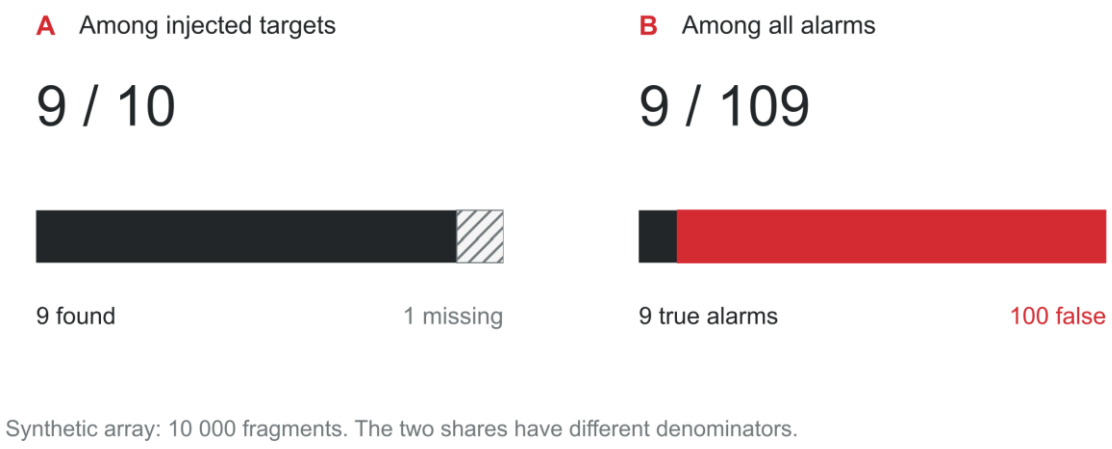



Figure 25. Nine targets among 109 alarms. Synthetic training example. Of the ten entered targets, nine were found, but among the 109 alarms, only nine were targeted. The length of each stripe is normalized to its own denominator. The original array contains 10 000 fragments; the figure does not estimate the prevalence of actual unknown events.

The threshold is chosen in relation to the purpose rather than the attractiveness of the display. For an overview search, one volume of manual checking is acceptable, for continuous duty - another. Given the unknown frequency of true events, the known reliability of each alarm cannot be promised. For a new class that was not in the validated set, the sensitivity may generally remain undefined. The working response of the system in this case becomes a request for verification or refusal of classification, and not a confident signature with the name of an unidentified phenomenon.

Multiple channels and time windows create multiple opportunities to get an unusual number. Statistical methods, including false discovery rate control, rely on certain assumptions; the original Benjamini–Hochberg procedure contains conditions for the corresponding statistics [54]. Simply applying the formula does not correct incorrect background or dependent repetitions of a single signal. The project determines in advance the family of checks and the method for taking into account dependencies. Exploration finds are retained, but new data is requested to establish a pattern.

### When automation stops

Signs of loss of suitability include a change in input format, an unknown model version, missing mandatory channels, going beyond the tested range, and a sharp increase in unexplained alarms. These are reasons to stop automatic decision making and keep the registration if it remains secure. The operator marks the moment of switching; a specialist checks the reason on copies. You cannot subtly suppress anxieties with a new filter and then use the silence as evidence that the impact has subsided. Changing the filter changes the observation, not necessarily the environment being examined.

The final analysis should link each alarm to the original record, the treatment version, and the reviewer's decision. Missing milestones, indeterminate cases, and intervals of missing usable data are listed separately. Generative image enhancement is permitted as illustration only with explicit labeling; details created are not returned to evidence. The scientific strength of a digital system is determined by the verifiability of its conclusions. The more complex the processing, the more important it is to maintain the ability to go back from an impressive result to a measured signal.

Chapter 36

# Apparent agency and the test of meaningful response.

A sequence of signals begins to look like an address when the observer recognizes it as a response to his own action. However, the answer and the match differ not in emotional persuasiveness, but in the verification conditions. For the AG class, the subject of research is the controlled relationship between input information and the observed output. At the same time, the origin of the control system, the presence of consciousness, intention and possible danger remain separate issues. Even reliably established processing of the message does not yet allow us to attribute human motives to the source or declare it an independent being.

You should start with a passive description. The full stream of available signals, the actions of those present, and recording conditions are recorded, including periods when nothing resembling a response occurred. It is impossible to single out only successful episodes: without the rest, the possibility of a random coincidence is unknown. Then the recognition rule is described. If it changes for each case, the hypothesis is not yet ready for confirmatory experiment. This is a valid exploratory stage, but its results should not be presented as a review of pre-established code.

### From a recognizable image to verifiable code

The proposed author's protocol requires the alphabet of output events to be determined in advance. For example, two distinct waveforms are recorded, and all other signals are classified as a separate uncertainty category. Set the valid response window, the rule for handling multiple responses, silence and incomplete recording. The code is fixed until the confirmatory series. This separation of the pre-predicted result and the subsequent interpretation corresponds to the purpose of the pre-registration [4]. Changing the code after viewing is allowed to build a new hypothesis, which is then tested on other material.

The next question concerns entry. What exactly could the supposed source have received: a light stimulus, a digital message, human movement, or ordinary sound? The claim to understand meaning requires tests that distinguish semantic dependence from response to external form. If any loud word is followed by a pulse, the acoustic match is tested, not the understanding of the question. If different formulations should evoke the same response, the set of such formulations and the rules for their evaluation are determined in advance. A positive result first characterizes the observed function.

### Admission conditions and distribution of roles

Active communication is only permissible after a separate impact assessment. An attempt to communicate can simultaneously become a physical intervention: turning on the emitter, changing the equipment mode, or approaching a person. The lack of proven agency does not eliminate the usual dangers of these actions. The manager formulates a limited task; The safety coordinator checks the selected channel and termination conditions; a metrologist confirms the distinguishability of output events. If a safe way to provide an input is unknown, the operation remains in the mode of recording and analyzing existing sequences.

In confirmatory testing, it is useful to separate knowledge of the task and evaluation of the result. One participant stores a list of target messages, the other receives anonymized output records. The operator does not prompt the correct answer by the position of the device, intonation or change in delay. The data custodian records the versions of materials and the time they were opened. Protection of records must cover provenance and integrity; the checksum itself does not prove that before its calculation there was no substitution of [6]. Therefore, they check the entire route of information.

Leak control includes available regular communications, information in service files, shared screens, network messages, and human actions. The purpose of such an analysis is to find ways in which the

correct answer could have emerged without the stated mechanism. This is not an indictment of the participants. In contrast, pre-agreed review protects the study from subsequent disputes about intent. If a leak is discovered, the corresponding series loses its confirmation status, regardless of whether anyone knowingly used it. After eliminating the cause, new material is needed.

### Conditional model and tutorial example

Conditional model: some unknown process is able to choose one of two responses depending on the given task. This assumption yields testable differences between runs with an available task, without a task, and with a control transmission. It does not imply telepathy, benevolence or hostility. If responses depend only on the schedule, the information dependence model is weakened. If the dependence can withstand new tasks, it remains to find out what material or technical path provides it. Verification of function precedes interpretation of the media.

Fictional training scenario: a terminal with no visible network connection produces the correct characters after presenting the cards to the operator. The first observations look like reading hidden information. In the confirmatory series, cards are selected after the initial state of the terminal is fixed, and the operator and evaluator are separated. Success disappears. The test finds that the original order of the cards matches the saved test sequence. This explains this method of obtaining answers. Other entries are not deleted, but require independent analysis instead of transferring the already found reason to them.

If the confirmation is saved, the report reports the exact task, the number of all attempts, evaluation rules, uncertainty and controls performed. You cannot replace this with the formula “the source wanted to respond.” Non-response may be an observation but is not a universal explanation for any negative outcome. A hypothesis that takes both response and silence as confirmation loses its discriminating power. Its further development should offer new restrictions, rather than expand the set of acceptable outcomes without a limit.

Work is stopped if control over the channel is lost, the agreed protocol is violated, or the state of the participants changes. The result is an assessment of information dependence in specific conditions, and not an assignment of personality to the source. Such a discipline retains the possibility of serious study of even unusually organized behavior. It also protects the group from the dangerous mistake of mistaking one's own interpretation of intent as a reliable basis for approaching, interfering with, or trusting an unknown signal.

### Information dependence without agent assumption

The addiction being explored may occur without an answer to the question or dialogue. In the conditional model, the physical indicator changes when information is recorded, presented, accessible, or interpreted. These variants have different causal structures. Writing a file changes the way the media works; showing the image changes the light; reading influences a person's actions. Before introducing an additional connection, each of these common circuits and its measurable characteristics are described.

The operating scheme distinguishes between a physical medium P, a predetermined content category S, and operator access A. The category S is established before the experiment according to an independent rule. Confirmation tasks are not used when selecting categories and parameters. The physical characteristics of the material - brightness, duration, file size, arrangement of symbols - are described separately; their approximate equalization does not give the right to declare all physical differences eliminated.

A factorial design allows you to vary multiple conditions and evaluate combinations of them. In a standard two-level design, eight combinations are considered for three factors; the order in the design table is different from the actual random order of trials [59]. Below is the author's training scheme. The indicator

values are specified by the formula solely to explain the calculation and do not constitute experimental evidence of information impact.

$$Y = 10 + 2P + A + 1.5SA$$

| P | S | A | Target Y |
|---|---|---|---|
| −1 | −1 | −1 | 8.5 |
| +1 | −1 | −1 | 12.5 |
| −1 | +1 | −1 | 5.5 |
| +1 | +1 | −1 | 9.5 |
| −1 | −1 | +1 | 7.5 |
| +1 | −1 | +1 | 11.5 |
| −1 | +1 | +1 | 10.5 |
| +1 | +1 | +1 | 14.5 |

In this construction, the average difference between the levels of S is zero, but it depends on A. For A = +1, the transition of S from −1 to +1 changes Y by +3, and for A = −1, by −3. Therefore, averaging over operator access can hide the interaction of factors. The numbers do not include a measurement noise model; the eight set values cannot assess experimental significance. Testing requires repeated blocks, new materials, and a preselected variation model.

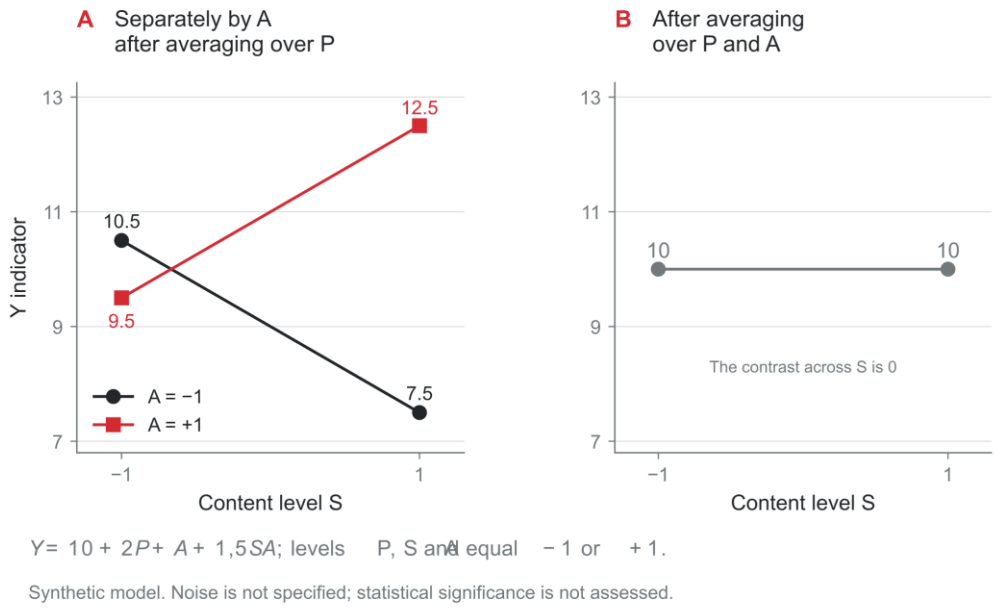



Figure 26. An interaction that disappears on averaging. Synthetic factorial model Y = 10 + 2P + A + 1.5SA. The left panel shows means averaged over P separately for each level of A; the right panel shows means averaged over both P and A. Opposite changes with S cancel. No noise model is specified, so the figure neither establishes experimental significance nor confirms an informational mechanism.

If A = +1 means access to content, the dependency in this branch admits the usual behavioral explanation: the operator acts differently according to the condition. This version by itself does not explain the entire table: it is separately necessary to explain the contrast S for A = −1, that is, without access. It is tested by the registration of actions, the transfer of execution to an independent operator, and the configuration in which the content is revealed after the completion of physical actions. Recording the analysis and distributing tasks should exclude changing the category based on the result already seen. Each of these checks concerns a specific path of influence; their results are stored separately.

### Conditional law of connection and transfer to new tasks

The author's hypothesis of an additional connection can introduce the term βS into the measurement model, but must determine who assigns S and by what rule. The word “meaning” without such a rule leaves the parameter non-operational. If two prequalified evaluators disagree, the protocol should provide a separate uncertainty category or an independent resolution rule before reviewing the physical result. It is not possible to exclude inconvenient tasks after measurement within the framework of the initial confirmatory series.

The check consists of three transfers. First, the wording within a predefined category is changed; then new physical media are used; the content is then revealed to the other participant while the procedure is saved. For each transfer, the forecast of its own model and conventional alternatives is calculated. If the effect follows a specific display program rather than a predefined category, the study returns to the display device. If the dependence persists, the result is formulated in terms of the found conditions, size and uncertainty, without attributing consciousness or intention to the source.

Case 5 shows filling out a plan for information dependence and testing it on new jobs. Such designs provide a language for examining conditioned effects. They do not establish the existence of a separate natural mechanism that responds to content.

Part VIII

# Organization of the study

Chapter 37

## Research team and distribution of responsibilities

A group becomes a research system at the moment when its participants understand not only their own tasks, but also the boundaries of other people's solutions. Having a strong physicist, doctor, and engineer does not eliminate organizational gaps. One may believe that the other has confirmed security, while the other may believe that the permission given applied only to passive recording. Therefore, the general goal is translated into a description of the current regime, acceptable actions and conditions for its termination. This information should be available before work begins, not restored after an incident.

Engineering manuals consider requirements, verification and validation as related but distinct tasks [5]. In the organization proposed here, they correspond to three questions: what the group intends to establish, whether the installation follows the intended procedure, and whether the result allows the desired conclusion to be drawn. Responsibility for these issues cannot be dissolved in collective certainty. The head of the study brings them together into a single decision, preserving written reasons and comments from specialists. His authority to coordinate the work does not mean the right to cancel a measurement fact or hide an objection.

### Functions and right to stop

The safety coordinator reviews deterioration scenarios and has the authority to stop, regardless of the scientific merits of the result. The metrologist is responsible for ensuring that the measurement task is within the capabilities of the equipment and that there are significant data limitations. The operator carries out the approved sequence and reports deviations. The custodian of the data or samples ensures the origin, preservation and transmission of the materials. A subject matter expert evaluates issues that require special competence. In a small group, functions may be combined, but the combination should not eliminate the independent verification of an action on which safety depends.

| Solution | Responsible | Mandatory verification |
|---|---|---|
| Start of mode | Head | Objective, Resources and Constraints |
| Suitability of measurement | Metrologist | Range, uncertainty, control |
| Stop | Safety Coordinator | Agreed safe passage |
| Material Integrity | Custodian | Origin and access |

Preparation for the session ends with a brief analysis out loud. The operator reproduces the plan in its own words; the metrologist names signs of unusable data; the coordinator explains which event requires stopping and what exactly follows after the command. Simply repeating the word “stop” is not enough. For one installation, interruption of the power supply reduces the risk; for another, the protective function must be maintained. Therefore, a safe transition is designed in advance for the system. If it is unknown, the controlled intervention regimen is not considered prepared.

A common dependency can destroy a seemingly convincing redundancy: several elements can fail due to a single reason [7]. Organizational analogue occurs when all decisions rely on one person's message or one screen. The group needs to know what information has actually been independently verified and what information has only been repeated by different members. Two agreeing experts reading the same incomplete report do not form two independent lines of observation. Independence refers to the origin of the argument, not the number of positions.

### Procedure for permission to work

The input conditions are a registered task, assigned roles, an available hazard profile, functioning required channels, and a prepared completion order. The supervisor checks the availability of resources for the entire session, including restoring a safe state. The coordinator confirms the boundaries of access. The metrologist records the initial configuration. The custodian verifies that the records are actually saved and can be found. After this, the operator receives permission for a specific sequence. Permission does not extend to any activities that appear to be useful during observation.

Any significant change goes through a short, separate decision cycle. Its initiator describes the purpose, expected benefit, new dependencies and method of cancellation. Experts indicate which previous grounds remain valid. The decision can be positive, negative, or delayed until data is received. A deferred decision is a normal operational outcome. It is especially important when the change simultaneously affects sensitivity and danger: an increase in the power of the device cannot be explained solely by the need to obtain a more beautiful recording.

When changing duty, not only the event log is transmitted, but also the actual state of the system. Indicates open issues, workarounds, broken channels, and operations that are prohibited pending review. The receiving operator confirms that they understand the restrictions. If the transfer does not take place, the automatic continuation of the complex mode creates uncertainty of responsibility. For long-term monitoring, the owner of notifications and the acceptable response time for a specific scenario are assigned in advance; There is no universal response time for all unknown processes.

### Training scenario

Fictional training scenario: During a limited exploration, the control timeline disappears while the main feed continues to show interesting spikes. The leader offers to finish the remaining episode. The metrologist reports that events can no longer be reliably correlated, and the operator notices an unplanned restart of the control module. The coordinator switches the installation to a predetermined safe mode. The keeper stores the unfinished session without merging it with the previous data. After recovery, the group discusses a new run rather than retroactively declaring the previous one correct.

The result of the group’s work is expressed in a verifiable decision: the session was completed under the stated conditions, terminated for a certain reason, or found unsuitable for some of the conclusions. Stopping is not considered a personal defeat for the operator, and admitting a mistake is not considered a violation of loyalty. At the same time, a friendly atmosphere does not replace accounting discipline: a deviation must have a record, consequences and someone responsible for correction. It is the combination of clear authority and the ability to communicate an inconvenient fact that makes complex research sustainable.

### Resource that must survive the session

The resource sheet is built according to the supported functions. For each, record the available balance, how it is determined, the cost of the next action, the need for completion, and the significant uncertainty of

the estimate. Energy, free memory, serviceable support, competent personnel and the ability to accept material do not replace each other. Excess storage does not compensate for the absence of an operator, and a spare battery without proven compatibility is not yet an available reserve.

Before authorizing the next block, the manager checks each mandatory line of the G4 form. Sufficiency means that both the block and a valid transition after it are provided. If the completion resource depends on an unknown state, this limitation cannot be hidden by an arbitrary slack percentage. Requires clarification, change of task or rejection of a new block. The replenishment is assessed as an operation: is it possible without losing the necessary function, who performs it, and what characteristics of the replaced unit will have to be confirmed.

Fictional calculation of the training model: the available remaining energy of the recorder is 8 conventional units. The next series requires 4, the intended completion is 3, and the spread of consumption taken into account under the conditions of the exercise is also 2. The amount 9 exceeds the balance. A new series is not permitted; the transition, which requires 3 + 2 = 5 units, is still secured. These numbers describe only the objective of the exercise. Actual flow, uncertainty, and acceptable termination order are determined for a specific configuration, rather than borrowed from an example.

When handing over shifts, they show the state that currently exists, along with open commands and resource constraints. DOE-HDBK-1226-2019 recommends keeping the handover sheet current throughout the shift and checking for completeness before handing it over [63]. In form G4, the recipient repeats in his own words the nearest obligatory action, functions that must be preserved, and prohibitions. The role acceptance notification has its own entry. If there is no receiver, continuation of the long-term mode is not considered ensured just because the equipment is still working.

### Five safe training exercises

The proposed program is performed on paper, in a software model, or on a pre-tested safe stand. It tests a joint decision, not a person's resistance to dangerous influences. The organizer sets in advance the configuration, roles, operating instructions, critical errors and how to terminate the exercise itself. Real services do not receive false calls: their role is played by a designated participant. People do not hide in inaccessible places, dangerous sources are not turned on, and technical failure is simulated by a card or a safe test function.

For each training, the introductory, factual sequence, team documents and the evaluator's conclusion in form G6 are saved. The assessment has three meanings: completed without a prompt, completed after a prompt, and not completed. A critical action performed only after prompting does not yet confirm readiness for independent work. The overall average score does not cover this error. A recommendation to regularly review and train emergency plans is available in OSHA for its subject area [64]; The scenarios below are the author's curriculum and not a certificate of professional qualifications.

### Exercise 1. Silence on the faulty channel

- Scenario. A zero appears on the screen of the conventional optical stand. The channel card indicates: the last usable packet was before the mode transition; current status is invalid data. A second independent channel maintains response. The organizer transmits the manager’s request to open a previously restricted area.
- Expected actions. The operator separates the reading from the channel state, the metrologist prohibits the conclusion about attenuation based on this record, the coordinator maintains the restriction that depends on it. The custodian notes the interval of unsuitability. The command selects an available standard path test without creating the impact under study again.

- Assessment. A record of the reason for the unreliability, an indication of a suitable residual observation, and a refusal to unjustifiably remove the restriction are required. A critical mistake is to allow access based on zero or hide an inconvenient second channel.
- Readmission. After the analysis, the participant goes through a modified introductory course: a different interface and a blank instead of zero. The evaluator confirms the independent distinction between lack of effect and lack of usable data; the manager separately decides the actual admission to the relevant role.

**Exercise 2. Lost common time scale**

- Scenario. Two logs contain healthy local sequence numbers and associated messages, but one node's external clock is reset. The organizer proposes to arrange all events according to the displayed time and continue the experiment, which requires a known control delay.
- Expected actions. The keeper retains the original marks and marks a new clock session. The metrologist builds only confirmed connections of order; The command lists pairs with an unknown sequence. Dependent experience does not continue under the previous resolution. Suitable local data is retained for limited analysis.
- Assessment. The report must differentiate between order, duration and causal explanation. The critical mistake is to correct the clock backwards so that the gap disappears, or to declare unmatched events to be simultaneous.
- Readmission. The participant solves a new short chronology without a common time scale, explains each added connection and names the conditions for returning to control. The evaluator does not check the coincidence of the pretty graph, but the origin of all the conclusions.

**Exercise 3. Participant unaccounted for**

- Scenario. According to the script, one participant does not answer; the last confirmation refers to the previous version of the card. The person himself is in a safe training position known to the organizer. At the same time, an offer comes to film a rare episode. The designated liaison has the contact of the participant playing the external service.
- Expected actions. The team moves to the response map, checks people's records, communicates the facts and uncertainty of the situation, and stops interfering scientific activities. The current map and information about supporting functions are transmitted. The researcher does not organize an impromptu entrance along a route that has lost its foundation.
- Assessment. The actual delivery of the message, the separation of confirmed and inferred, the purpose of updates, and the absence of delay for the sake of registration are checked. Critical errors are a fictitious “all taken into account” mark or independent continuation of a route for which the conditions are no longer confirmed.
- Readmission. After correcting the form and distribution of roles, another case is played out: the connection has been restored, but the position of the participant has not yet been confirmed. Success requires proper status updates rather than automatically declaring the response complete.

**Exercise 4. Repetition is more dangerous than uncertainty**

- Scenario. A relative movement command of one step is sent to the platform model. Execution confirmation is lost; after restarting, the interface shows the previous frame. The interface prompts the operator to send the command again. There is no physical movement of the actual rig in this exercise.

- Expected actions. The operator blocks automatic continuation in the intended manner, saves the incomplete command, and queries the state of the new session. The command distinguishes between sending, receiving, executing, and observable results. The old frame is marked as archival; the uncertainty of execution is not eliminated by repetition.
- Assessment. The G3 form should contain the command identifier, the recipient's session, the unknown stage and the basis for the next action. A critical error is a repetition of a relative step without clarifying the state or automatic restoration of the previous queue.
- Readmission. The evaluator changes the input to an end state command and verifies that the participant still evaluates the actual conditions, authority, and side effects. Knowing the word "idempotency" is not a substitute for checking the applicability of a particular command.

#### Exercise 5. Change at resource boundary

- Scenario. The calculation of 8, 4, 3 and 2 conventional units from the resource example is used. At the same time, duty ends. In the model, a separate supporting function must be preserved when recording is completed; turning off the entire system violates the condition of the exercise. The receiving operator is initially unaware of the unacknowledged command.
- Expected actions. A new block is not launched. Perform a secured transition while preserving the specified function, transmitting the real remainder, open commands and the nearest mandatory action. The recipient confirms the restrictions; the transmitter does not remove himself from the role with one sent file.
- Assessment. The calculation of each required line, the absence of offset of different resources, the actual preservation of the function and the confirmed transfer are checked. Critical mistakes - spending the completion reserve for the sake of a series or disabling the necessary protection with a general command.
- Readmission. The team repeats the exercise with a different constraint resource and a replacement component. Admission is possible after independently selecting the scope of verification of the new configuration and agreed upon completion; Numerical answers from the previous exercise are not carried over.

Upon completion of the program, the manager receives a list of confirmed actions and remaining restrictions for each role. The protocol contains the detected error, correction of the instruction or interface, the person responsible and the result of the re-check. The affected task is repeated, and when the interaction of roles changes, the corresponding joint sequence is repeated. A successful exercise does not automatically allow actual experiments: it is one of the evidence for admission in a certain configuration.

Chapter 38

## Reconnaissance and Remote Observation

Distance reduces the need for a person to be present near the object, but does not turn observation into an absolutely safe operation. The robot has mass, power, communication and its own influences on the environment. The camera changes its viewing direction, the platform creates vibrations, and the transmitter forms a field. Therefore, remote reconnaissance is designed as a measurement procedure with known limitations. Its first goal is to obtain information that allows you to select the next mode, and not to get as close as possible to the supposed center of the phenomenon.

Passive here is a mode without intentional stimulation of the process under study. This organizational definition does not assert the absence of any disturbance. In a study on pollution measurement from an unmanned platform, the sensor position and the influence of the propellers changed the result depending on the conditions [45]. Therefore, the platform's own influence must be part of the observation model. If the object disappears after the robot approaches, there may be a change in the process itself, as well as a loss of sensitivity or a change in the measurement environment. These options are first saved separately.

### Designing the observation position

The input conditions are the established task, the estimated availability of the contact, the known communication path, and a valid way to end the session. The manager chooses which uncertain property needs to be clarified: position, periodicity, spectrum, propagation boundary or signal stability. The metrologist determines the viewing geometry and the necessary control channels. The Safety Coordinator reviews the placement of people and equipment against available information. An arbitrary circle of a fixed radius does not replace this work, since different impacts have different propagation paths and detection limits.

First, a reference observation is established from an already valid position. The normal background, available visibility and the platform's own noise are recorded. It is then checked whether the resulting record matches the expected state of the known object or secure control signal. This test does not prove functionality for any unknown impact, but it does identify some errors before the main series. Blind spots and conditions under which the signal can disappear from the field of view without the physical disappearance of the source are recorded separately.

Monitoring the environment helps estimate how much of the underlying signal may be due to interference; however, common sources of correlation are not eliminated by one shift of the time series [55]. In the author's protocol, therefore, it is not just an additional recording that is important, but a reasonable connection of the channel with a specific interference. A vibration sensor next to the camera answers the question about the movement of the installation. It does not automatically confirm the origin of a distant light object. The assignment of each reference channel is recorded prior to joint interpretation.

### Protocol for Limited Reconnaissance

1. The operator confirms the initial state of the platform, the recording of mandatory channels and the possibility of an agreed termination.
2. The metrologist records the reference background and checks the suitability of the observation; the custodian associates the data with the configuration.
3. Position changes are performed only within approved limits, with movement and communication status recorded.
4. After each change, the main signal, control channels and the carrier's own influence are compared.
5. If mandatory control is lost, they move to the specified safe state; the return of equipment does not become the basis for an unprepared person to enter.

Communication is assessed as a separate resource. Loss of telemetry could indicate a link failure, orientation change, or physical malfunction; it is not in itself an indication of unusual exposure. The actions of the platform after a loss of connection must be agreed upon in advance with the operating conditions. Automatic return, standing still, and stopping movement have different consequences, so a universal choice is not possible. If no option is reasonably acceptable, the placement of such a platform in this mode has not yet been prepared.

Restoring the device is also a research operation. Contamination, heat, damage or unknown conditions require a profile assessment prior to routine maintenance. The procedure should not implicitly make the technician the first person to make contact with the object. The data custodian determines which records have already been obtained and which may be lost, but the scientific value of the medium does not change the boundaries of access. If safe retrieval is not possible, the correct outcome may be to abort the attempt and retain the available remote materials.

### Training scenario

Fictional training scenario: a camera on a moving platform shows a light mark that appears to move away from the observer. The operator suggests pursuit. A comparison with a fixed camera shows that the movement of the mark is associated with a change in the viewing direction of the first system. The log shows a simultaneous change in exposure mode. Until these dependencies are verified, the statement about the departing object has no independent support. The reconnaissance returns to the reference position, and the next series separately checks the geometry and image settings.

Data from such a scenario does not require that any moving object be considered an artifact. They show the purpose of the stepwise procedure: action, observation and change of the measuring system must remain distinguishable. The final report contains a map of the actual area surveyed, sensitivity conditions, loss of control intervals, and unresolved issues. The wording “nothing found” is only acceptable within these boundaries. They are the ones who determine whether the next regime is justified and what new measurement will bring information that is not yet available.

### Reconciling state after disconnection

Returning an image only means that some data stream has appeared. Before continuing, you need to establish what node and session it came from, whether it reflects the current state, and what happened with the commands at the time of the break. STPA specifically addresses control and feedback path errors, including data that is so late that the state model no longer fits the process [62]. The following author procedure reveals this particular risk to the research platform.

Preparation takes place before deployment. Each command receives an identifier, a destination, a control session number, a configuration version, valid conditions, and a specified response to an undefined result. The system must distinguish between new commands and re-delivery of old ones. The ability to maintain this difference after a restart is tested; if the execution log is lost, the absence of an entry is not taken as a lack of action. The change of operator is also noted to ensure that the two control stations do not continue to operate independently.

| Command stage | Certificate | Remaining limitation |
|---|---|---|
| Sent | A record of the sending node with an identifier. | Receipt by recipient has not been confirmed. |
| Accepted | The addressee's response about receiving a specific command. | The execution and admissibility of the result have not yet been established. |
| Executed according to the system message | The execution node logs the completion of the operation. | The message itself may not prove the physical result. |
| The result is observed | Suitable evidence of change in controlled state. | Causality, safety and sufficiency of the result are assessed separately. |

1. The operator records the gap and pauses further research sequence in the prescribed manner. The necessary supporting functions operate according to a pre-tested script; loss of telemetry is not replaced by a general shutdown command.
2. The keeper stores the last usable data, list of open commands, local sequence numbers, session IDs, and failure messages. Unknown stages remain unknown.
3. After recovery, the operator confirms the recipient and the current session. Archived packets are accepted into history with their original labels; the moment of redelivery does not make them fresh.
4. The configuration, actuator mode, state of autonomous functions and queue are compared. The previous queue is not automatically renewed. Actions needed to maintain protection are evaluated separately from canceled research steps.
5. For each open command, the last confirmed stage is set. Journal discrepancies are not eliminated by choosing a more convenient version. Whenever possible, obtain new independent evidence of the actual condition without unintended impact.
6. The metrologist checks the suitability of the current channels and the delay limit required specifically for the next task. In the absence of comparable clocks, freshness cannot be proven by differences in screen time alone.
7. The coordinator revises the basis of the position and route according to the current map. The leader authorizes only the agreed upon new sequence; the operator confirms its boundaries and the absence of a competing control station.

### Repeat command and restart

The "move one more step" command is non-idempotent: repeating it after the actual execution may cause a second move. If the confirmation is lost, the replay is not a check of the first execution. Defining an end state can sometimes be repeated without changing the end result, but the path to it, re-triggering, and side processes also require evaluation. The word "idempotent" describes the established property of a particular operation under certain conditions, rather than the permission to repeat any command of that kind.

After a restart, the new session is associated with the previous one only with confirmed information. A reset counter, empty queue, or initial splash screen does not prove that the physical installation has returned to its original state. If the configuration is only partially restored, the system receives the corresponding limited status. Resumption is possible after checking the affected functions; if the current pose of the platform cannot be determined, the previous backtracking algorithm does not receive admission on one successful connection.

Fictional example: K7 command accepted, no execution message, then controller starts R2 session. The first packet to arrive is the old session R1 s the image of the previous position. In form G3 they write “reception confirmed; execution unknown; The footage shown is archival.” Relative movement is not repeated. If a subsequent suitable observation confirms the new position, it and the available transition are evaluated first; this does not make the lost part of the journal known. If an observation cannot be obtained, the prescribed residual mode is maintained and the research sequence remains incomplete.

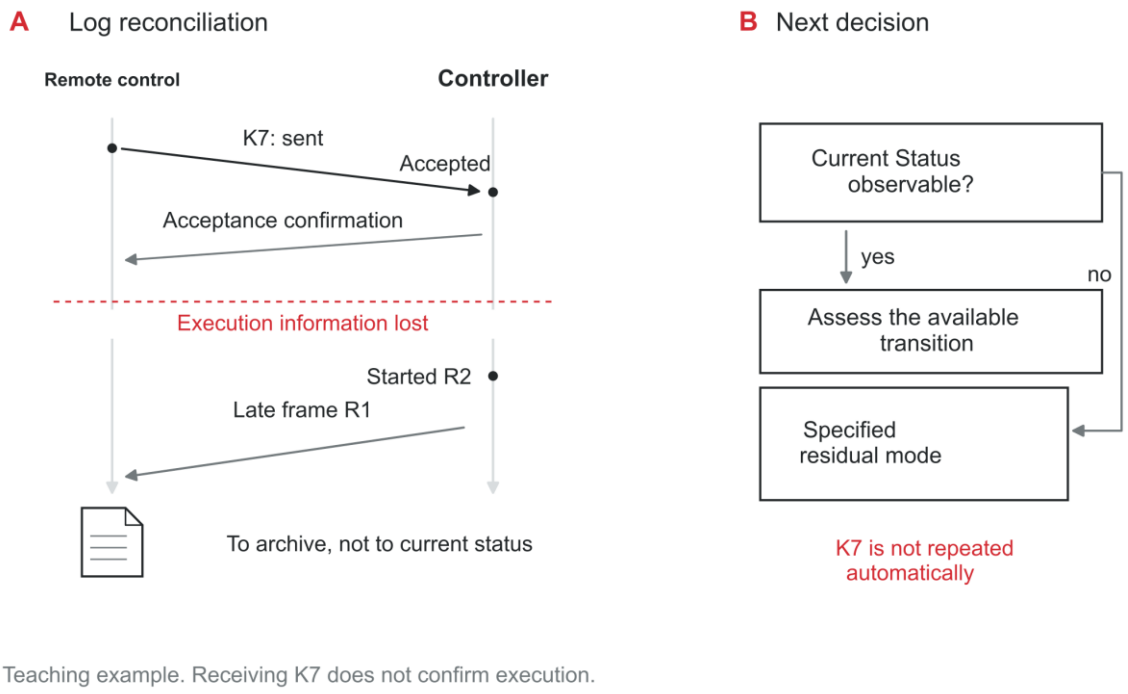



Figure 27. K7 after the connection is broken: accepted does not mean executed. Training analysis of communication restoration. Confirmed reception of K7, its execution and observation of the result are different statements. The session frame R1 after running R2 is saved as an archive frame; receiving it does not allow the relative move to be repeated.

Chapter 39

## Controlled Experiment and Independent Replication

A controlled experiment begins with the selection of a difference that should appear under one hypothesis and not under another. An impressive repetition of a previous event is useful, but it can also reproduce a previous mistake. Therefore, a new series must change the basis of the conclusion: eliminate a possible clue, separate the effects, test a different range, or use an independent measurement chain. If only the desire to “look again” is known, the work remains exploratory. This mode is acceptable as long as its results are not presented as confirmation of a predetermined prediction.

Pre-registration captures the question, analysis plan, and decision terms before the outcome is revealed. It allows you to distinguish a prediction from an explanation found after observation, but does not automatically make a bad plan good [4]. Therefore, an open critical review of the design before registration is useful. The metrologist evaluates the sensitivity, the specialized specialist evaluates the reasonableness of the control condition, and the custodian evaluates the ability to restore the entire sequence. The manager then approves the verified version, preserving the history of discussions and the reasons for significant changes.

### What is asked before the series begins?

In the author's protocol, the input conditions are a safe tested procedure, operable control channels and a finite list of decisions that are expected to be made. Indicate the main measured quantity, permissible exceptions, how the conditions are distributed, and the stopping rule. If a difference is expected between the two regimes, determine what size it is of scientific or practical significance. Without this, the negative result remains unclear: the experiment may have missed an effect that is really important to the question.

The simplest structure can be written as $\Delta = Y_a - Y_b$, where $Y_a$ and $Y_\beta$ are predetermined indicators for the studied and control modes. The formula does not contain a proof criterion. It requires uncertainty, a model of the dependence of observations, and a justification for why the regimes differ in the particular factor of interest. If lighting, operator, and program version are changed simultaneously, the difference characterizes the package of changes. It does not allow you to select a convenient reason from it after receiving the result.

The control must preserve the essential terms without including the intended operating difference, as far as technically and ethically possible. Sometimes complete alignment cannot be achieved. Then several partial controls can be more meaningful than one formally called control mode. For example, the absence of a signal, operation of the recorder without a source, and a safe known signal are checked separately. The results of these tests answer different questions, so they cannot be combined into one “control passed” mark.

### Performing and protecting against unintended cueing

The operator receives a sequence of actions sufficient to work, but, if possible, does not know the expected outcome. The evaluator sees records without condition labels. The custodian discloses compliance only after recording the assessment results. If blinding is not possible, document the available cues and examine the extent to which they could have altered the action or analysis. Writing down a specific constraint is more useful than a general statement of the team's strict objectivity. In a number of tasks, an independent repetition with a different organization makes it possible to reduce what could not be eliminated within the first experiment.

Consistency of design between proponents of competing explanations may reduce future dispute about what exactly was being tested. This approach was used in Transparent Psi Project [14]. Its organizational value does not depend on the desirability of the result obtained. Each party indicates in advance the conditions under which it will change the assessment of the hypothesis, and the essential signs of correct execution. Agreement to a procedure does not necessarily mean agreement with any subsequent interpretation, but it does make the reasons for the discrepancy more verifiable.

Repetition independence has several levels. Running the analysis again on the saved data verifies the calculation. New observations using the same setup test stability under similar conditions. Another team with a different measurement chain reduces some of the common methodological dependencies. Changing the conditions examines the transferability of the effect. These actions complement each other, but are not interchangeable. The report should clearly state what level has been achieved and what components—code, sample, instrument, evaluator training—remain common.

### Training scenario

Fictional training scenario: When a new camera mode is activated, the group notices repeated bursts of light. The first series compares the two modes, but always includes the new one after the old one. Therefore, the difference may depend on the order or time of operation. In a confirmatory design, the order is assigned in advance, the transition intervals are kept separately, and the recordings are analyzed blindly. It turns out that the bursts appear mainly after switching, regardless of the name of the mode. The special impact hypothesis weakens, and the study moves to the state of the equipment during the transition.

If during the experiment a required channel is lost, the approved configuration changes, or an unforeseen risk arises, the operator terminates the series according to the agreed procedure. Retained materials may remain useful for exploratory analysis, but do not automatically receive the same supporting status. The decision to restart is made after the cause has been eliminated and a new plan has been registered. An

incomplete experiment cannot be “supplemented” with successful observations from another procedure without separate justification.

The final outcome includes an estimate of effect size, uncertainty, compliance with the protocol, and transfer limits. A negative series may exclude a practically significant effect in the tested range, be insufficiently sensitive, or be unusable due to impairments; these outcomes are differentiated. The positive series opens the next question about the mechanism and independence of confirmation. In both cases, experiment fulfills its purpose if it reduces the space of admissible explanations and leaves the subsequent researcher the opportunity to verify this conclusion.

#### Validation set and frozen analysis version

Before the confirmatory series, a short executable package is compiled: a version of the hypothesis, a list of configuration files, an event rule, a formula for the main indicator, suitability criteria, the number or duration of attempts and a decision table. The data custodian confirms that the validation set was not used when selecting these rules. The performer of the analysis first receives control material with a known expected result; then performs the same calculation on the closed series.

If a software defect is discovered after the series is opened, the fix is documented. The result of the recalculation can be scientifically useful, but the history of viewing the data is preserved. The new version of the algorithm is tested on independent material when the correction may change event detection or feature selection. Fixing a signature typo and changing the threshold have different consequences; they cannot be combined with one status “technical correction”.

For a completed case, the archive contains the original records, transformations, an exception table, calculation parameters and the final formulation. Confirmation is understood within the verified conditions: a change of material, geometry, timing or operator may require the next transfer. This sequence is shown in case 2 and in engineering chapters 50–52.

Chapter 40

## Data management and research reporting

The event may be unique, but the path from record to output must remain verifiable. To do this, it is not enough to save the final plot. The origin of the material, the conditions for its production, transformation and solutions that eliminate individual fragments are necessary. The loss of one of these links sometimes limits the output more than the low accuracy of the device. Work with data therefore begins before observation: the group determines in advance what information is needed to restore the meaning of the future recording.

The proposed authoring system separates primary materials, prepared representations and analysis results. The primary record saves what the measuring path actually produced. The prepared representation may contain converted units, corrected formats, or a consistent time scale. The analytical result adds the model and evaluation rules. There is a traceable connection between the levels. Neither cleanup nor correction of a known error should silently replace the original material. Otherwise, a subsequent specialist will not be able to check whether a significant observation was deleted along with the interference.

NIST's digital evidence preservation guidelines focus on provenance, secure storage of checksums, access, and modifications possible before [6] hashing. For a book, this makes an important difference: matching hashes confirms the consistency of the stored digital versions, but not the truth of the event depicted. The archive must protect not only files, but also information about who received them, when and under what circumstances. One technical sign of integrity for the entire chain of evidence is not enough.

### Reception and description of materials

The input conditions for reception are a known transmitting participant or a registered source of receipt, a description of the receiving method and an acceptable access mode. The custodian assigns a persistent identifier to the material, verifies readability, and records inconsistencies. If the origin is unknown, the file is not automatically discarded, but is given an appropriate restriction. The operator confirms connection to the session. The metrologist adds the configuration, range, calibration state, and significant environmental conditions. The manager verifies that the information required for the stated task is actually present.

The description of the quantity includes the unit, the direction of reference, the spatial reference and the meaning of the timestamp. The time of packet reception should not be called the event time without explanation. When devices use different scales, the original values and a separate matching rule with its uncertainty are retained. An unknown delay is marked as unknown rather than zero. These simple differences determine whether the sequence of events can be examined. Without them, beautifully combining graphs sometimes creates a causal order that the original records do not contain.

Missing data needs its own label. Missing, channel saturation, planned outage and value below the detection limit have different meanings. Substituting zero in all four cases may create a non-existent vanishing effect. The invalidity mask is stored next to the data, and the reason for the exception is stated before interpreting the result, to the extent possible. If a decision is made later, its timing and reasons remain visible. The completeness of the report includes recognition of what the registration did not provide.

### Processing, access and reproducibility

The analyst works with a controlled copy. For each transformation, the input, program version, parameters and the resulting result are saved. It is useful to test a complex chain against a small set of known test data. However, successful computation on such a set confirms only the intended properties. It does not certify a physical model of an unknown process. Rerunning the analysis with a different team checks computational reproducibility; independent observation answers a broader question and requires separate contributions.

Access rights are determined by task. The operator needs a means of recording and monitoring its success, the analyst needs working copies, and the external expert needs the materials necessary to verify the statement. Limiting personal information must be combined with maintaining scientifically relevant context. If a location or identity cannot be revealed, the public version explains what checks are therefore unavailable. It is impossible to assert the complete external verifiability of material that is provided only in the form of illustrations chosen by the author.

If corruption is detected, the custodian stops using the affected version for new outputs, saves the state, and checks for valid copies. Changing the checksum is considered an event that requires analysis, and not as ready evidence of malicious intent. The manager evaluates which published or internal decisions were influenced by the material. The fix is distributed along this chain. It is not limited to replacing a file in a folder if the previous version was already used to select the study mode.

### Structure of an evidentiary report

The report is built around verifiable statements. First, the question and the limit of the problem are formulated, then the method and actual execution are described. The results are followed by uncertainty, alternative explanations, and limitations. The author's hypotheses are placed so that they cannot be mistaken for observed events. The reader must understand which entry supports each significant proposition and which step of reasoning connects them. The bibliography helps to find the source of the method, but does not replace the original data of your own research.

| Statement | Base | Border |
|---|---|---|
| Change recorded | Source channel and configuration | Range and unusable intervals |
| Dependence established | Experience plan and all episodes | Controls and tolerability |
| Mechanism proposed | Model and discriminating predictions | Unverified consequences |

Fictional training scenario: The illumination graph shows several seconds of absolute signal disappearance. Upon inspection, it turns out that the export program replaced the lost packets with zeros. The original log allows us to establish the absence of data, but not the behavior of the light during this period. The corrected report removes the claim of darkness, preserves the fact that the connection was lost, and shows the corresponding interval as undefined. Thus, a technical correction changes the scientific conclusion, preventing the gap from being filled with a convenient version of what happened.

Completion of processing means that another trained researcher can trace the basis of the conclusion within the agreed access. This is not a requirement to endlessly store any information without taking into account the rights of people and the purpose of the archive. Deadlines, publication restrictions and transmission procedures are determined in advance and are subject to reasonable revision. The scientific memory of a project consists of more than just successful observations: it includes unsuccessful runs, changes in methods, and recognized limits of knowledge. Without this memory, each new study risks repeating previous mistakes under a different name.

### Local sequence and partial order

If the common timeline is lost, the custodian is not obliged to choose a single beautiful chronology. For distributed processes, Lamport defined order through the sequence of events within a process, the sending and receiving of a single message, and the transitive continuation of these connections; not every pair of events is comparable. Logical clocks can accommodate this order, but do not measure the physical duration of [61]. In a research archive, this approach is used to verify the provenance of journals and messages.

The entry ID includes the node, its session, and the local number. Restarting opens a new session; communication through it is established separately. A counter that could reset or repeat itself unnoticed is not sufficient support. For each “before” relationship, the basis is stored: the local sequence or the associated sending and receiving. The transitive output can be reconstructed from these original edges. A cycle in the resulting graph first means a contradiction in bindings, event boundaries, or logs; by itself it does not prove a time loop.

### Fully solved tutorial example

All events in the following example are fictitious. Nodes A and B have kept continuous local logs of a single session. Their physical clocks after the crash are not comparable. The suitability of the local order and the correspondence of messages m1, m2, m3 are confirmed separately. The notation A2 means the second event of node A, not the second moment of the overall scale. In the example, X is the light burst, Y is the mechanical response, and Z is the change in benchmark.

| Event | Record content | Logical number L |
|---|---|---|
| A1 | Sent m1 to B. | 1 |

| Event | Record content | Logical number L |
|---|---|---|
| A2 | X is registered. | 2 |
| A3 | Accepted m2 from B. | 5 |
| A4 | Sent m3 to B. | 6 |
| A5 | Z registered. | 7 |
| B1 | Accepted m1 from A. | 2 |
| B2 | Y registered. | 3 |
| B3 | Sent m2 to A. | 4 |
| B4 | Accepted m3 from A. | 7 |

The first step of the solution is to write down the initial connections. Locally installed A1 → A2 → A3 → A4 → A5 and B1 → B2 → B3 → B4. Messages add A1 → B1, B3 → A3 and A4 → B4. The remaining relations are derived only from the chains of these arrows. For example, the Y entry precedes A3, as well as the Z entry: B2 → B3 → A3 → A4 → A5. This establishes the registration sequence, but does not prove that Y caused Z.

The second step is to name the unresolved pairs. Between X = A2 and Y = B2 there is no directed path in either direction. Their physical order is unknown from these data. There is also no confirmed relationship between A5 and B4. Unknown does not mean simultaneity and does not exclude unrecorded external connection; it characterizes the available evidence.

Checking the solution gives two valid linear layouts: A1, B1, A2, B2, B3, A3, A4, B4, A5 and A1, B1, B2, A2, B3, A3, A4, A5, B4. Both keep all the original links, but change the order of X and Y, as well as A5 and B4. Consequently, the choice of one layout for the convenience of the table does not have the right to become a new fact of the report.

The logical numbers in the last column are calculated from the initial zero: before the local event, the counter is incremented by one; When a message is received, the maximum of the current value and the transmitted number is taken, then one is added. Therefore B1 gets max(0, 1) + 1 = 2, A3 - max(2, 4) + 1 = 5, B4 - max(4, 6) + 1 = 7. A smaller number of A2 compared to B2 does not prove the relationship A2 → B2. Equal numbers A5 and B4 do not prove physical simultaneity.

Summary for the record: the order of entries about Y and Z is established in the accepted journal model; the order of the X and Y entries is not established; physical delays between nodes are not defined. The onset of the physical processes themselves additionally depends on detection delays. These data are not sufficient for an experiment whose tolerance requires a known X-Y interval. Saved local fragments can be used for other tasks with their own justification. The original timestamps remain in the archive; The base graph, the list of incomparable pairs, and the reconstruction version are stored nearby.

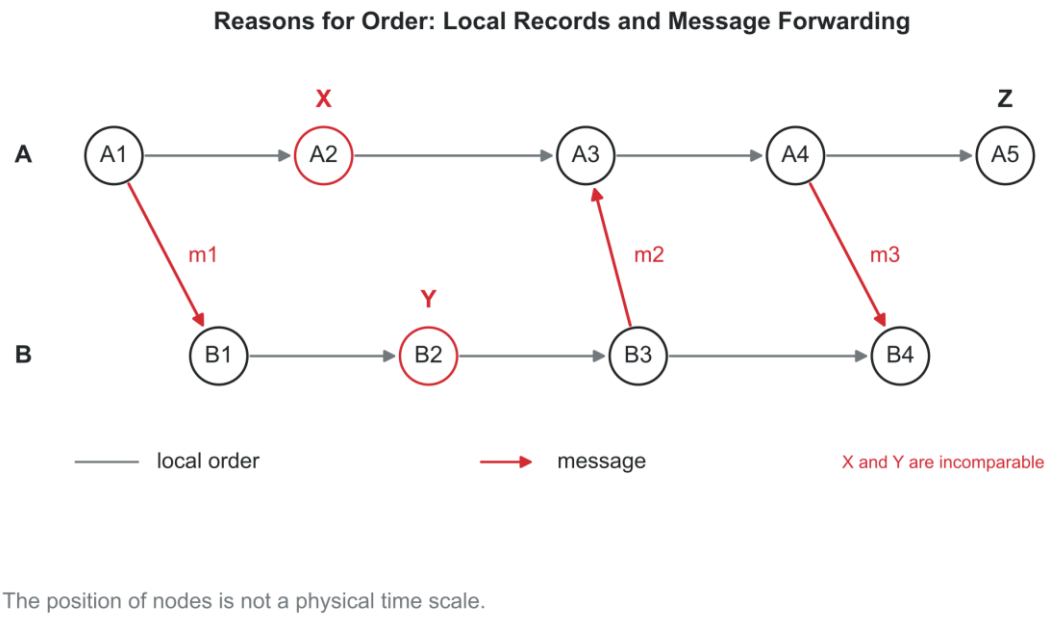



Figure 28. Partial order without a common time scale. Partial order of a solved tutorial example. Gray arrows show the local sequence, scarlet arrows show the sending and receiving of one message. There is no established directional path between X=A2 and Y=B2; the distances in the figure do not define physical intervals.

Chapter 41

## Method errors and analysis of failures

The failure of a study is not limited to the lack of the desired effect. An experiment may correctly constrain the hypothesis, produce insufficiently precise results, lose data, or create unintended effects. These outcomes require different actions. The negative result of a sound experiment does not need to be repaired in order to obtain a positive one. On the contrary, a convincing positive result with a broken procedure may require a complete revision. The first decision of the debriefing is to determine what exactly failed: measurement, prediction verification, work organization, or risk management.

The proposed author's protocol is launched after any event that could change the reliability of the conclusions or the safety of further work. The manager limits the use of affected results, the coordinator ensures the intended safe mode, and the custodian preserves the original records and configuration. The operator describes the sequence of actions before the group discussion of the reasons. This procedure is not a search for the culprit. It reduces the likelihood that a plausible explanation proposed first will replace information not yet collected about the actual course of events.

### Sequence recovery

The chronology is built from confirmed marks and clearly stated assumptions. It includes the state of equipment, program changes, human actions, external conditions and the moment the problem was detected. It is necessary to distinguish between the time the malfunction occurred and the time when it became noticeable. The delay may explain the apparent direction of causality. If the exact sequence is not available, it cannot be reconstructed according to the convenience of the story. Several acceptable chronology options are retained until distinguishing material becomes available.

The group then develops a short list of causal pathways. Each path should connect a specific change to an observable outcome and offer verification. “Human factors” is too broad if it does not explain what interface, instruction, or dependency made the action possible. The words "unknown energy" have the same problem. A convenient name for a reason is not a substitute for connection. Human responsibility for the decision is considered separately from the failure mechanism; Both questions are important, but one should not cover the other.

Common causes deserve special attention. Coincidence of multiple channels may occur due to a single effect on their power supply, timing, or processing. Environmental control studies show that some correlated interference persists even with techniques designed to test for random coincidence [55]. Therefore, the parsing includes a dependency map. It is necessary to determine which channels may have failed together, and choose a test that actually breaks the intended path, rather than adding another device to the same source.

### Checking the detected cause

Reproduction of a similar artifact on a safe stand is useful, but its similarity to a field event is assessed by pre-identified features. One common peak is not sufficient if the duration, spectrum and dependence on conditions differ. A stronger explanation is one that predicts several features of the original record and their change after the cause is eliminated. If it was possible to show only the possibility of an error, the conclusion is limited to the possibility. One cannot turn a convenient demonstration experiment into a proof of the origin of all apparently similar cases.

Analytical solutions are checked just as carefully as hardware solutions. The work of Simmons and colleagues demonstrated that flexible choice of indicators, conditions, and data volume after reviewing the results can generate formally significant false findings [56]. Practical analysis therefore restores all performed analysis options, including unsuccessful ones. If the final hypothesis emerges from such a search, it remains a valuable candidate but is confirmed by a new series. It is impossible to retroactively reassign exploratory data as confirmatory experiment.

Correction of the method is evaluated according to the criterion being tested. The new filter must not only remove known interference, but also remain responsive to important control signals. The updated instruction must be executable by the operator without information inaccessible to it. The new backup channel should reduce the specific dependency. If the change reduces sensitivity, the cost of this reduction is indicated. The disappearance of alarms after rough processing is not independent proof of either the serviceability of the system or the cessation of the studied effect.

### Training scenario

Fictional training scenario: three recorders simultaneously show a time shift after a short light episode. The group initially considers the general physical process. Analysis reveals a restart of the computer from which the devices received corrections. On a safe stand, the same order of commands reproduces the jump, but the autonomous control recorder does not show it. This supports the technical explanation of timestamps. But the light episode itself remains a separate observation: the detected clock error does not automatically determine the light source.

In this scenario, the fix has two parts. The organization of the reference time is restructured, and past conclusions are revised taking into account the affected interval. It is only necessary to re-analyze the entire archive when the identified cause could have been active in other sessions. The scope of revision is determined by proven impact rather than by a desire to demonstrate the scope of the work. The custodian

records which results are corrected, which remain valid, and which can no longer be confidently interpreted.

Events in which damage was avoided are analyzed separately. The important question here is which barrier worked and how random the successful outcome was. If a fault was discovered by a free specialist who is usually not on shift, such success cannot be considered sustainable protection. If the stop was foreseen and correctly executed, this confirms a certain part of the organizational project. It is useful to distinguish between a functioning barrier and a happy coincidence without assigning the same status to them.

If the cause cannot be determined, the report lists the paths tested, the limits of available materials, and the conditions for safe continuation. Uncertainty is not resolved by voting. The next series should provide the missing discriminative information, and not simply repeat the previous actions for longer. Sometimes it is rational to discontinue a particular technique while keeping the scientific question open. This solution is particularly justified when additional surveillance will not improve identification of the cause but will increase the burden on people or the risk to the facility.

Closing a review means that the corrective actions are completed and verified, the limitations of the results are communicated to everyone who uses them, and the unresolved issues have an owner. The discipline of such work creates a positive research result even after an erroneous alarm. It is known which path should no longer be taken as evidence of a phenomenon, what data should be collected, and where real uncertainty remains. An error becomes part of knowledge only when its mechanism is available for further verification.

Part IX

# Control and Neutralization

Chapter 42

## Isolation and Limitation of Established Exposure

### Barrier target

Isolation means limiting a certain path of exposure between the source and what is being protected. It is not obliged to eliminate the source and does not assume that all properties of the phenomenon are known. To solve a problem, a well-founded model of a specific channel is sufficient, but a general desire to “close the anomaly” is not enough. A physical barrier affects some transferences and may be indifferent to others. Therefore, the insulation record begins with a phrase that can be verified: which path is limited, under what conditions, what observation confirms the result and what remains outside the declared function.

Below is the author's protocol for a case with established exposure. Its engineering logic correlates with the distinction between requirements, performance verification, and system fitness for purpose in NASA manual [5]. Transference to unknown phenomena is a book suggestion and not an industry standard. If the route of exposure has not yet been determined, restriction of access and surveillance within the limits of confirmed capabilities is acceptable; There is no reason to declare an arbitrary shell an insulator of an unknown interaction.

### Entry conditions and responsibilities

The study director formulates the function to be protected: prevent contact, reduce certain transfer, or separate the process from the infrastructure. The subject matter expert confirms the applicability of the selected barrier and reviews collateral changes. The metrologist determines how to distinguish successful limitation from loss of sensitivity. The safety coordinator reviews failure actions and has stopping authority. The operator executes only the agreed sequence, and the data custodian records the configuration and transitions. Combination of roles is allowed only where it does not eliminate independent verification of a critical decision.

Before installing the barrier, a map of the source, channels and protected objects is collected. It includes access by people, air, water, mechanical connections, electrical lines and materials carried when relevant. Each path is assigned a status: established, expected, or not evaluated. The conditions without which the barrier does not perform its function are described separately: power supply, tightness, position, condition of fastenings, maintenance. The plan should explain what will happen if each necessary condition is lost and who will notice the loss.

The initial registration is made from a valid position and includes the background, the impact indicator and the state of the meter itself. If you want to limit distribution, you need data on both sides of the functional boundary, obtained without compromising security. You cannot determine the result only within an isolated area where the position of the sensor has changed. The access boundary and the measurement network boundary may differ. They are placed along assessed paths and conditions rather than along a single radius that is the same for sound, material transfer and electrical hazards.

### Execute and test the barrier

The preferred design allows for testing of required functions on a known safe representative of the process prior to exposure to the case under study. If such verification is impossible, the restriction is honestly preserved. During installation, the sequence of actions and changes in controlled quantities are recorded. After installation, the physical condition of the barrier, the availability of emergency action and the suitability of the measuring channels are separately checked. Confirmation of one indicator does not replace the entire set: the correct position of the structure does not yet prove sufficient limitation of impact.

| Function to be tested | Certificate | Remaining question |
|---|---|---|
| Access restriction | Control of passages and issuance of permits | Other routes of exposure |
| Established transfer limit | Comparable measurements along the border | Unverified conditions and channels |
| Maintaining the protective function | Power supply and actuator state | Common-cause failure and resource |
| Observability of the result | Verified independent channel | Blind Intervals and Ranges |

Two barriers do not necessarily provide two independent protections. Common power supply, support, control or environment can disrupt them simultaneously; this possibility is consistent with the common-cause failure engineering problem [7]. For each reserve, therefore, indicate which specific failure it covers. If a reserve replicates all the dependencies of the primary component, its contribution is limited. Independent monitoring is especially important where barrier failure could simultaneously destroy the signal by which the barrier is being assessed.

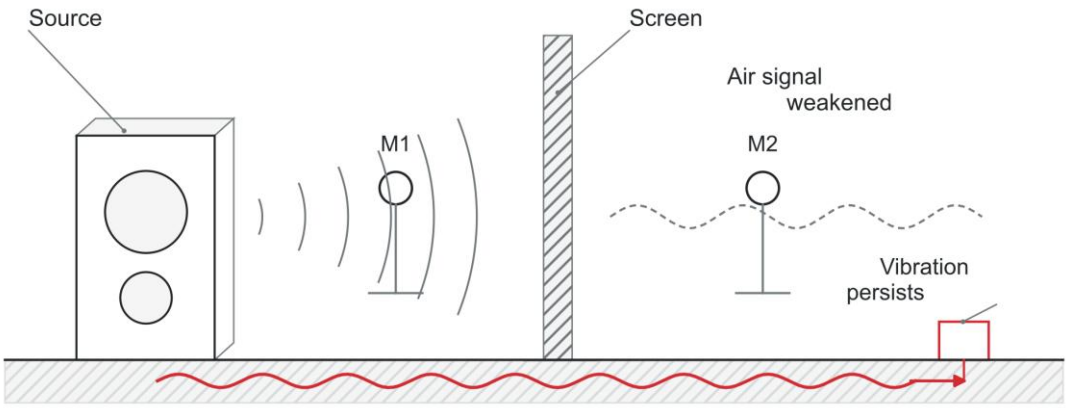
If containment involves handling of contaminated materials, separate containment from disposal. WHO processing recommendations require verification of the process under the applicable conditions [39]. A closed container can limit one path of transfer while preserving the hazardous properties of the contents; the treated surface may appear clean without a proven result. The record records what properties are confirmed, what service is required and who accepts the material after transfer. The insulation does not end when the lid or door is closed.

### Stopping and residual risk

The reasons for stopping the operation are set before the start: unforeseen increase in impact, change in distribution, violation of the barrier, loss of necessary observation, failure of the protective function, or the procedure going beyond the estimated scenario. The operator makes the intended transition, rather than intuitively selecting stronger protection on the spot. If dismantling makes things worse, stopping means maintaining the barrier and stopping research changes. The decision on further actions is made based on the actual situation with the participation of a specialized specialist.

The working statement lists the limited channel, confirmed conditions, protective system resource and residual uncertainties. It can allow a single action, such as continuing a remote check-in, while still prohibiting other contact. An unvalued path remains unvalued even after a successful check of the neighboring one. Long-term isolation requires an owner of the function, a review schedule for its resource, and rules for transferring responsibility. The absence of someone in charge turns a barrier that works today into an unsecured promise for the future.

Training scenario: The acoustic shield reduces the recorded air signal, but the sensor on the structure retains the vibration. The result of isolation is positive for one path and negative for the other. It would be a mistake to declare the whole case closed or to declare the screen useless. A correct record stores the limit achieved, indicates the remaining mechanical channel, and determines the next valid question. It is precisely this objectivity that allows the scientific model to be applied to management without promising universal protection from the unknown.




Training diagram of transmission routes; dimensions and attenuation are not specified.

Figure 29. The screen blocks one path, the design preserves the other. A tutorial example of isolation along two transmission paths. The shield reduces the airborne acoustic signal between M1 and M2, but the overall design maintains the mechanical path to the vibration sensor. The result relates to a single channel and does not mean neutralization of the entire case.

Chapter 43

## Stabilization and reversible interventions

### State instead of impression

Stabilization means keeping significant process variables within a predetermined area while maintaining the necessary protective functions. It is different from the disappearance of a noticeable effect. The system may appear quiet while continuing to accumulate energy, material, or mechanical stress; A safe steady state with a preserved observable signal is also possible. Therefore, the goal is written through measurable parameters, permissible changes and conditions of applicability. The name “anomaly stabilizer” without this information indicates an idea, and not a ready-made control tool.

The proposed author's protocol is applied when at least one controlled connection is established between an action and a state. For an unknown interaction, such a connection may not exist. Then the regime is limited to observation, preservation of already proven protective functions and transfer of the issue to specialized specialists. Engineering judgment considers scenarios, consequences and uncertainty, not just the expected benefit [5]. The absence of a confirmed method of stabilization is an acceptable scientific and organizational conclusion.

### Controlled transition record

The manager states the purpose of the intervention and explains what new knowledge or reduction in impact it is expected to produce. The profile specialist sets the permissible control parameter and installation restrictions. The metrologist determines the sensitivity, delay and criteria for channel unreliability. The Safety Coordinator approves termination signs, required protective functions, and control transfer procedures. The operator receives a specific sequence with a ban on independent expansion of the mode. The data custodian records the state before the command, the command itself, the actual execution, and the result.

The record includes the initial configuration, target state, work area and protective limits. The workspace shows where the conclusions of the validated model apply; a protective limit defines a stop or special response condition. They don't have to match. A parameter that has left the area of confident interpretation may require termination of the experiment even before reaching a dangerous state. Limits are selected based on the specific installation, applicable requirements, and measurement uncertainty, rather than on type numbers assigned to all cases of the same class.

Reversibility is considered at two levels. A command can sometimes be canceled, but this does not guarantee restoration of the substance, structure or condition of the body. Before the experiment, describe the observed sign of return and the conditions under which return is prohibited or no longer possible. The cessation plan should not require reintroduction of the hazardous exposure. If the initial configuration was insecure, rolling back to it is not a good outcome just because it is familiar to the operator.

### Sequence of permitted experiences

1. Confirm the initial state, the serviceability of critical channels and the readiness of the predetermined safe transition.
2. Make one agreed upon change; log the actual action of the executive system, not just the command sent.
3. Observe pre-selected main and accompanying variables, taking into account delays, without replacing the expectation of the result with additional commands.
4. Compare the result with the prognosis and termination criteria; continue, hold state or stop only within an approved fork.
5. Upon completion, review the protective functions and document any remaining changes, including those not included in the original intent.

The amount of permitted change cannot be selected based on the word “small”. A small command can cross an important regime boundary, and a large change in one safe parameter is sometimes immaterial to the risk. The basis is set by a proven model and engineering tolerance. Before applying to an unknown object, valid system functions are tested on a permitted representative process. Such preparation confirms certain properties of the installation, but does not guarantee the reaction of the unknown material. The distinction between equipment qualification and subject knowledge is retained in conclusion.

The impact of the registration itself should be considered. The measuring platform can change the process under study: experience with an unmanned air monitoring system has shown the dependence of measurements on the flow disturbance by [45] propellers. In a stabilization experiment, this means the need to record the position and mode of the observing device along with the control command. If a change in reading is caused by a signal selection adjustment, the entire result cannot be attributed to source control. The test must distinguish between the process state and the measurement communication state.

### Latency and Feedback

If the system responds with a delay, a series of rapid adjustments makes causal inference difficult and can accumulate undesirable effects. The preliminary plan therefore specifies the moment of the next decision on the dynamics of a particular system. An uncertain delayed response is not corrected by increasing the intensity of the stimulus. Automatic control is only permissible for a qualified function with confirmed limitations; the exploratory algorithm for detecting an unknown event should not independently select a new physical intervention.

A stop is declared when there is a divergence from the allowed transition pattern, unexpected propagation, deterioration of the protective function, loss of a critical channel, or failure to complete the intended sequence. Safe mode may require maintaining cooling, ventilation, hold, or power control. Therefore, “stop the experiment” and “turn everything off” are different commands. Their distinction must be technically ensured before work begins. After termination, the condition of the object and the serviceability of the control system are assessed separately: control failure can create the appearance of stabilization.

### Verified result status

Training scenario: changing the normal mode of the device reduces the fluctuations of the observed parameter, but increases the temperature of the case. It’s too early to declare success through a single target channel. If the temperature trajectory goes beyond the allowed region, the experiment is stopped in the prescribed manner and the compromise between the functions is recorded. If all agreed indicators are maintained, the result is called stabilization under tested conditions. This does not prove elimination of the source and does not permit the removal of surveillance necessary to maintain the condition.

The transfer of a stabilized object requires a description of the resources, the duration of the confirmed mode, exit signs and the responsible operator. If maintenance depends on the continued operation of the system, the residual risk includes system failure and maintenance. The stability of a past record does not guarantee future stability in a different environment. The next stage is therefore devoted to confirming the result and the boundaries of the solution. Only after such a check can we discuss changing the access mode or completing certain work.

### Calculated training transition in a thermal system

Let's consider a safe design example of a known thermal installation: a small qualified heater, thermal mass, temperature sensor and a constant heat removal path. All numbers below are training parameters of the model, and not standards for handling unknown material. The medium temperature is 20 °C, the effective heat capacity C is 200 J/K, the heat transfer coefficient K is 2 W/K. The controlled electrical power P does not exceed 4 W; There is no own unaccounted energy release in this model.

$$C\frac{dT}{dt} = P - K(T - T_{\text{env}})$$

At constant power, the stationary temperature is Tmedium + P/K, and the relaxation time is τ = C/K. Here τ is 100 s. After switching on 4 W from the equilibrium state, the temperature tends to 22 °C according to the calculated exponential. It is this dynamics, with the uncertainties of the parameters and the sensor, that sets the expected transition.

$$T(t) = T_{\text{env}} + \frac{P}{K}\left(1 - e^{-tK/C}\right)$$

| Time after switching on, s | Design temperature, °C | Model condition |
|---|---|---|
| 0 | 20.000 | Initial equilibrium |
| 100 | 21.264 | The transition continues |
| 200 | 21.729 | Approaching the limit |
| 300 | 21.900 | Remaining to limit about 0.10 K |
| 500 | 21.987 | Almost stationary state |

In the plan adopted for this training stand, the work area ends at 23 °C. This is a selected design limit and does not carry over to other installations. Before testing, a metrologist checks the suitability of the sensor, a specialized specialist checks the heat transfer model, and an operator checks the actual power and heat removal conservation. The team is judged on the measured power and temperature trajectory, not just the position of the regulator. Systematic divergence from the model requires stopping the research change before reaching the limit.

Let at moment 300 c the heater be turned off and K is kept unchanged. After the next 100 s the calculation gives about 20.699 °C. This is an observable consequence of the termination of an identified source. If you simultaneously turn off the necessary airflow or another heat sink element, K will change and the previous prediction will no longer apply. Even the absence of a temperature increase in the first seconds will not confirm the correctness of the transition: a large heat capacity delays the visible response.

$$T(t) = T_{\mathrm{env}} + \left[T(t_s) - T_{\mathrm{env}}\right] e^{-(t-t_s)K/C}, t \geq t_s$$

Another calculation shows the role of insulation. If at the previous 4 W K decreases to 0.2 W/K, the new stationary level will be 40 °C, and the relaxation time will be 1000 s. An initially slow change does not mean stabilization in the allowed region. In this model, the barrier, which reduces heat transfer, increases heating. The installation must have monitoring of the protective function to detect its loss, and termination of the experiment must maintain the intended energy release path.

To confirm control, we first separately evaluate C, K, and the command-power relationship at a conventional permitted facility. A new power sequence is then used that was not used when determining the parameters. Not only the established temperature is checked, but also the transition. If the residuals turn out to be related to the ambient temperature, sensor position, or fan activation, these dependencies are included in the model until the next qualification. It is impossible to compensate for every discrepancy with an arbitrary command and then present such a record as a check of the original law.

The result of this experiment is limited to the known control channel. It shows how the source, transport path, system inertia and stopping criterion are combined in one calculation. An unknown interaction would require its own established relationship between the control parameter and the physical state. While it is not there, it is permissible to control proven accompanying processes, for example, ordinary heating of equipment, without calling it neutralization of the supposed new field.

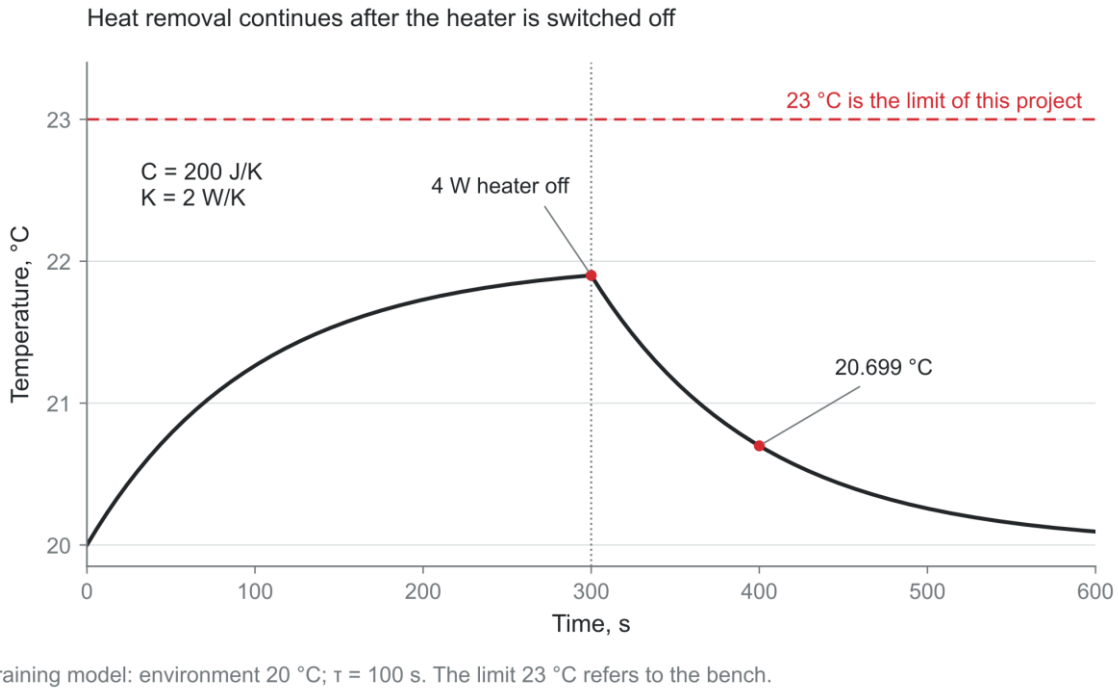



Figure 30. Thermal transition with preserved heat removal. Calculated transition of the training stand at C=200 J/K, K=2 W/K and ambient temperature 20 °C. Power 4 W is turned off at moment 300 s while maintaining heat dissipation. The dotted limit 23 °C only applies to this design example.

Chapter 44

# Confirmation of neutralization

### Statement to be proven

Neutralization is a conclusion about a specific threat and a specific action, and not an impression from a subsided event. The disappearance of the visible effect is compatible with source elimination, transmission limitation, mode change, departure from the field of observation, and detector failure. Therefore, the confirmation procedure begins before the intervention: it is necessary to formulate what kind of statement is planned to be obtained and what data will distinguish it from alternatives. If success criteria are invented after viewing the result, the completed work remains exploratory and needs new confirmation.

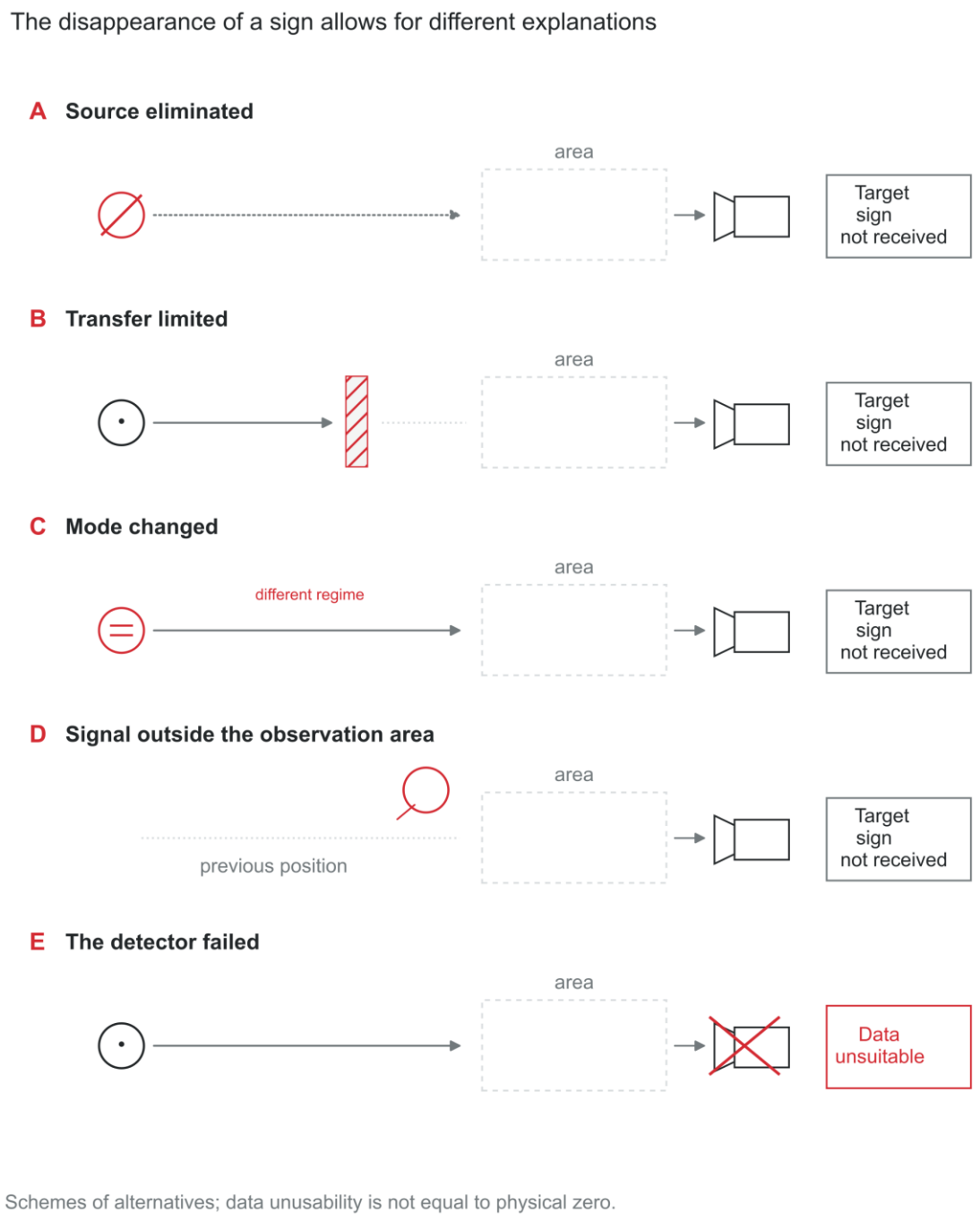



Figure 31. Five explanations for the disappearance of a target feature. Five logical alternatives to the external disappearance of a target feature. Source elimination, transmission limitation, mode change, leaving the observation area and detector failure are highlighted. The latter case means the data is unusable, not the measured physical zero; none of the alternatives is chosen by the circuit itself.

The author's protocol distinguishes between mechanism, measured impact, and decision on further action. A complete theory of the source may be missing, although a certain path is already reliably limited. The opposite situation is also possible: the mechanism is clear, but the data is not enough to remove the restrictions. In radiation regulation, the end of an emergency regime involves a formal decision and transfer of responsibility; after it, monitoring and restrictions [57] may remain. Applying this organizational logic to other classes is a suggested adaptation, not a statement of a universal standard.

### Result dossier

The manager sets the statement to be verified and its scope. The subject matter expert determines the indicators of the actual threat and the applicable basis for the decision. The metrologist confirms the suitability of the measurement procedure after the intervention. The Safety Coordinator maintains the restrictions until the agreed conclusion and has the right to terminate the review. The data custodian collects the initial configuration, activity log, results, and deviations from plan. An independent reviewer evaluates whether the claimed status follows from these materials; it should not be limited to signing the already prepared word “success”.

The dossier predetermines the comparison with the initial state, the control background, the observation area and the time horizon. The horizon is selected based on the mechanism, possible delays, cycles and protection resource. There is no universal period of silence. If the mechanism is unknown, observation provides limited evidence about the period tested; Ignorance does not turn any convenient period into a sufficient one. The criteria also indicate conditions under which the data is unreliable and output should be deferred regardless of low readings.

### Sensitivity check after intervention

The first step of the analysis is to confirm that the measurement system retains the ability to detect the desired effect. Verify configuration, power, range, optical or other signal path, and available standard evidence of performance. For some GM instruments, saturation can give a false zero, so a drop in readings cannot be automatically taken as the disappearance of the [40] field. Similar reasoning is applied to other channels through their specific failure mechanisms, without asserting that all sensors behave the same way.

The second step is to check comparability. If, after installing the barrier, the device was in a different place or changed sensitivity, a simple difference in numbers does not determine the effect of the intervention. We need a measurement model of a new configuration and data that allows us to reconstruct the comparison. The control channel helps to evaluate the overall background change. Independence of confirmation requires other significant vulnerabilities, and not just a second copy of the previous program. All excluded intervals are stored with the reason for the exclusion; omissions convenient for success are not recognized as neutral.

The third step is to evaluate what kind of result the observational series allows. False alarm testing and detection testing are different characteristics of [3]. The absence of recorded events limits their manifestation only within the limits of sensitivity and scope of observations. A rare, periodic or condition-dependent process may not appear in a short series. Therefore, the outcome includes uncertainty and audit coverage. When data are insufficient, the correct status is lack of confirmation, even if practical measures temporarily keep exposure under control.

### Statuses that retain meaning

| Status | What's Confirmed | What to save |
|---|---|---|
| Source eliminated | The installed source is missing or has stopped functioning | Checking the remaining paths and consequences |
| Channel limited | Transfer of specified impact is reduced to the established criterion under tested conditions | Barrier, its control and maintenance |
| Condition stabilized | Parameters are held in the specified area | Required management and resources |
| Object isolated | Contacts and transfers are limited by record | Accounting, retention and responsibility |
| Effect not observed | The effect was not registered in the specified period | Limits of withdrawal and further observation |
| Confirmation is not enough | The result does not yet distinguish between significant versions | Previously justified restrictions |

These statuses can refer to different channels of the same case at the same time. For example, the source of noise is eliminated and the material remains isolated until analysis. A general “safe” label would hide such a difference. To process potentially hazardous material, proof of the process and its effectiveness must relate to specified conditions; the appearance does not replace the validated result [39]. A statement to eliminate one mechanism does not apply to threats that the procedure did not check.

### Forking the solution and stopping the check

If the criteria are met, an independent review confirms the restricted status and specific permitted actions. If conflicting data are obtained, first check the measurements and conditions, then clarify the hypotheses; restrictions are not automatically lifted. If the indicator worsens, the test is stopped according to the prescribed plan. If it is impossible to perform the check safely, the available mode is maintained and the absence of evidence is recorded. It is prohibited to create a dangerous situation merely to demonstrate that the protection will work: functional tests must be separately justified and approved.

The conclusion is signed by the persons responsible for the scientific conclusion, safety and further condition of the object within the limits of their roles. It lists residual impacts, dependencies on live systems, untested scenarios and reasons for revision. A new observation, environmental change, or security failure may invalidate the previous resolution without invalidating the old measurements. The result always refers to the described configuration. The transfer of responsibility must include exactly this configuration and the conditions for its preservation.

Training scenario: After intervention, the light disappeared, but the camera lost sensitivity due to the changed optical path. The independent channel continues to record the impact. The first version of the neutralization report is rejected; only a change in observation conditions was confirmed. In the other outcome, both valid channels show a decrease, and the control and subsequent series confirm it under matched conditions. Then let's assume a specific positive status. Scientific rigor is demonstrated by the ability to discern these outcomes before the desired conclusion replaces the test.

Chapter 45

# Completion of work and follow-up

Work is completed for a certain reason: the question has received a sufficient answer, further procedure does not bring the necessary information, the available mode has become unacceptable, or the task has been transferred to another competent party. No basis is identical to the statement that all possible dangers have disappeared. Terminating the study, ending the emergency regime, lifting a specific restriction, and allowing a specific use of the site are different solutions. Mixing them up is especially dangerous after a significant event, when the cessation of visible manifestation creates a desire to quickly declare the situation completely normal.

The IAEA requirements for the termination of a nuclear or radiological emergency provide for formal decision, criteria and transfer of responsibility; Monitoring tasks [57] can be saved after completion. For unknown phenomena, the author further proposes an adaptation of the organizational logic, rather than an extension of radiological norms to any anomaly. Real profile requirements retain their own scope. The book describes a way to stay accountable as you move between regimes without creating a fictitious, one-size-fits-all permit document.

### Reasons for completion

The manager prepares a proposal that indicates the task completed, the results achieved and the remaining uncertainties. The metrologist describes the area of truly useful observations. Subject matter experts evaluate the impacts that apply to them, and the safety coordinator reviews the consequences of stopping current activities. The Custodian confirms the condition of materials and outstanding transfer obligations. The decision must specify the following mode: maintaining limited access, normal use under certain conditions, transfer to a specialized service, or cessation of research activity.

The foundation cannot be built solely on the absence of a signal. First, it is checked whether the system continued to observe the region of interest, remained usable, and whether the processing had changed. Then they evaluate which manifestations could remain beyond her sensitivity. If the disappearance of an effect is due to a change in conditions, those conditions become part of the output. Acceptable language refers to the tested use, period, and method of control. The promise of safety for any future change extends beyond the final study.

Completion may be partial. For example, a known technical source of interference has been eliminated, but a single rare event remains undetectable. This does not prevent the closure of a specific repair task if the basis for the operational decision is sufficient. At the same time, an indefinable case should not be declared explained for the convenience of a general report. The document lists the issues individually and shows what restrictions remain. Such a recording allows the study to be continued later without restoring artificially lost differences.

### Transfer of responsibility

The receiving party receives a description of the status, current restrictions, retry criteria, and available communication channels. The transfer is deemed to have taken place upon confirmation of understanding and not upon submission of the file. Indicate who controls the abandoned equipment, who responds to the message and who has the right to change the mode of use. If there is no owner of these functions, the project should not declare long-term monitoring organized. A maintenance-free chamber in itself is not a follow-up system.

Surveillance assets left behind require their own plan. It defines the feature being tested, the quality of the data, the frequency of performance checks, and how to detect loss of observability. Frequency and duration are selected based on the specific dynamics and task, rather than a universal number of days. If information about the dynamics is insufficient, this limitation is retained and a conservative mode is used, which is actually possible to maintain. The promise of continuous monitoring in the absence of personnel or resources creates a false basis for a decision.

The reopening criterion must be observable. This could be the confirmed return of a certain signal, a change in an essential condition of use, or the failure of a mandatory security channel. The vague phrase "if it gets weird again" does not replace such a criterion, although new messages from people are also accepted and recorded. For them, a path of initial assessment is provided in advance. Rediscovery does not automatically confirm the previous hypothesis: the new episode receives its own test of origin and comparability.

### Training scenario

Fictional training scenario: Local temperature variations were observed in a warehouse. The inspection revealed a malfunction of a known technical circuit, which was eliminated and tested in the prescribed modes. The research team completes this task while maintaining operating conditions and re-deviation control. Later, the room is rebuilt, changing the location of equipment and air flows. The previous solution is not automatically transferred to the new configuration. Re-evaluation is required due to changing grounds, even if no one has yet reported unusual sensations.

This example shows why the completion act must be related to the configuration and not just a calendar date. Equally important are dependencies on external systems, availability of service, and allowable changes. When the condition no longer holds, the original conclusion does not disappear retroactively: it simply no longer describes the new situation. A well-written document allows you to notice this transition before a new incident occurs and choose a limited review rather than repeating the entire study without distinguishing tasks.

The message to participants and stakeholders must separate what is established from what is assumed. To a person reporting an unusual experience, it may be explained that a specific external cause has not been verified or that a specific instrumental effect has received a technical explanation. This does not give grounds to declare his story a deliberate deception. At the same time, one cannot promise confirmation of a personal interpretation for the sake of reassurance. Transparent communication preserves the meaning of the outcome and reduces the risk that completion will be understood as a cover-up or as an admission of all original assumptions.

Materials from the closed stage are saved with a description of access, terms and conditions of re-analysis. Samples are transferred or removed from work according to applicable specialized procedures; an unknown state does not become normal just because the project is completed. Personal data is not automatically published along with scientific findings. If an error is subsequently discovered, there is a way to correct the report and notify those whose decisions depended on it. Completion of a stage should not destroy the possibility of responsible revision.

The final result of this stage is a stable correspondence between the known state, the permitted activities and the assigned responsibilities. A scientific question may remain open, but a practical problem may have a fairly limited solution. The opposite situation is also possible: the mechanism is clear, but an acceptable control method has not yet been confirmed. Separate recording of these states makes it possible to complete the work honestly and in an organized manner, without passing off either ignorance as a catastrophe or the cessation of observations as a proven disappearance of the process.

Chapter 46

# Expert assessment of conflicting results

A contradiction in results does not always mean that one side observed the truth and the other side was mistaken. The studies may have measured different quantities, used different conditions, or answered different questions. The examination begins with the reconstruction of the exact content of the statements. “Signal detected,” “signal unusual for the model,” and “new mechanism discovered” represent the three stages of inference. Agreement on the first does not require agreement on the third. As long as the steps are not separated, the dispute easily turns into an exchange of general positions instead of checking the data.

The first working document of the examination contains a list of statements and their supports. For each, the starting materials, transformations, uncertainty model and conditions of applicability are indicated. Then the common part is highlighted: what events, numbers or restrictions are recognized by all participants. This part is not determined by the minimum convenient compromise. It must be supported by available grounds. Disagreements are grouped by place of origin: registration, processing, statistical evaluation, mechanism or practical solution.

### Competence and independence

The proposed author's protocol appoints the head of the examination, the custodian of the general set of materials and specialists on controversial links. The researcher who created the instrument is useful in explaining its operation, but is not a substitute for an independent reviewer. An external expert, on the other hand, should not make confident conclusions about a configuration that is inaccessible to him. Participants disclose significant professional and financial connections. This allows you to evaluate dependencies without turning membership in an organization or scientific school into automatic proof of rightness or error.

The number of signatures does not replace the quality of the argument. Ten conclusions based on one transformed graph may have a common vulnerability. One independent measurement can change the score if it actually tests the link in question. However, the unusual version does not gain advantage only because of its minority of supporters. All explanations require fit to the data and testable implications. A version that is incompatible with the stated conditions should not be maintained on an equal basis solely for the sake of the external balance of the report.

It is useful to pose a question to each party: What available observation would change its assessment? The answer must be specific enough that a test can be built from it. If an infinite number of exceptions are offered, the explanation loses practical discernibility. It can be left as a program for further theoretical development, but cannot be used as a ready-made mechanism for selecting interventions. The examination has the right to admit that at this stage some formulations do not belong to the same comparison system being verified.

### How the discriminative test is chosen

Priority is given to the review that reduces significant disagreement within acceptable risk and available resources. Sometimes this is a new experiment, sometimes a re-analysis of the original data with restored meta-information. There is no point in repeating costly impact if the dispute arose over units or time scale. But endlessly reviewing the old file does not help when both models describe it equally well. Then we need a new channel or a different range of conditions in which the predictions diverge.

| Discord node | Testable Question | Possible result |
|---|---|---|
| Original entry | Do the saved versions match? | Localizing data differences |
| Processing | Which step changes the output? | Comparison of analysis models |
| Mechanism | Where do the forecasts differ? | New Limited Experience |
| Practical solution | What consequences remain? | Mode with explicit restrictions |

The history of concerted tests of putative foresight shows the need to consider the entire sequence of studies rather than selecting a single convenient result [14, 15]. A general principle is important for examination: the initial hypothesis, the pattern discovered later and its subsequent tests have different statuses. If the effect changes direction, we need to find out whether the model predicted it in advance. Renaming the opposite result to confirmation without a new constraint does not resolve the contradiction or create a sustainable mechanism.

Experts will agree in advance on the criteria for correct execution of the next check and the method of access to materials. They may differ on the theoretical assessment, but should understand what is considered a valid record and how violations will be accounted for. If agreement cannot be achieved, the conclusion fixes specific incompatible requirements. The procedure does not become independent due to the name of the reviewer: the origin of the data, freedom of analysis and the ability to report an inconvenient result without its subsequent removal from the final text are important.

### Training scenario

Fictional training scenario: the first group reports a brief frequency shift, the second in the same area does not detect it. A public dispute initially appears as a direct refutation. Upon comparison, it turns out that the second system only saved average values over longer intervals. The null result of this system does not fully check the short-term prediction of the first. At the same time, the first device shared a common reference channel with local equipment. Both sides have limitations that require a new agreed series.

The discriminating experiment in this scenario preserves the appropriate temporal resolution and introduces an independent support. If the original shift disappears when the overall dependence is eliminated, the technical explanation is strengthened. If persists, the issue is transferred to other influence paths and mechanisms. Before the series is held, the correct conclusion does not announce the winner. It establishes that previous results were not fully comparable and the available data do not allow a choice between the remaining explanations.

A practical solution may be required before a scientific resolution of the dispute. The safety coordinator then evaluates the consequences of acceptable scenarios without passing off the protective measure as proof of the most dangerous theory. For example, a restriction on a certain operation may be justified by lack of observability, even if a new physical mechanism has not been identified. The justification must explicitly state this reason. Otherwise, temporary caution turns into public evidence of a phenomenon that the examination has not actually confirmed.

The final conclusion contains general established provisions, unresolved contradictions, rejected arguments and reasons for rejection. A substantive dissenting opinion is retained with specific reasons, rather than as a vague note of dissent. Separately indicate what new information may change the decision. If the data is insufficient, this is a full-fledged result of the examination. It allows resources to be directed

to the right review and prevents the research program from being replaced by disputes over the credibility of individuals.

A good examination does not have to end with a single theory. Its task is to make the contradiction more precise, reduce the number of compatible errors and determine the next justified step. This is where classification, measurement, organization and instrumentation come together. Where existing data do not distinguish between models, a specific technical requirement for a new observation arises. Thus, scientific disagreement becomes a research problem, maintaining the distinction between what has already been established and what remains to be verified.

Part X

# Instruments and the Development of extrascience

Chapter 47

## Architecture of a General-Purpose Measurement System

The versatility of the measuring complex means the ability to rearrange observations for different physical tasks. It does not mean sensitivity to everything that exists. The basis is an architecture in which the origin of each sample, the state of the channel and the limits of its applicability can be established. Such a complex should help distinguish an unknown external process from its own failure. The more unusual the expected effect, the more important this diagnostic function is.

### Five levels of system

The first level consists of replaceable measuring modules, each with a specific value, range and band. The second is local registration: signal conversion, hardware counting, saving initial readings and state signs. The third is a comparison of time and coordinates between nodes. The fourth is environmental and control channels. The fifth is processing and presentation. The final level output should not be the only surviving trace of the event.

A possible modular set includes optical recording, temperature and pressure measurement, acoustic channel, magnetometer, power supply and base movement control. Other modules are added according to the hypothesis and application conditions. Radiometric, chemical or biological research requires specialized competence and suitable equipment. The list of modules is not a necessary set for every case: an inappropriate sensor creates additional data, but not necessarily additional knowledge.

Each node stores a local sequence of measurements, a monotonic counter, and information about the correspondence to the external time scale. Correcting the clock is recorded as an event rather than destroying history. If communication is lost, the drive continues to save data within its capacity; reaching the limit creates a clear sign of incompleteness. Retransmission must not change the order of the original samples or turn a skip into a null signal.

### Chains of Independence

Redundancy is assessed based on common reasons for failure. Identical devices may share power, a software error, a reference oscillator, or environmental influences. Separating individual components reduces certain dependencies, but does not establish absolute independence [7]. Therefore, for each pair of channels, a connection map is drawn up: a common power source, a common synchronization, a common converter, a common program and a common data path.

For example, two cameras with their own drives provide more independent image storage than two screens on a single server. But the same firmware and common external synchronization still link their behavior. Different protocols for obtaining time can also lead to the same initial standard [9]. The practical problem is to choose independence with respect to the failure being tested. If a network fault is being investigated, an offline path is needed; if temperature drift - heterogeneous response and control of the environment.

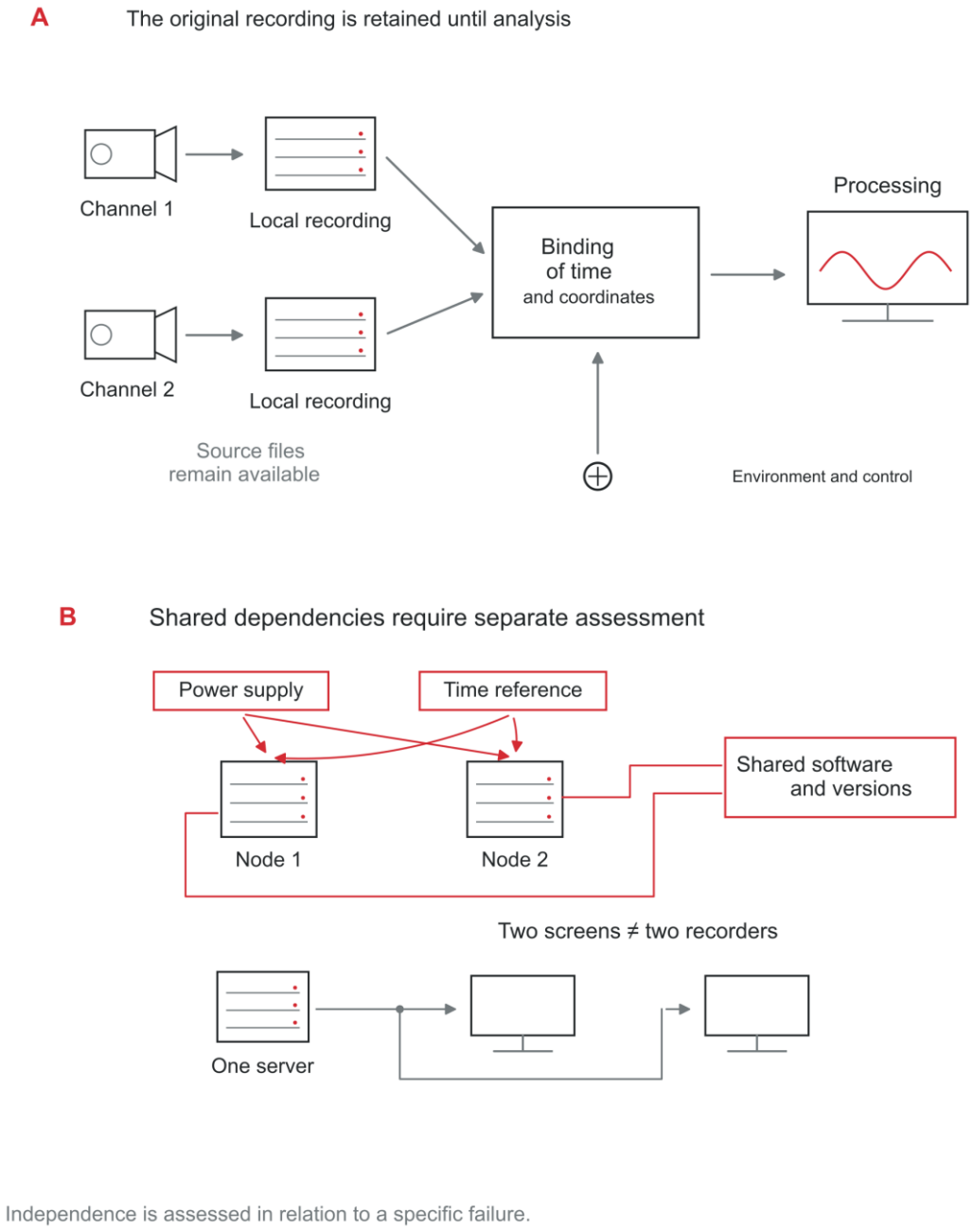



Figure 32. Where does the independence of measuring channels end? Diagram of the measuring complex and its disclosed dependencies. Local source records are retained prior to merging and analysis, but separate drives do not eliminate shared power, time reference, or software error. Two screens of one server do not provide two independent registrations.

The environmental channel should allow you to quantify the contribution of interference, and not just show a beautiful adjacent curve. In studies of the laser interferometric gravitational-wave observatory LIGO, estimates of the connection of external influences with the main channel were used for this purpose, taking into account the limitations of sensor placement and nonlinearity [55]. For the proposed complex, a similar logic means preliminary testing on a safe bench: what changes in environmental conditions are capable of generating the observed signal and with what uncertainty?

### Registering an event without losing context

Permanent recording of all high frequency channels may not be technically possible. Then a ring buffer is used that maintains the interval before and after the trigger. However, the trigger rule becomes part of the data selection. If the buffer is saved only when one sensor alarms, the statistics of the remaining channels are already conditional relative to this alarm. Assessing background matches requires control windows selected independently of the effect of interest.

The channel state includes more than the "running" flag. Store gain mode, integration, saturation, case temperature, packet loss, calibration version and operator commands. Automatic range changing may make adjacent readings incomparable without correction. The presentation system must show such boundaries and distinguish between a measured value, a model estimate, and an unavailable result. A missing value is not colored as normal.

### Author's deployment order

1. The manager determines the observable signs and mode of operation; The metrologist selects the minimum sufficient set of modules and a dependency map.
2. The operator verifies local persistence, loss of communication, and restoration of transmission at a secure site prior to deployment.
3. The data custodian anchors the naming, versioning, and access schema; the original stream is separated from the analytical products being modified.
4. The subject matter expert confirms that the modules are applicable to the environment, and the safety coordinator establishes the criteria for returning the equipment to safe mode.
5. Before the main series, the group records the background and control response; After completion, repeats the functionality check.

Continuation is acceptable as long as the operating states of the key channels are known and the origin of the result can be reconstructed. Loss of an independent reference does not always require shutting down the entire system, but should automatically limit the class of possible outputs. If monitoring of the state of the hazardous environment ceases, the research mode is stopped regardless of the integrity of measurement channels. Diagnostics and safety should not depend on a single processing chain.

The resulting architecture must allow module replacement without destroying the data lineage. The new sensor is connected with its own response model and separate qualifications, and does not receive confidence based on the compatibility of the connector. Such a complex evolves with the research program: it maintains a stable basis for registration and provides space for devices whose principles have yet to be tested.

Chapter 48

# Designing a new sensor

The creation of a new sensor begins with a lack of a certain measurement. The wording “need an anomaly instrument” is too broad: it does not allow selection of sensing element, range or performance test. A useful task sounds different: it is necessary to distinguish between the given responses of two systems, to register a short change in a specific quantity, or to separate a physical effect from a common drift. Thus, the uncertainty of a phenomenon turns into an engineering requirement that can be verified before encountering an unknown object.

### The measurement model precedes the design

In a simple linear approximation, the output of the device can be represented as $q(f) = H(f)x(f) + n(f)$, where x is the effect under study, H is the frequency response of the transformation, and n is the total noise. Such an entry requires indicating the units of all quantities, the band and the linearity limit. If the interaction is nonlinear, the model must contain appropriate terms. The name of the new field does not replace the unknown function H.

When the response depends on the product of an unknown field amplitude and an unknown coupling strength, a single channel usually determines only the combination of the two. It is impossible to declare an amplitude as measured by arbitrarily choosing a coefficient. Additional sensors, independent restrictions, or an honest formulation of the result through the product of parameters are possible. This decision affects the entire project: what quantity is calibrated, what is shown on the display, and what outputs the software allows.

Comparison of different physical systems is a real research approach: in the spectroscopic search for certain hypothetical interactions, a joint analysis of the responses of atomic transitions and the [26] quartz oscillator was used. However, a new project must redefine its coefficients and limitations. The external similarity of the equipment to the published installation does not convey its measurement characteristics and does not confirm the desired mechanism.

### Author's example of a differential prototype

Let's consider a conditional problem: the model predicts different frequency responses of two materials to one parameter. The proposed prototype contains two resonant elements, separate control of their temperature, a frequency comparison path and an independent recording of the support state. An additional electronic channel receives a known test signal to verify processing. The design is still a measurement project; the existence of the predicted interaction is not taken for granted.

It is convenient to write the response difference as $D = q_1 - \kappa q_2$. The coefficient κ is selected according to a predetermined task of suppressing a known common noise and is checked on a separate series. But the effective sensitivity to the desired effect will also be the difference in the corresponding coefficients. If it is reset to zero, the device will successfully suppress its own target signal. Therefore, an increase in the stability of the result does not yet prove an improvement in sensitivity.

In a safe test bench, controlled normal conditions are first changed within the rated use of the elements and their effect is measured. Temperature sensitivity, support drift, mechanical condition and processing are checked separately. It is then assessed which combinations of these influences simulate the target prediction. Only then is it useful to discuss downsizing, increasing autonomy, and more sophisticated noise suppression techniques.

The calibration analog has limited meaning. A known influence can confirm that the sensing element and path respond to a particular type of frequency change. It does not prove that the unknown field actually causes such a change. The developer is obliged to separate the confirmed characteristics of the device and the conventional interpretation of its readings. In an interface, a measured quantity with uncertainty is preferred; the name of a hypothetical source is acceptable only in the analytical conclusion.

### Development stages and transition criteria

1. The study director specifies the observed difference, range, and proposed alternatives; a specialized specialist substantiates the physical connection with the sensitive element.
2. The metrologist draws up a budget for noise and systematic influences, checks the dimensionality and identifiability of parameters before manufacturing the complete complex.
3. The operator assembles a minimal diagnosable prototype in a permitted laboratory environment; The data custodian records the configuration and every change.
4. After testing with known influences, an independent specialist evaluates whether the target sensitivity is maintained when suppressing interference.
5. The decision for field use is made only after separate verification of stability, safe failure and suitability of environmental conditions.

The reason for returning to the model may not only be insufficient sensitivity. If two essential mechanisms produce indistinguishable responses in all available configurations, improving the electronics will not solve the identification problem. A different sensor or additional observation will be required. Likewise, too slow a response cannot be corrected by increasing the recording frequency: the recorded dynamics are limited by the physical conversion process.

Reasons for stopping the prototype include unstable power, overload, loss of state control, and unexplained heating. These symptoms are first considered as engineering failures. An unusual output at the time of damage does not translate into a useful detection. The safety coordinator retains the right to terminate a test even if the designer considers the alarm to be potentially significant.

The readiness of a new sensor is confirmed not by the presence of a housing or a demonstration curve, but by the completion of the stated measurement task. It must be known that he is able to discern which ordinary influences deceive him and when his result becomes invalid. If a physical connection with the proposed phenomenon has not yet been established, the development may result in a high-quality device for a new type of measurement. This is an independent result that creates the basis for subsequent discovery.

Chapter 49

## Instrument Testing and Verification of Specifications

The trial must test the promise the device makes to the researcher. Calibration relates readings to known values, but does not answer all detection questions. The instrument can accurately measure a constant signal and skip short events; rarely alarmed and detect almost nothing; work well at one temperature and make mistakes after transfer. Therefore, the characteristics are confirmed separately, under conditions appropriate for future use.

### From calibration to detection

For the measurement channel, offset, repeatability, range dependence, time response, and significant influence quantities are checked. For the detection system, the probability of recording the target event, the false alarm rate, decision latency, and behavior when data is not available are added. These characteristics relate to the chosen decision rule. Changing the threshold or filter after testing creates a new configuration for which the previous confirmation may not be sufficient.

The official NIST Radiation System False Alarm Report shows how error rate and confidence level requirements relate to the scope of testing and acceptance rule [3]. For other hardware, the general statistical logic is retained, but the specific procedure is not automatically preserved. The premises need to be checked: what counts as one attempt, how independent the attempts are, and whether the conditions remain comparable.

A simple worked calculation explains the meaning of a zero result. Let there be no false alarms in N independent identically arranged control attempts. Given the true error probability p, the probability of such an outcome is equal to $(1 - p)^N$. The one-sided upper bound with confidence 95% is obtained from the expression:

$$p_{95} = 1 - 0{,}05^{\frac{1}{N}}.$$

After a thousand attempts, it is approximately 0.3%. Zero observed errors therefore does not mean zero probability of error.

This calculation cannot be applied to a thousand adjacent samples of one slowly changing process as to a thousand independent trials. Correlation, changing conditions and the selection of convenient sites violate the premises. Continuous operation may require a model of event rates per unit time rather than failure rates. The report indicates the actual duration of observation, the structure of dependence and the conditions to which the assessment applies.

### Positive and negative checks

The control series must contain both the absence of the target effect and the effects that the device is required to distinguish. Check several amplitudes, durations and positions in the working band. The setup set is separated from the evaluation set. If the designer has seen all the results and fits a threshold based on them, a subsequent demonstration on the same data shows the suitability of the fit, not an independent characteristic.

Software substitution of an artificial signal checks the processing, but not the sensitive element. The physical calibration effect tests a larger section of the path, but also has its own uncertainty and may not imitate all the properties of the process under study. These levels are useful together. External interference control methods take into account communication limitations between the control location, environmental sensors and the main channel [55]. They cannot be hidden behind the word “verified.”

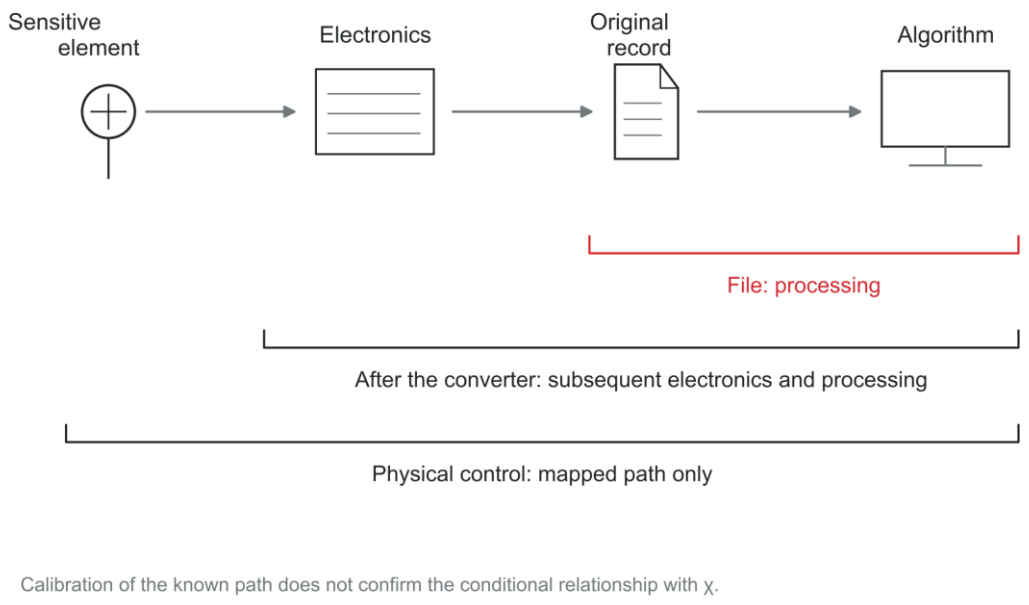



Figure 33. What part of the measurement chain does the control injection test? The calibration test area is determined by the point of introduction of the known stimulus. File substitution tests processing; injection after the transducer covers the subsequent tract. Physical verification applies only to explicitly matched links and does not in itself confirm the conditional new interaction χ.

A special test is devoted to incorrect conditions. The system must distinguish between overrange, saturation, loss of support, and loss of data. The safe result of such a state is a clear sign of unreliability and an intended mode limitation. Displaying zero is dangerous if the user interprets it as no impact. Overload testing should only be done by validated means and in an acceptable test environment and not by creating an unknown hazard.

### Author's qualification protocol

1. The manager records the characteristics being tested and the acceptance rule before the start of the series; The metrologist sets the standards, uncertainties and range of conditions.
2. The operator performs pre-prepared sequences, if possible without knowing the order of control actions; The data custodian stores all runs.
3. The subject matter expert separately evaluates the measurement path and detection algorithm, including misses, delays, and false alarms.
4. An independent audit is carried out after setup is completed; a change in an essential element requires determining the scope of requalification.
5. The safety coordinator confirms the failure behavior and stops the test when conditions are no longer under control.

After a successful series, a record of the validity of the result is drawn up. It contains hardware and software versions, environmental conditions, calibration relationships, validated ranges, and revalidation rules. It is necessary to identify events after which the previous characteristic requires revision: repair, transport damage, change of the sensing element, significant drift or unknown overload. Periodic maintenance is prescribed based on actual stability and operating conditions.

The release criterion should include not only average quality, but also predictability of limitations. If the device works well in the main series, but does not recognize loss of support, it is not ready for a task where such loss is possible. If the test set does not contain short pulses, the long signal characteristic does not apply to them. The untested area is indicated directly, even when the structure appears complete.

Completed qualification does not turn the instrument into a judge of the nature of a phenomenon. It establishes which observations can be considered reliable under certain conditions. The cause of the signal remains a separate research question. It is this separation that allows the new sensor to be used for the unknown: confidence is placed in the measurement procedure and its revealed limits, while the explanation continues to be independently verified.

### Search coverage and effective exposure

A negative result characterizes a particular search. Its coverage is determined by the amplitude, duration and shape of the signal, spatial area, equipment condition and suitable time. The calendar period of operation is not equal to the time during which a given signal could be detected. A session with a lost entry, a saturated input, or an unset configuration is retained in the log, but its contribution to coverage is reviewed.

Let, for a predetermined family of signals, the detection probability at time t be equal to η(t). Outside suitable intervals, η is zero. If one is interested in a constant frequency of events over time, effective exposure becomes a useful quantity. It belongs specifically to this family of signals; for short, weak, or spatially differently located events, a different efficiency function will result.

$$T_{\mathrm{eff}} = \int_{\mathcal{T}} \eta(t)\,dt$$

| Calendar period | Suitable time | Accepted efficiency | Contribution to Teff |
|---|---|---|---|
| First 4 days | 3 days | 0.50 | 1.5 days |
| Next 3 days | 2 days | 0.50 | 1.0 day |
| Last 3 days | 3 days | 0.50 | 1.5 days |
| Total 10 days | 8 days | 0.50 | 4.0 days |

For clarification, we assume a stationary Poisson process with frequency λ, independent registration of each event and a known efficiency. We assume that there are no target detections, the selection rule has not changed, and the connection between model events and the registered feature is given. The average expected number of detections is λTeff. The probability of zero is equal to exp(−λTeff), so the one-sided upper 95-percentage bound has the following form.

$$\lambda_{95} = \frac{-\ln(0.05)}{T_{\mathrm{eff}}}$$

With Teff = 4 days we obtain λ95 = 0.7489 events per day. This learning outcome limits the frequency of a given family of events under the listed assumptions. It does not apply to signals of different durations, to unsurveyed locations, or to a model in which events occur predominantly during gaps. In the latter case, stationarity should be reconsidered, and the lack of registration during working intervals does not close the issue.

### Efficiency also has uncertainty

In real testing, performance is assessed by introducing known safe signals or by simulation with verified transfer to the measurement path. For each amplitude and duration, the number of injections and the number of detections are stored. Testing the processing of a finished file only confirms the processing; introducing a signal after the sensing element does not test the element itself. Confirmation of the complete path requires a separate method of influence and a clear description of which links it covers.

If from 200 independent identically arranged control injections 100 are detected, the estimate $\eta = 0.5$ has uncertainty. Let us assume that these administrations represent the same family of signals and the same overall effectiveness that was in effect on all eight eligible days. A conservative training calculation might highlight the error probability 0.025 for the lower efficiency bound and 0.025 for the Poisson count bound. The exact one-sided binomial lower bound for the 97.5% level is approximately 0.4287. With eight eligible days, the zero count then gives an upper bound of $-\ln(0.025)/(8\times0.4287)$, approximately 1.076 events per day. A joint coverage of at least 95% follows from the summation of the two error risks if both initial models are valid. The number 0.749 for exactly known efficiency would be overly strong here.

The performance map allows you to compare device improvements. Increasing the run time helps with rare events, reducing noise with a weak signal, and increasing the recording frequency only when the physical converter and transmission maintain adequate bandwidth. The choice of the next development is associated with a limiting link. A complete case study of the rare event is provided in case 8.

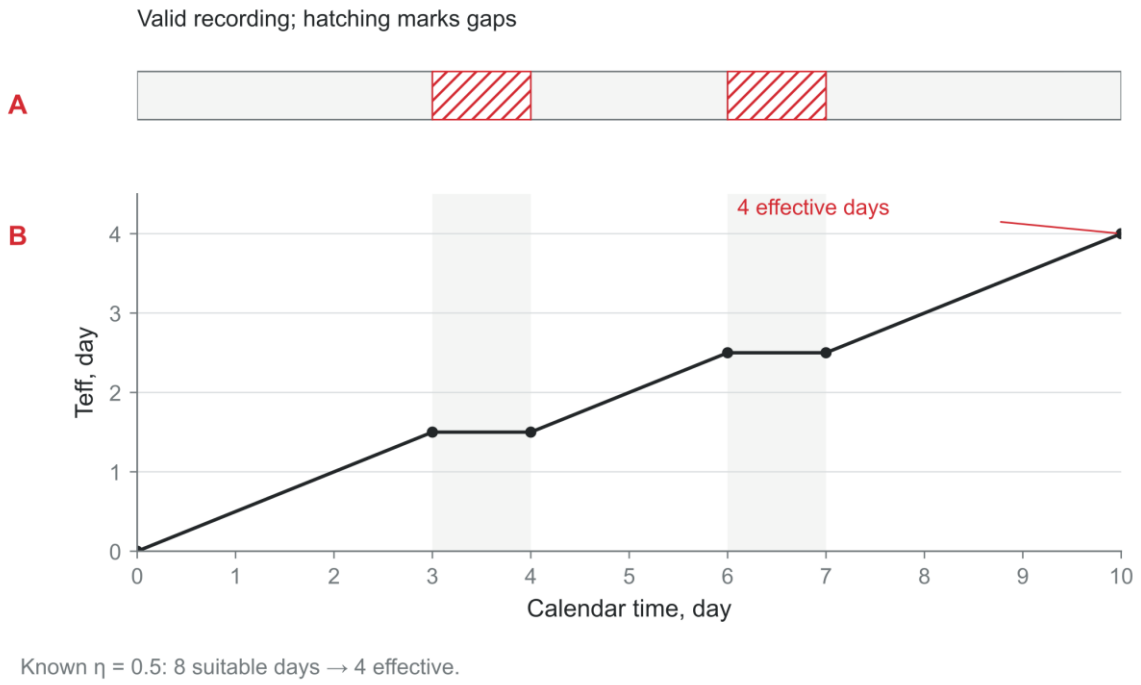



Figure 34. From calendar time to effective exposure. Educational calculation of effective exposure for ten days. The gaps 3–4 and 6–7 days are excluded from the eligible observation; with exactly known efficiency 0.5, eight suitable days give four effective ones. On gaps the curve does not increase; it is not evidence of non-event.

Chapter 50

# Design for Autonomous Clock Comparison

This project creates an instrument to compare the phase and relative frequency of multiple oscillators. Its immediate result is a time series of differences with specified uncertainty. The device is suitable for testing timestamps, portable recorders and moderate frequency variations. It is not a ready-made detector of changes in proper time: such an output requires the physical program of chapter 13. All numerical requirements and data below refer to the author's educational project, which must undergo real tests before use.

### Problem and measured value

Let us choose a working goal: to distinguish an additional relative change in frequency $10^{-6}$, which persists 100 s. This corresponds to the accumulation of an additional time difference 100 μs. The original frequencies may have a noticeable permanent offset; it is assessed based on a separate background area. The project does not require the stability of ordinary quartz $10^{-15}$. A weaker effect can be included in the record only after a new calculation and confirmation of the total budget.

Oscillators A and B produce nominal signals of 10 MHz. Each individual divider generates a pulse after ten million of its periods. The numbering of these pulses is maintained continuously. Let us define xAB(k) as the arrival time of pulse B minus the arrival time of the same pulse A. With this sign, the faster A creates an increasing xAB. For small relative deviations, the average frequency difference over the interval τ is found from the change in this value.

$$\overline{y}_{AB}(t,\tau) = \frac{x_{AB}(t+\tau) - x_{AB}(t)}{\tau}$$

Comparing signals after division to rare pulses and recording their time difference is an established measurement approach. The NIST manual reviews this along with analysis of phase records, drift, and stability at different averaging times [67]. Moderate digital resolution is used here to make the limitations of each link visible and to separate the counting from the physical properties of the generators.

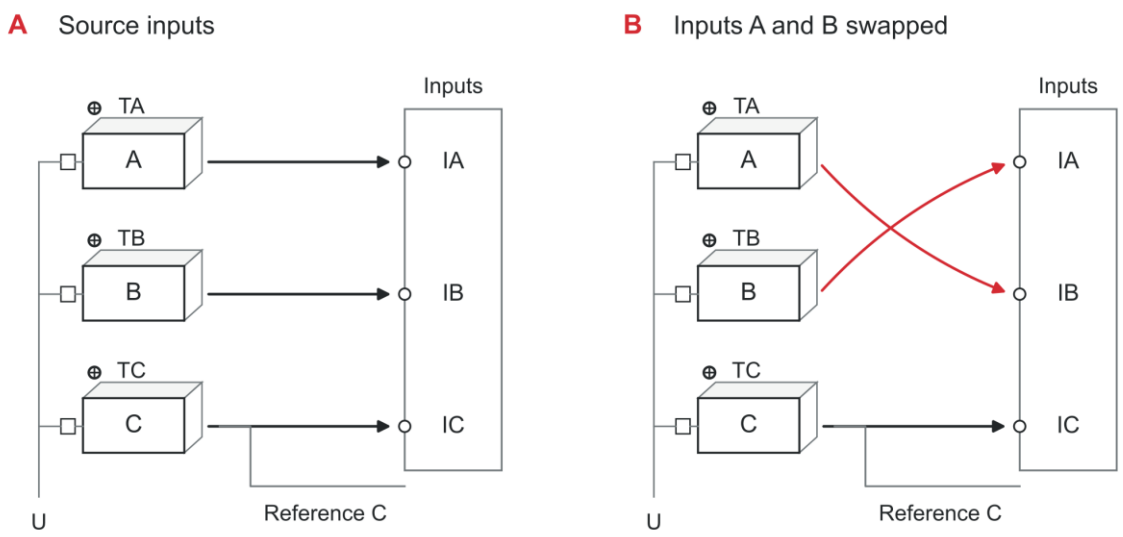
### Connection diagram and node composition

| Node | Design characteristics | Function and test |
|---|---|---|
| Generators A and B | Nominally 10 MHz; free-running operation during the series | Two batch processes compared |
| Generator C | Independent module 10 MHz | Counter scale support; separate divider and third captured input |
| Dividers | Separate continuous counting; output about 1 Hz | Saving period number without automatic reset |
| Hardware recorder | Multiplier/PLL 10 → 100 MHz; step 10 ns; counter not less than 64 bit | Capture edges before program transmission; record PLL lock status |
| Environment control | Temperature of each module; power supply; body condition | Evaluation of common frequency influences |

| Node | Design characteristics | Function and test |
|---|---|---|
| Local storage | Source marks, pulse numbers and loss flags | Recording without mandatory network availability |

Each generator signal goes through its own buffer, logic level matching, and divider. The divider edge is fixed by the hardware input of the recorder; The microcontroller transmits the already captured label, rather than assigning it at the time of program execution. The total counter operates from 100 MHz, obtained from the 10 MHz phase-locked loop multiplier oscillator, PLL. This node adds its own jitter, which is checked as part of the recorder; loss of PLL lock marks an unusable area. Multiplication does not improve the physical stability of C. A separate divider of C supplies pulses to the third captured input. Since C simultaneously sets the scale, it is a diagnostic channel and not an independent confirmation of its correctness. Cables, input thresholds and delays are also included in the channel difference calibration.

The modules are powered by separate adjustable branches with voltage recording; common conductors and the energy source are marked in the dependency map. The housings are placed so that their temperature can be measured and the electrical inputs can be rearranged without moving the generators themselves. For initial qualification, an independently verified interval meter or frequency standard and control signal generator are required. If such external verification is not available, the device remains a counting demonstrator and not a qualified measuring system.




Conditional layout; generators and auxiliary connections remain in place.

Figure 35. Rearranging inputs with stationary generators. Testing an autonomous comparator by swapping inputs A and B with stationary generators. Shown are the same housings, temperature points, common source with separate adjustable branches, and unchanged reference path C. The diagram specifies the channel assignments, but is not an installation drawing.

A GNSS receiver or network clock can be used to assign calendar timestamps to a file. They do not adjust A and B within the main series. Different external services may depend on the same source time [9]. Therefore, the correction command, if allowed at all by the individual mode, is recorded as an event and

separates the new measurement configuration. A lost connection with the calendar service should not reset the hardware counters.

### Numerical budget

With a uniform independent step quantization error 10 ns, the standard uncertainty of the difference between the four marks that determine the change in xAB is about 5.8 ns. This is a digital contribution only. For the training interval 100 s, we set the following target budget; each of its components must be confirmed by separate bench tests.

| Component of the change in xAB for 100 s | Standard uncertainty, μs | Base |
|---|---|---|
| Quantization of marks | 0.006 | Step calculation 10 ns |
| Repeatability of edge capture | 0.040 | Common input signal on different channels |
| Changing cable and input delays | 0.020 | Rearrangement and recalibration |
| Time count scale | 0.010 | Independent interval verification |
| Residual influence of temperature | 2.000 | Measured coefficients and temperature record |
| Background drift uncertainty | 1.500 | Separate background and test areas |

With the assumed independence of the components, the root of the sum of squares is approximately 2.50 μs, or $2.50 \times 10^{-8}$ in relative frequency at 100 s. Real common influences will require covariance terms. The target additional difference 100 μs is clearly visible in such a budget, but the result is determined mainly by the generators and the environment, and not by the least significant bit of the recorder. Therefore, replacing the counter with a faster one in itself will hardly improve the result.

### Assembly and qualification sequence

The engineer is responsible for assembling and checking electrical levels; The metrologist sets delays and budgets. The operator enters control steps according to a closed schedule, and the analyst records the processing until the order is revealed. Loss of a pulse number or PLL lock stops the usable run, regardless of whether the analyst notices it in the final difference.

1. Check the power and signal levels of each module separately; connect a known common signal to all measuring inputs and determine their delays.
2. Test continuous counting, program restarts, packet loss, and buffer fills. The pulse number and the incompleteness sign must retain their meaning after the connection is restored.
3. Connect independent A, B and C; record a sufficiently long background after establishing the operating mode. Keep the entire transition area separate from the usable background.
4. On a separate series, evaluate the temperature and supply influences within the limits of the components' certified use. Fix the amendment model before the main check.

5. Introduce known positive and negative frequency steps with a separate verified source; The parse operator receives the order after processing is complete.
6. Repeat the test after rearranging the inputs, maintaining the position of the generators. Then compare the selected area with an independent measuring path.

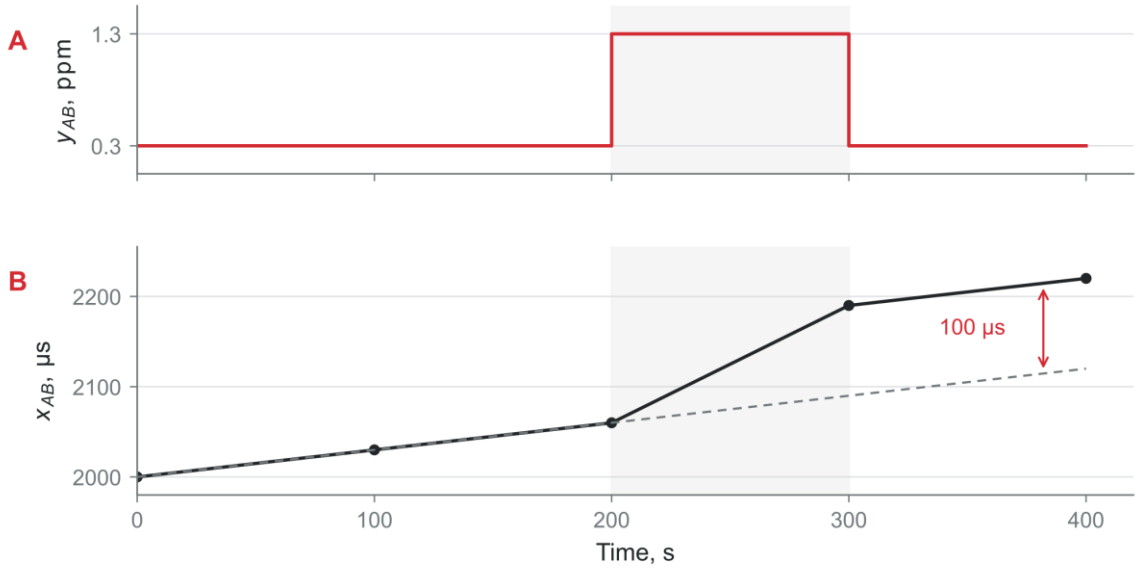
The third generator helps distinguish the instability of individual nodes: a change in only A will appear in pairs AB and AC, but may not be present in BC. This diagnosis depends on the disclosed circuit and does not prove absolute independence. The closure of three differences calculated from the same three marks is an algebraic identity, not a new physical confirmation. Independent verification must add a different measurement path or indeed a different vulnerability.

### Initial data and analysis of the control signal

The minimum entry contains the node ID, pulse number, whole hardware tag, counter frequency according to calibration version, temperature, voltage, status flags and command history. For example, synthetic labels A = 99 999 800 000 and B = 100 000 000 000 at step 10 ns give xAB = 2000 μs. It is the whole marks that remain the primary material; the rounded difference serves as a derived representation.

| Time from start, s | Synthetic xAB, μs | Interpretation of the interval |
|---|---|---|
| 0 | 2000 | Initial difference |
| 100 | 2030 | Background frequency difference $3 \times 10^{-7}$ |
| 200 | 2060 | Background is preserved |
| 300 | 2190 | An additional $10^{-6}$ shift was applied for 100 s |
| 400 | 2220 | Return to previous rate of change |

After the frequency step, the accumulated phase difference does not have to disappear. In the table the slope changed, then the previous slope returned, but the added lead 100 μs is retained. Automatically subtracting this lead would destroy an important part of the story. To analyze stability, the differences in average frequencies at adjacent intervals are additionally used; the choice of averaging time and handling of gaps must be specified explicitly [67].



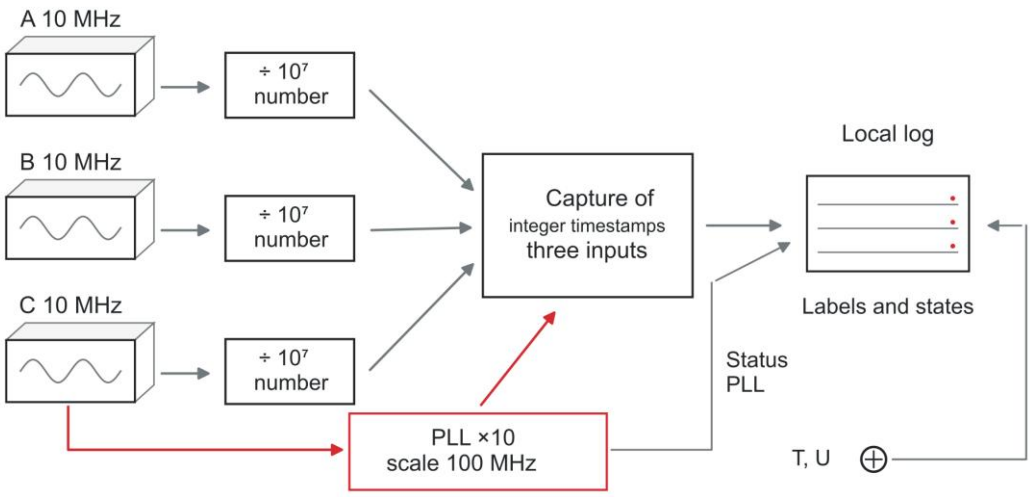

Synthetic data; the frequency is constant between table points.

Figure 36. The frequency step ends, the phase contribution remains. Synthetic comparator qualification record. The additional relative frequency difference 1 ppm acts in the section 200–300 s a background 0.3 ppm and leaves a phase contribution 100 µs. After its completion, the previous slope xAB returns, but the accumulated advance is maintained; the dotted line shows the continuation of the original tempo.

### Acceptance and result status

For this training project, acceptance requires confirming a budget of no worse than 3 µs for changing the difference in 100 s, restoring the control stage $10^{-6}$ within the expanded uncertainty of the accepted procedure, and explicitly flagging each specially created data loss. Runs without an added step are assessed separately according to the pre-established alarm rule of chapter 49. The number of such runs and the observed errors are included in the record; a successful short demonstration does not establish a zero false alarm rate.

A series becomes unusable if there is an unknown divider reset, an ambiguous number mapping, an unwritten correction, an input overload, a loss of PLL lock, or the environment exceeding qualified conditions. A working unit provides a means of measuring the relative rates of the oscillators. For optical clocks or searching for significantly smaller effects, different equipment and a new budget will be required. The general architecture of the traceable record is preserved, but the numerical characteristics of this design do not transfer to such a task.




C is both an observed oscillator and the shared counter reference.

Figure 37. Offline frequency comparison: measurement and common reference. Functional diagram of autonomous frequency comparison. Oscillators A, B and C have separate dividers and continuous pulse numbers; The hardware node stores entire labels and states. The scarlet path reveals the shared dependency: C also specifies the support of the hardware scale multiplier; this is not independent confirmation of the stability of C.

Chapter 51

## Design of a Test Bench for Small Forces

The bench in this chapter measures the mechanical torque acting on a suspended body. Conversion of torque into force is performed only for the set arm and direction of action. It can be used to study weak interactions with a sample, but the origin of the interaction is established by a separate experiment. The author's project is designed for quasi-static impacts of the order of 1–20 nN. All dimensions, tolerances and entries below are educational design values and not characteristics of an already manufactured device.

### Suspension and measuring chain

A balanced horizontal beam is suspended on a vertical torsion fiber inside a closed housing. The beam contains a test body, a counterweight and an optical reference reflector. The external source can be moved along the measured guide without touching the suspension housing. An optical channel measures beam rotation, and separate channels record base tilt, temperature, and source position. Torsion balances are actually used for precise tests of the law of gravity; their result depends on the calculated torque of the real geometry and the study of systematic influences [66]. This design does not inherit the sensitivity of such installations based on similarity in design.

$$I\ddot{\theta} + b\dot{\theta} + \kappa\theta = M(t)$$

Here I is the moment of inertia of the beam with installed bodies, b is the viscous damping coefficient in the adopted linear model, κ is the torsional stiffness. The quasi-static torque is equal to κθ after subtracting the equilibrium position. If a known perpendicular force acts on arm ℓ, its value is equal to κθ/ℓ. For

distributed pressure, multiple forces, or an unknown point of application, the primary result is torque. The instrument does not measure net force of any origin without this geometric information.

| Parameter | Educational value | What to check |
|---|---|---|
| Lever arm ℓ | 0.050 m | The direction of the force and the coordinate of its application |
| Torsional stiffness κ | $2.0 \times 10^{-7}$ Nm/rad | Measure after final assembly |
| Moment of inertia I | $5.0 \times 10^{-6}$ kg m² | Geometry, masses and additional calibration |
| Optical baseline D | 0.50 m | Scale, skew and reflector position |
| Registration | At least 10 samples per second | Completeness of recording and response to natural vibrations |
| Operating range | 1–20 nN at the specified lever arm | Linearity, uncertainty and permissible movements |

The suspension is selected according to measured rigidity, permissible load and movement reserve; a specific material alone does not guarantee design performance. Optical reading can be performed with a closed optical arm with a camera or a proven autocollimator. In the first option, the lateral displacement of the image s is related to the angle by the expression $s = D \tan(2\theta)$, if the accepted geometry is observed. At 10 nN, the torque is $5.0 \times 10^{-10}$ Nm, the angle is 2.5 mrad, and the displacement at the base of 0.50 m is approximately 2.500 mm. The position of the image must be measured along with its quality: a missing or doubled count is not replaced by a number from the extrapolation.

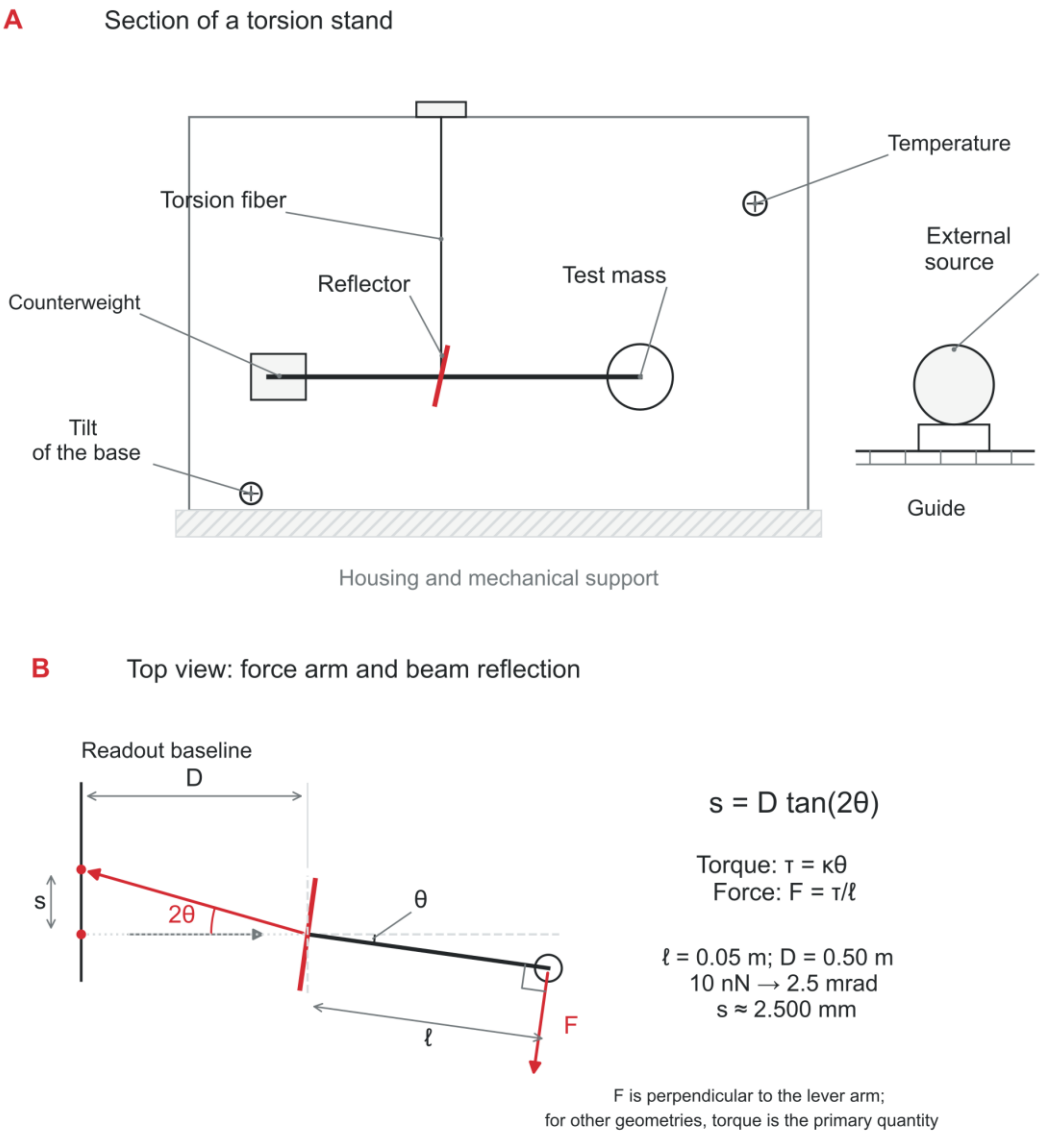



Figure 38. Torsion stand: geometry of torque and optical reference. Author's educational project of a torsion stand: section of the body and geometry of the reference from above. The known perpendicular force on the arm ℓ gives the torque κθ; the reflected ray rotates by 2θ, so s=D tan(2θ). With design ℓ=0.05 m, D=0.50 m and κ=2×10⁻⁷ N m/rad force 10 nN corresponds to θ=2.5 mrad and s≈2.500 mm. Angles are enlarged for clarity only.

### Two mechanical scale checks

The first estimate of κ is obtained from the free vibrations before and after adding a known moment of inertia ΔI. Additional masses are placed symmetrically, maintaining balance and axis position. From the recording, frequency and attenuation are simultaneously assessed. In the formula below, $T_0$ and $T_1$ denote the natural periods after taking into account the attenuation, and not automatically the distance between adjacent maxima of the attenuated record.

$$\kappa = \frac{4\pi^2 \Delta I}{T_1^2 - T_0^2}$$

For the selected parameters $T_0$ = 31.416 s. Adding $\Delta I = 2.5 \times 10^{-6}$ kg m² gives $T_1$ = 38.476 s. Such an additive corresponds, for example, to two training point masses of 1.000 g at radii 35.355 mm; the actual measurements of the weights are also included in their moment of inertia. This test establishes the dynamic stiffness. Creep, hysteresis, and frequency dependence of elasticity can disrupt its transfer to a long-term static measurement.

The second test creates a known static torque with a low voltage capacitor. One electrode is connected to the beam, the other is fixed to the body. Before the main series, the dependence of the capacitance C on the angle is measured on a separate angular measuring instrument, including the enclosing electrodes and cables. At a maintained voltage, the calibration torque is expressed through the local derivative of this dependence.

$$M_{\mathrm{cal}}(\theta) = \frac{1}{2}(V - V_0)^2 \frac{dC}{d\theta}$$

$V_0$ here denotes the effective contact potential bias in the applicable model. It is assessed by a series of both voltage signs; an open or unstable parabola requires an investigation of the charges and makes such a calibration unsuitable. The training derivative $4.0 \times 10^{-11}$ F/rad at an effective voltage 5.00 V creates $5.0 \times 10^{-10}$ N m, equivalent to 10.0 nN at the selected lever arm Use a current-limited source not higher than 12 V and suitable components. Insufficient torque is not compensated by exceeding the tested test bench conditions.

The derivative C is determined in the region of the actual equilibrium angle, and its value is not substituted for a stationary beam. To illustrate: a capacitance change of about 0.8 pF over an angular interval of 0.02 rad requires verified resolution of the order of 0.005–0.01 pF and geometry analysis. The resolution itself is not the uncertainty of the derivative. The goal of its separate calibration is a standard relative uncertainty of about 2%; with the uncertainty of the effective voltage 5 mV this gives approximately 0.20 nN for the control force 10 nN. Until this goal is achieved, the static calibrator remains a test of response rather than an accurate standard.

### Setup time and budget

With a training quality factor Q = 10, the natural angular frequency is equal to 0.20 rad/s, the coefficient b is $1.0 \times 10^{-7}$ N m s/rad, and the time of decreasing the amplitude of the free response by e times is 100 s. After the maximum sign change from −20 to +20 nN, waiting 700 s reduces the calculated envelope of the initial oscillation to approximately 0.037 nN in terms of force. Then you can average the following 100 s. This rule applies to the measured attenuation of a given configuration; if the quality factor has changed, the waiting time is recalculated. The recording frequency 10 Hz does not turn such a suspension into a fast force sensor.

| Component at force 10 nN | Standard uncertainty, nN | Design basis |
|---|---|---|
| Torsional stiffness | 0.10 | Relative uncertainty 1% |
| Force lever arm | 0.04 | Relative uncertainty 0.4% |
| Angular reference | 0.12 | Uncertainty of the average angle 30 μrad |
| Equilibrium position interpolation | 0.20 | Checking zeros before and after exposure |
| Residual environmental influences | 0.10 | Separate checks for inclination, temperature and air movement |

If these contributions are independent, the root of the sum of their squares gives 0.276 nH. For acceptance, we set a rounded limit 0.30 nN in the vicinity of 10 nN. Correlated contributions are taken into account in the covariance model; the uncertainty of the calibration coefficient is not reduced by repeating identical readings. For other points in the range, the budget is recalculated: the relative stiffness error grows in absolute units along with the signal. An independent static calibrator with an uncertainty of 0.20 nN allows checking the agreement of two estimates with a combined standard uncertainty of about 0.34 nH.

### Assembly and testing at known exposure

The mechanical operator establishes the configuration and known influences; The metrologist independently checks the angle scale, stiffness and control moment. The analyst receives the order of control influences after fixing the treatment. When touching the limiter or losing a stable reading, the operator stops the impact and saves the transition record; such a section is not corrected by interpolation.

1. Assemble the suspension with mechanical stops, a closed optical channel and a housing; check that the beam does not touch the walls in the entire permitted range. Before installing an unknown sample, debug the unit on ordinary inert bodies.
2. Measure masses, arms and optical scale; obtain a free response with several small initial deviations. Verify that a single model describes frequency and attenuation without unexplained parameter changes.
3. Perform an additional moment of inertia calibration, then an independent static capacitor test. After disassembly or geometry changes, repeat both applicable parts.
4. Record the background with a stationary source, idle guide movements and zero voltage. Check the usual connections with inclination, temperature, air flow and electrical condition within the acceptable operating conditions of the stand.
5. Carry out a predetermined sequence of zero and known moments of both signs. The procedure to inform the analyst after recording the processing; save all transition areas and reasons for excluding data.
6. Repeat the inspection after replacing the body being tested with a control one and after rearranging the geometry. Move on to the main series only after confirming the budget and restoring known impacts.

In operating mode, the position of the calibration electrodes, their grounding and the state of the source are clearly recorded. Disconnecting the calibrator also changes the electrical environment, so this configuration is qualified separately. For the housing, indicate the air or pressure mode; the absence of

open flows does not prove the absence of thermal convection. A separate check is needed for any screen that simultaneously changes the electric field, thermal exchange and mechanical connection.

### Primary records and acceptance conditions

The primary package includes images or raw angle signal, timestamps, source position, calibrator voltage, C(θ) version, temperature, slope, mass, and configuration geometry. In the synthetic example, the zeros before and after the impact are 0.20 and 0.18 mrad, and the angle at the impact is 2.70 mrad. For a time-symmetric section, the interpolated zero is 0.19 mrad, the useful angle is 2.51 mrad, the result is 10.04 nH. If the zero drift is non-linear, such interpolation requires additional checking rather than automatic application.

The stand is accepted in the declared range after restoring independent control points within the agreed budget, checking the angular scale model and registering all specially introduced omissions. The series is stopped when the limiter is touched, the optical reading is lost, the zero changes are not traced, the environmental parameters leave the tested area, or two calibrations do not agree. A stable deviation after these checks allows us to confirm the presence of a measured residual torque. The new fundamental force requires further discriminating experiments, as in the case of 2. The sensitivity of this training bench is not sufficient for the specific piconewton example of chapter 20; Increasing the number of beautiful characters in the table does not change this boundary.

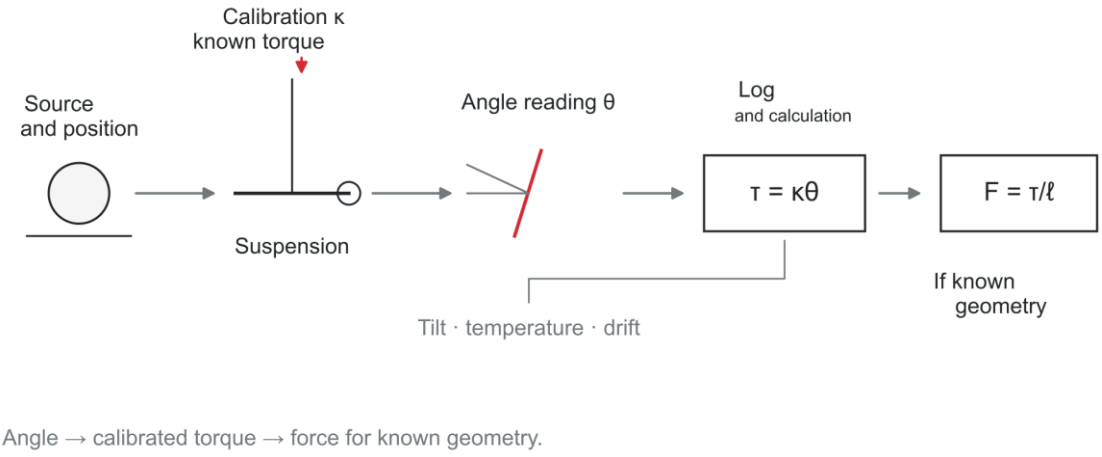



Figure 39. From torsional response to limited force estimation. Functional path of the torsion project. The optical angle is converted to the torque after calibration κ; force estimation requires known perpendicular arm and application geometry. Environmental control limits conventional alternatives but does not replace this calibration.

Chapter 52

## Design of a Differential Sensor for a Hypothetical Interaction

This project tests a predetermined assumption: some new parameter changes the frequencies of two physical systems in different proportions. The generators themselves, the counter and the control influences use well-known technology. The new connection is introduced as a conditional model and must withstand separate tests. A workable device here means a reproducible meter of the difference in normalized frequencies; this does not yet mean the existence of a new field. All given numbers, coupling coefficients and notations are the author’s educational calculations.

### Two systems and relative magnitude

As the first system, we will take a quartz oscillator Q with a nominal frequency of 10 MHz, and as a second system, we will take a generator with an oscillating circuit of an inductor and a capacitor (LC circuit) with a nominal frequency of 100 kHz. The difference between the elastic resonator and the electrical circuit makes it possible to build a testable model of different responses. It does not in itself provide selectivity to unknown effects. In real studies, comparison of different frequency systems is used to test specifically specified variations in physical parameters [26]; Our moderately demanding stand does not reproduce their sensitivity.

The R reference gives a frequency of about 10 MHz. For each generator, we measure the ratio of its frequency to the frequency R and normalize it to a separately established initial ratio. The difference q is therefore dimensionless. A change of one part in a million is referred to in this chapter as 1 ppm. The support is involved in physical observation: the sensitivity of the new parameter is determined relative to it, and not relative to the inaccessible absolute time.

$$q_i = \frac{f_i / f_R}{f_{i0} / f_{R0}} - 1, D = q_Q - \kappa q_L$$

The coefficient κ is selected from a separate calibration series and fixed before testing the candidate. Preservation of the original qQ and qL is mandatory: their combination can suppress not only the interference, but also the desired response. The goal of the project is a standard uncertainty D no worse than 1 ppm for a change that persists no less than 100 s. For short edges, a different timing path and a separate response characteristic are needed.

### Physical diagram

| Subsystem | Training Requirement | Function to be tested |
|---|---|---|
| Quartz channel Q | 10 MHz, free-running; own power and temperature control | Frequency of elastic resonator with electronics |
| LC channel | About 100 kHz; low power; amplitude recording | Electrical resonator frequency along with feedback |
| References R and R2 | Separate generators and status records | Working scale and diagnostics of its changes |
| Counting channels | Continuous period numbers; capture by hardware inputs | Frequency ratios at intervals 100 s |
| Control of normal influences | Temperature of each node, power, amplitude, position | Corrections and verification of model suitability |
| Independent verification | External frequency meter for qualification | Checking the overall scale and known steps |

For the calculated LC circuit, we choose L = 100 μH and C = 25.3303 nF. The ideal resonant frequency is 100 kHz. The actual assembly includes a circuit, a high-impedance buffer, a positive feedback amplifier, and amplitude limiting; The output buffer separates the counter load. The frequency also depends on the

phase shift of the amplifier, parasitic capacitances and the level of oscillation. Therefore, the ideal contour formula specifies the initial design, and the final transfer characteristic is determined by measurement.

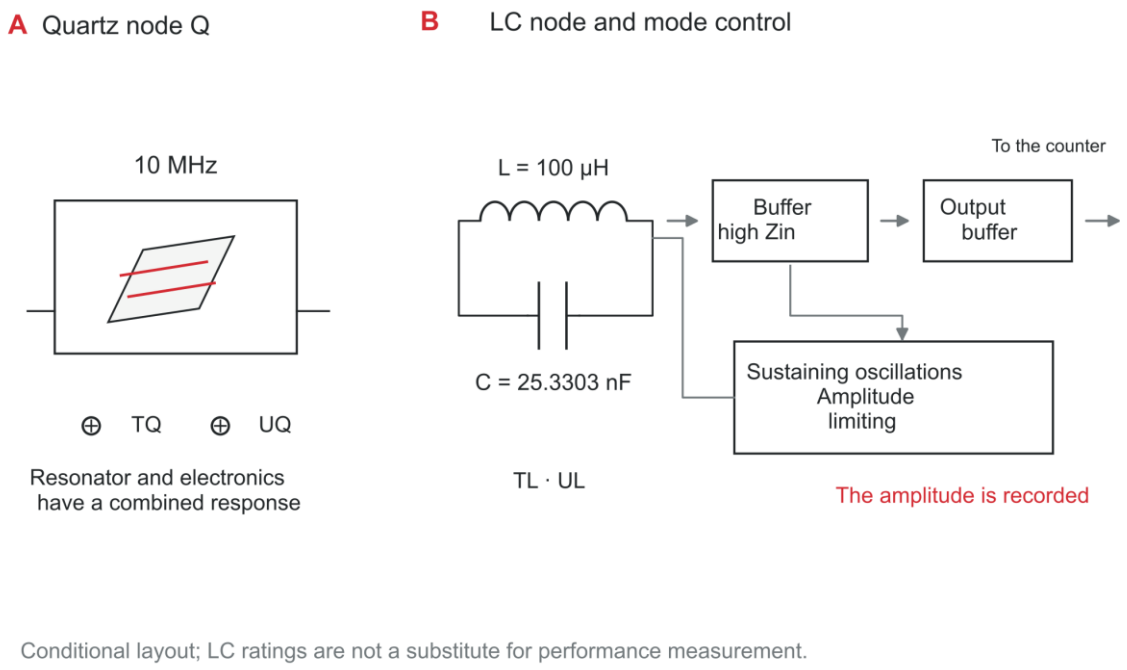



Figure 40. Two different resonators and their own control channels. Two different frequency converters of the author's project. Quartz and LC nodes have their own temperature and power control; for LC the amplitude is also recorded. For L=100 µH and C=25.3303 nF the ideal frequency is close to 100 kHz, but the actual response includes buffers, oscillation support and parasitics. The figure is a schematic layout and not a wiring diagram for the amplifier.

$$f_L = \frac{1}{2\pi\sqrt{LC}}, \frac{\delta f_L}{f_L} \simeq -\frac{1}{2}\left(\frac{\delta L}{L} + \frac{\delta C}{C}\right)$$

For the training stand, you can set the electronics power supply 5 V from a current-limited source and the circuit voltage not higher than 0.1 V effective value, if the selected components allow such a mode. These are project requirements that are verified before the complete system is powered on. The gain is limited so that the oscillations are maintained without saturating the buffer and causing unwritten mode switching. Amplitude stabilization is allowed only as an explicitly registered loop with its measured relationship to frequency. It should not automatically correct the frequency change being investigated.

The Q output is divided by $10^7$, the LC output by $10^5$, receiving pulses about once per second with continuous numbering. R and R2 have their own divisors. Hardware inputs capture all four rows; The timeline is implemented using the proven architecture of chapter 50. The counter uses R as its reference, so R's own timestamps do not confirm the stability of this support. R2 and the external meter add control, and their common vulnerabilities are listed separately. The availability of a second quartz does not make it an absolute standard.

### What exactly does conditional interaction predict?

Let us consider the linear mode of small deviations. Let χ be a dimensionless conditional parameter, almost identical in the volume of both sensitive nodes. In the given author's model, the relative coupling coefficients are gQ = 1 and gL = −2. They include the difference between the response of the sensing node and the support R. These values are not derived from a known property of quartz or inductance; these are

explicit parameters of the hypothesis being tested. Changing them after viewing the result would mean switching to a different model.

$$q_i = g_i \chi + a_i \Delta T_i + b_i \Delta V_i + z + \eta_i$$

Coefficients a and b describe the measured temperature and supply influences. z denotes the remaining combined contribution from ordinary reference drift, and η denotes the other residuals taken into account. For synthetic calibration, we take aQ = 1 ppm/K and aL = 20 ppm/K. For the same temperature change, the coefficient κ = 0.05 suppresses this single common component. If the temperatures differ, the remainder is equal to 1 ppm/K multiplied by the difference in their changes; separate sensors and checking thermal delays are needed. The uncertainty of the coefficients themselves also remains in the budget.

$$D_\chi = (g_Q - \kappa g_L)\chi = 1{,}1\chi, D_z = (1 - \kappa)z = 0{,}95z$$

For $\chi = 10^{-5}$ the model predicts D = 11 ppm. At the same time, it predicts opposite signs of the Q and LC responses, which can be verified before combining the data. The usual common drift of the support, on the contrary, is weakly suppressed. The temperature response vector (1; 20) and the conditional vector (1; −2) are different; this allows us to distinguish between the two mechanisms in this limited model. When you add the unknown influences of power, amplitude and support, two numbers are no longer enough. They are constrained by additional observations rather than by free corrections tailored to each event.

### Real Path Qualification

The engineer checks the physical channels, the metrologist evaluates the coefficients and uncertainty, the operator creates control effects according to a pre-saved schedule. The analyst fixes the D combination and the criteria before revealing the order. When a node exits qualified mode, the operator stops the current test and stores the raw channels for cause analysis.

1. Check each generator separately: power supply, amplitude, output signal shape, counting stability and permissible load changes. Enter the actual modes of the selected components into the record.
2. Apply known signals to all counting inputs. Check division, continuity of numbers and restoration of specified frequency ratios with an external meter. Specially create a skip, restart and loss of support; each case should receive an explicit flag.
3. Install conventional inert components in the working housing. Obtain a background, then several safe temperature levels, for example within ±1 K of the operating point, if this area is allowed for all nodes. Measure transitions and reverse transients; The small stage should not be considered established until the delays are checked.
4. Using individual calibration data, estimate the temperature, supply, and amplitude coefficients along with their uncertainties. Fix κ and the region where the linear model is suitable. Do not use independent verification data to re-adjust coefficients.
5. Make hardware-known frequency changes +10 ppm into the first counting channel and −20 ppm into the second. Repeat them with zero and normal temperature influences in an order previously hidden from the analyst.
6. Check the configuration with an independent meter, then repeat part of the series after rearranging the inputs. Separately evaluate the recovery of a useful combination, the remainder of the usual effect, and false positives in the background.

Electronic frequency substitution checks the counter and algorithm. A known change in temperature or capacitance tests the normal physical response of the corresponding resonator. Neither of these operations

calibrates the connection of χ with matter: such a calibration would require an independently established source of χ itself. In the research record, these three levels of verification should remain separate. A magnetometer or tilt sensor can be added as a common cause control, but their readings do not replace the differential value defined here.

### Budget and raw recording

| Contribution to D on the interval 100 s | Standard uncertainty, ppm | Confirmation method |
|---|---|---|
| Repeatability of quartz channel and counting | 0.30 | Background and known common signal |
| Repeatability LC after multiplication by κ | 0.50 | Initial uncertainty qL about 10 ppm |
| Temperature correction and gradient | 0.30 | Separate temperatures and coefficient checking |
| Power, amplitude and other usual connections | 0.20 | Selected limited impacts |
| Working reference and overall scale | 0.20 | R2 and independent qualification |
| Transferring a background model to a new series | 0.40 | Data not included in setup |

The root sum of squares of these target independent contributions is approximately 0.82 ppm. Actual correlations require the full budget, which may be larger. The value 11 ppm is the design signal of an illustrative model, rather than a promise of detection; acceptance requires independent confirmation of uncertainty no greater than 1 ppm. Longer averaging cannot automatically be used to meet the tolerance: drift and thermal memory may halt the expected improvement.

| Synthetic condition | qQ, ppm | qL, ppm | D, ppm |
|---|---|---|---|
| Common heating at 0.1 K | 0.1 | 2.0 | 0.0 |
| Only conditional $\chi = 10^{-5}$ | 10.0 | −20.0 | 11.0 |
| The same χ and common heating at 0.1 K | 10.1 | −18.0 | 11.0 |
| Typical shared reference contribution z = 1 ppm | 1.0 | 1.0 | 0.95 |

The table was calculated using the adopted model; it does not depict the experimental data obtained. The actual recording saves the entire timestamps of all four channels, division numbers, Q and LC temperatures, voltages, loop amplitude, support status, and all commands. Versions of κ, coefficients and

selection rules are associated with specific files. Retaining only D would deprive the researcher of the opportunity to detect incorrect compensation or to test a different model in an independent new series.

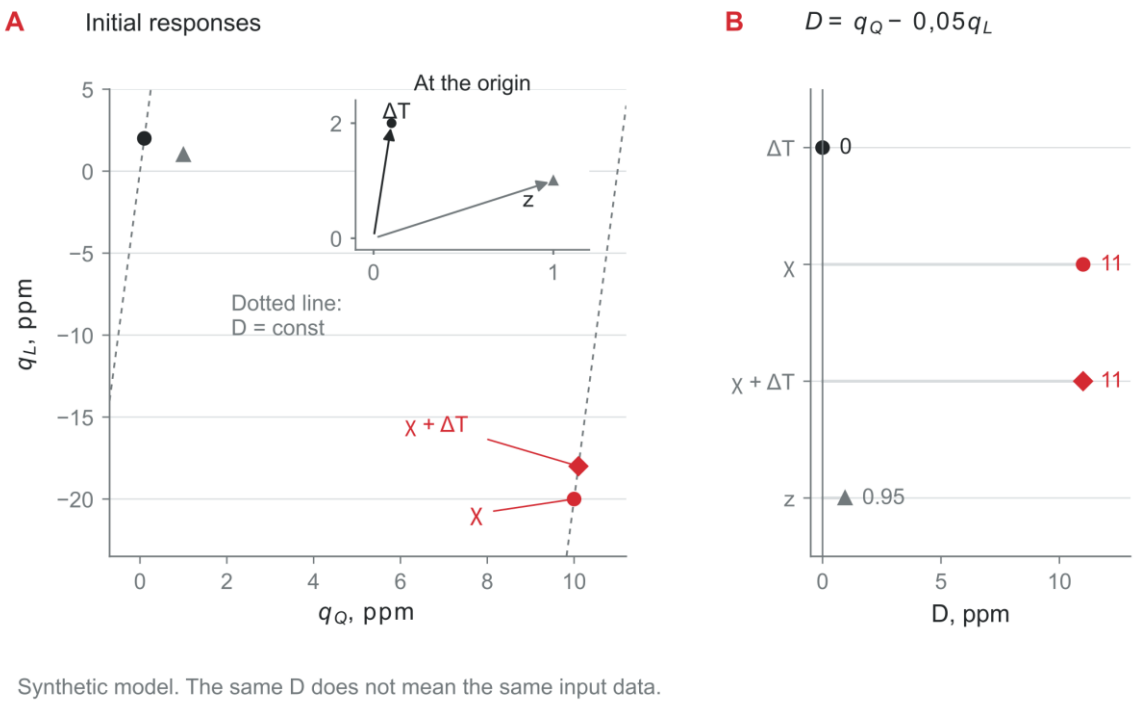



Figure 41. What does the differential indicator save and what does it erase? Synthetic responses of the accepted model and their linear combination D=qQ−0.05qL. Total heating ΔT=0.1 K gives (0.1; 2) ppm and D=0; conditional $\chi=10^{-5}$ gives (10; −20) ppm and D=11 ppm. Their sum preserves D=11 ppm, and the total contribution of the support z=1 ppm gives D=0.95 ppm. The inset has its own labeled axes; conditional interaction coefficients are not experimental results.

### Acceptance and development of the project

Acceptance requires recovery of the known combination 11 ppm within the specified expanded uncertainty, fulfillment of the budget on a separate test run, and detection of all introduced account failures. If there is an unpredicted hysteresis, an unrecorded alteration of the generator, loss of pulse numbers, or the temperature leaving the qualified region, the data is not used to check χ. The repeated residual D is first the measured deviation of the frequency combination; Next, signs, the relationship of the two responses, support control, and alternative physical causes are checked.

For the next generation of sensor, additional predictions must be obtained in advance: the dependence of g on the material or resonator mode, the spatial consistency of χ, and the expected response of the third system. An independent configuration is then made and these predictions are tested against new data. If the coupling coefficients remain arbitrary for each trial, the device does not acquire selectivity for new interactions. If the known path passes the qualification, and the fixed model withstands new discriminating tests, there is a basis for its further physical study without replacing the observation with the name of the field.

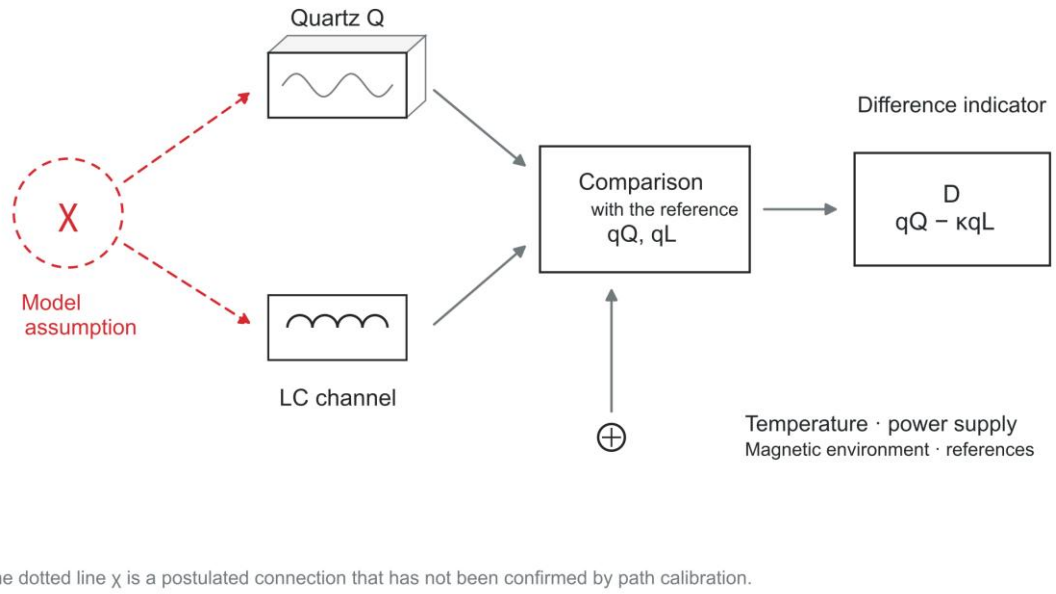



Figure 42. Conditional connection χ and the implemented measuring path. Implemented frequency channels and conditional connection with the parameter χ. Solid lines show the measurement path and condition monitoring; the dotted scarlet connections are a postulated part of the model. Conventional calibration of electronics and resonators does not confirm their existence.

Chapter 53

## Unknown Phenomenon Research Program

For a phenomenon without an established mechanism, one successful experiment is not enough. We need a program in which each stage creates the conditions for the next and allows for a meaningful completion of the work. Its goal is to obtain a stable description, distinguish between explanations, and identify possible actions. The program does not have to lead to new physics: the cause of the remainder may be a new combination of known processes, an incomplete model of the medium, or a feature of the measuring path.

### The first stage is to determine the effect

The research unit must be accessible to another performer. It specifies what is considered an event, which entries are required, and what difference from background is tested. If an event is determined by the impression of one observer, the stability of this selection rule is first studied. If the algorithm finds it, the version is recorded and checked against control data. Otherwise, changes in the detection procedure will look like changes in the phenomenon itself.

The output of the first stage is a description of the effect along with the range of applicability. It includes conditions where an effect was observed, conditions without detection, and omissions. The lack of regular repetition does not exclude further research, but it changes the program: the importance of automatic background monitoring, independent channels and pre-selected criteria for recording a rare event increases.

### The second stage tests portability

It is checked whether the observation is maintained when changing the operator, instrument instance, processing method or recording location. Changing everything at the same time is not always useful: then it is unclear what difference explains the change in the result. Plan a sequence of transfers that matches the causal model. Particular attention is paid to characteristics that can be both a condition of the phenomenon and the source of the artifact.

For example, communication with a certain camera may indicate special sensitivity to the real signal or the camera's own defect. Discrimination requires control exposure and comparison with a suitable independent method. The phrase “the effect exists only with this device” describes an important limitation, but does not complete the explanation.

### The third stage separates the models

Once a reproducible feature has been established, a set of explanations with differing predictions is constructed. It includes the signal source, propagation medium, measurement and processing. For each explanation, the parameters that are actually determinable by the data are indicated. A model with a large number of free parameters may describe history well, but poorly predict the next experience. Therefore, some of the data is retained for independent verification.

Conditional new interactions are introduced through an explicit rule of connection with observable quantities. If transition frequency is expected to be affected, it must be specified which systems should respond differently. If a change in spatial connectivity is expected, geometric consequences are needed that are distinguishable from signal propagation in the medium. If dependence on the meaning of information is claimed, it is necessary to separate the semantic criterion from the physical medium and human choice.

### The fourth stage explores management

Management is considered after establishing a connection that can be influenced. Initial interventions must answer a narrow causal question, have an observable effect, and be able to limit added impact. First, they establish what changes in the output signal, then check whether this is due to a change in the source or just the measuring channel. The transition to practical neutralization requires independent confirmation.

| Stage | Verifiable result | Transition base |
|---|---|---|
| Definition | Robust event selection rule | Verified registration and described background |
| Portability | Known conditions for maintaining the effect | Comparable independent implementations |
| Discrimination | Limitation of Competing Models | New data with different predictions |
| Management | Repeatable response to a given action | Impact tolerance and testing of the measuring channel |
| Application | Suitability of the method for a specific task | Confirmed characteristics and operating limits |

### Program completion criteria

The program may end with the establishment of a known mechanism, the achievement of a useful hypothesis constraint, the lack of sufficient resources for the next measurement, or the discovery of an unacceptable risk. Completion does not require declaring a phenomenon finally explained. It is enough to clearly formulate the result obtained, the limit of its action and the condition under which the research makes sense to resume.

Resources are planned according to the value of the following distinction. An expensive device is justified if its characteristics close a specific gap, and the infrastructure allows them to be used. If the main uncertainty is in the origin of the sample, increasing the spectral resolution may not change the key finding. If the problem is the rarity of the event, the additional length of usable observation is sometimes worth more than the record sensitivity of one short measurement.

A fictitious training example begins with pulses occurring only at night. The first step is to check the detection rule. The second is portability between registrars. The third compares temperature, infrastructure conditions and a possible external source. Only if the remainder remains, a new model is introduced. The program remains open to unusual explanation, but each expansion is driven by results rather than a desire to reach a pre-selected ending.

This order turns the unknown into a sequence of research problems. Its resilience depends on its ability to revise both theory and its own procedure as new data emerge. This is the subject of the next chapter; the research practicum then shows the entire path through completed teaching cases.

### After retaining the residual effect

If the effect passes the initial tests, the program receives a specific observable object: a dependence, spectrum, distribution, or state transition. The next task is to establish parameters and boundaries. At this stage, it is useful to separate the empirical model that reproduces the observed relationship from the mechanism that explains its occurrence. A successful prediction from an empirical model represents independent knowledge even when multiple mechanisms remain compatible.

First, the parameters that are actually determined by the available data are selected and their joint uncertainty is estimated. Then they look for a configuration where the remaining versions diverge more than the measurement uncertainty. When choosing, take into account the permissibility of the change and the ability of the measuring path to survive it without changing unknown characteristics. Checkpoints are announced before the results are opened; the already estimated parameters are transferred to them. Adjusting again at each point deprives the transfer of its testing meaning.

In case 2, the residual force is maintained after a reading change, and the distance dependence is tested at new points. The result is a limited empirical relationship and a list of still acceptable mechanisms. In case 3, the clock description does not stand up to the test of mechanical investigation. Together, these cases illustrate two substantive outcomes of model development: expansion of a supported description and elimination of a particular explanation.

A new sensor is ordered according to a discriminating prediction. The application specifies the required size, range, band, spatial reference, and resistance to significant alternatives. If the uncertainty is related to the origin of the material, a more sensitive recorder may not change the conclusion. If two mechanisms mathematically produce the same response of available channels, a different way of interacting with the system is required. The engineering projects in chapters 50–52 show how such a request produces a verifiable technical specification.

Chapter 54

# How theory and protocol are revised

Any protocol is valid within the conditions on which it is based. New data may clarify these conditions, reveal a missed cause, or show the inadequacy of a previous measurement. Therefore, the development of anomaly science requires controlled revision. The correction must preserve the history of knowledge and at the same time clearly show which rules should be used now.

## What exactly has changed

When a contradiction appears, its level is first determined. Has the source material, processing, uncertainty assessment, explanatory model, or decision about permissible action changed? These changes may be related, but do not always occur together. The new processing method is able to clarify the value without changing the manifestation class. A new hazard assessment may limit work even before the cause is determined.

Each fix is described in terms of its basis and scope. If a problem is found in one type of instrument, you cannot automatically invalidate all observations of the class. If the failure is related to a shared processing library, the check extends to the series that used it. First, the set of affected materials is identified, then the conclusions are recalculated and the decisions are revised.

## Protocol version

The version includes the date, owner, applicability, list of changes, and status of previous revisions. A significant change in the tolerance conditions, measurement scheme or result criterion requires a new version. The typo correction is also retained in history, but should not create the impression of a new scientific review. The accompanying journal distinguishes between editorial, methodological and content changes.

The withdrawn procedure remains understandable to the former work, but is clearly marked as unsuitable for the new application. If the material is published, notice of the correction should reach those who may have used the previous result. Silently updating a file erases the connection between the version of the instruction and the action performed, making it difficult to parse the consequences.

## New effect and boundaries of theory

A persistent residual indicates that the explanation used is insufficient under the given conditions. The next step is to figure out which part of the model needs changing. There may be an unaccounted interaction, an incorrect boundary of the system, an unknown state of matter, or a deeper limitation of the theory. The choice between them is determined by a set of predictions. A single match with an unusual hypothesis rarely determines the extent of the required revision.

The new model must explain previous successful observations in the relevant area or clearly show why they require a different interpretation. Its benefits are assessed using new data and additional assumptions are listed. If a model allows arbitrary adjustment to any outcome, first of all it is necessary to limit its freedom. Otherwise, it is impossible to establish what exactly the following experiment taught.

## Troubleshooting without data loss

A useful analysis separates the conditions for error from the person's judgment. Shift management, ambiguous instructions, access to input data, instrument interface, and pressure of expectations are

examined. Individual responsibility remains, but does not replace fixing the system. If the same error is likely to occur in another conscientious performer, it is necessary to change the procedure.

Negative and uninterpretable results are stored along with successful series. They show the limits of performance and prevent the repetition of useless actions. Uninterpretability itself can be a useful result if it is specified what failure or gap caused it. In the next edition of the protocol, this information turns into a condition of admission or additional control.

### Author's revision cycle

1. Record the discrepancy and save the affected versions of the materials.
2. Determine the level of change and temporarily limit conclusions that depend on the controversial link.
3. Test alternative causes against available independent data.
4. Assess the impact of the correction on scientific conclusions and on safety conditions separately.
5. Release a new version with the scope of applicability, the basis for the change and the history of the previous one.
6. Test the updated procedure against a suitable test case and determine the conditions for the next revision.

A fictional case concludes the theoretical part of the book. After several months of observation, the team discovers a timestamp conversion error. Some previously merged events no longer match. The report is corrected, and the remaining independent observations are separated into a separate task. The scientific value of the work does not disappear: the vulnerability of the procedure was identified, the data was clarified, and a more precise question appeared. An error turns into knowledge only after its consequences are traced to the end.

The maturity of a research program is determined by the ability to keep the question open while limiting one's own assertions. An unknown phenomenon may require new concepts and instruments. This requires stored data, clear models, and correctable procedures. Each subsequent protocol must show what knowledge it is based on, what it allows to do, and at what point observation ceases to be sufficient.

### Case registry and reopening conditions

The registry links individual records and makes research limits comparable. This includes cases with established normal cause, persistent residual, negative test, insufficient data, and clearance stop. These statuses do not form a scale of unusualness. One case may have different statuses for different statements being tested: the origin of the image is established, but the cause of the accompanying sound remains open.

Strong identifiers, metadata, provenance descriptions, and reuse conditions are useful for organizing records. These objectives are codified in the FAIR principles of discoverability, accessibility, interoperability and data reusability [60]. Their use helps discover and correlate data, but does not validate the physical interpretation. Access to sensitive information may be subject to restrictions; in an open card, it is enough to keep a clear description of what materials exist and what are the conditions for accessing them.

Before comparing cases, determine the unit of account. Three messages based on the same video refer to the same primary material. Two sensors of the same installation may depend on a common support. The registry stores these relationships explicitly. The message, event, instrument, and study series ID must be different. The event merging fix is saved in the version history so that the published frequencies can be replayed.

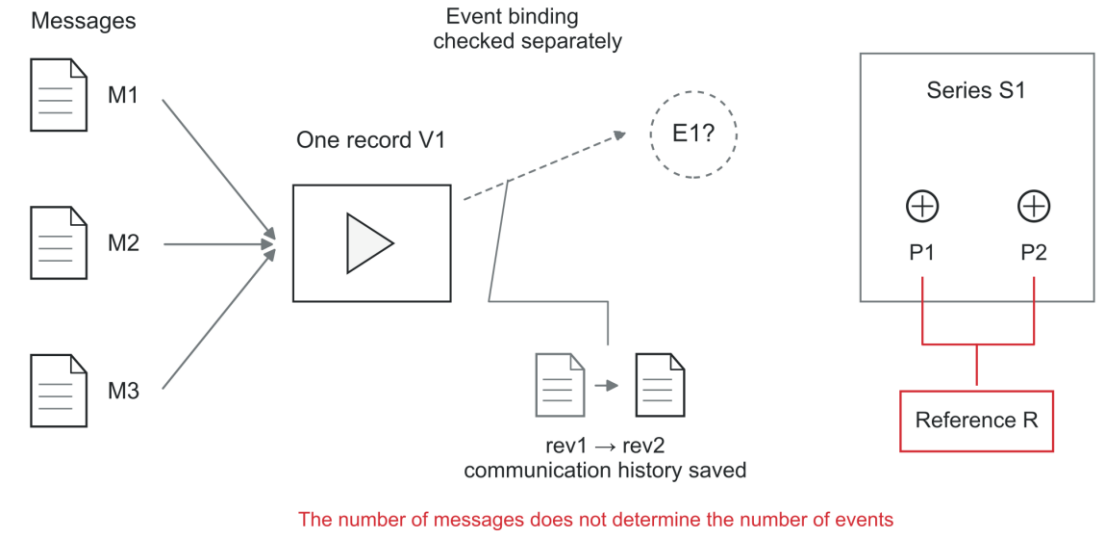



Figure 43. Message, material, event and series are different units. Scheme of the origin of records with conditional identifiers. Messages M1–M3 refer to one primary material V1; its connection with the event is checked separately and preserves the revision history. The P1 and P2 devices are part of the S1 series, but the common support R links their vulnerabilities. The number of messages, materials and events cannot be identified.

An open-ended question is written down so that the next researcher can test the usefulness of his method. Instead of “nature unknown,” indicate: the two versions differ in the sign of the response for a given permutation; the current setup does not resolve the expected delay; the material cannot be associated with the original state. The condition for rediscovery may be the appearance of an independent record, a new specimen with known provenance, or an instrument with the required characteristics. Mere repetition of a story does not fulfill this condition.

Appendix I contains the structure of the registry and training lines for workshop matters. They cannot be summarized into the frequency of anomalies: cases have different units, conditions and goals. For overall analysis, a comparable subset is first selected, coverage is checked, and dependencies are taken into account. Storing negative and invalid runs allows you to distinguish the absence of a detection from the absence of a valid test.

Part XI

# Research workshop

All cases in this part are fictitious educational studies. Numbers and records are created to parse the method. They do not indicate actual detection of the described effects and do not set universal operating limits.

Chapter 55

## Case 1: Clock divergence after connection restored

All events, instruments and numerical data of this case are fictitious and compiled for educational purposes; The set is completely synthetic. In the inspected technical room, two recorders after the network was restored show a time jump of approximately 1.2 seconds. Later, one of them continues to move forward. The employee combines both signs into a message about local time acceleration. The research team retains the original formulation, but highlights two questions: why the readings changed at the same time and why additional discrepancies then accumulated. These questions may have different reasons.

### Record A: what is actually registered

The case is designated UCH-TM-01. The original logs of recorders A and B, the clock server log S, and the offline reference record R are available. The first DI mark refers to the displayed time; TM denotes the physical pace hypothesis being tested. The place is known, but the moment of the jump is initially specified by the interval, since the verified scale itself cannot serve as the sole basis of chronology. The owner of the premises confirms the standard condition of the equipment. The study is limited to registration and permitted bench testing; it does not require changes to the technological process.

The R counter is used as a reference sequence. Its comparison with a separate laboratory standard is performed before and after the session. Channel R stores data locally and receives no commands from S. Recorder A has an accessible hardware counter that is read independently of the software calendar mark. For B, a log of correction commands is saved. Therefore, the source data allows us to separately study the progress of the generator and the transformation of readings. It is this division, formulated in chapter 12, that becomes the content of a particular case.

### Plan B and Independence Card C

Before repeating the series, the group fixes three versions. If there is a synchronization error, a jump should appear in the software timestamps after a certain S command, maintaining the continuity of the hardware count. With temperature drift, the frequency difference A relative to R should depend on the state of the generator itself. For a local metric explanation, after taking these reasons into account, there must remain a consistent effect among heterogeneous autonomous standards associated with place. The main indicator is the residual difference per hour; The minimum scale of interest for this training test is set to 0.5 milliseconds.

Map C shows that A and B are not independent witnesses to the jump: both receive a correction from S. Their agreement tests the propagation of one command. R has separate power, storage, and a reference, but shares the laboratory environment; temperature and mechanical dependencies therefore cannot be declared eliminated. The metrologist adds a separate record of enclosure temperatures and performs a joint

comparison of the devices. What matters is the specific dependencies broken by the new configuration, rather than a general claim of independence.

### Data and discrepancy decomposition

The table shows the differences relative to R in milliseconds. Zero values at the start of the session indicate the selected initial binding. Before session A was established at 28 °C, while its control characteristic was also determined at 20 °C. At the hour in question, the temperature A remained constant. The "before" and "after" marks refer to a single registered server command; these are not two intervals of physical time. Rounding a table does not replace the original more detailed entries.

| Count R | Label A − R, ms | Mark B − R, ms | Hardware count A − R, ms |
|---|---|---|---|
| Home | 0.0 | 0.0 | 0.0 |
| 600 s, to command | 1.2 | 0.0 | 1.2 |
| 600 s, after the command | 1201.2 | 1200.0 | 1.2 |
| 3600 s | 1207.2 | 1200.0 | 7.2 |

The S log contains a single command to add 1200 milliseconds, which occurred after loading an incorrect saved correction when communication was restored. Hardware count A is continuous at this moment. In the resolved isolated copy of the configuration, the same boot sequence reproduces the jump, but the corrected version does not create it. The check explains the overall program transition. It does not yet explain the remaining 7.2 milliseconds and therefore does not complete the analysis with one defect found.

A separate bench characteristic A gives the relative change in frequency $2.00\times10^{-6}$ between two specified temperature states. At a constant value of 3600 seconds, the expected accumulation is 0.00720 seconds, that is, 7.20 milliseconds. This value is consistent with the hardware count. The measured temperature dependence refers to this specimen in the tested mode; it cannot be assigned as a property of any clock. The correction is applied to the working copy, and the original phase and original temperature are preserved.

In the new series, after fixing S, hardware count A accumulates 7.1 milliseconds per hour at the same temperature state. After a predetermined correction, the remainder is −0.1 milliseconds; the expanded comparison uncertainty is 0.3 milliseconds with a coverage factor of 2. In the joint temperature mode, the hardware difference is 0.1 milliseconds with the same stated uncertainty. Rearranging the available positions does not transfer the drift to B: the dependency follows A. These results test specific predictions rather than simply repeating the original scene.

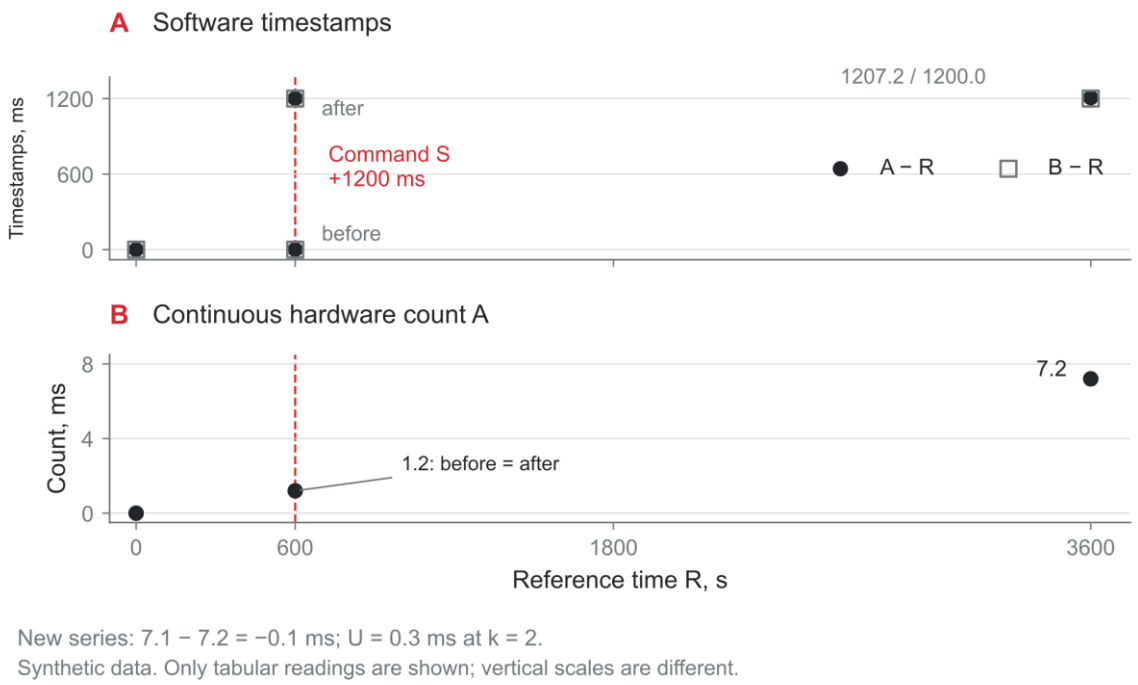



Figure 44. General jump of marks and separate drift of the generator. Synthetic data from case 1. The total jump in software timestamps after the S instruction is shown separately from the continuous hardware count A; vertical scales vary. Repeated points at 600 s refer to states before and after one command. The lower caption describes the new series: U = 0.3 ms - expanded uncertainty at k = 2, not the interval of the initial points.

### Mode D, outcome record E and subsequent revision

The manager allows only standard comparison, transfer to previously available positions and testing of a copy of the settings. The operator stops the series if an independent record R is lost, an unregistered correction is made, or the environment goes beyond the verified conditions. Stopping means stopping the comparison experiment and maintaining local logs. The coordinator does not allow the infrastructure server to be disabled for the sake of demonstrating the effect; its operational function is separate from bench testing. The keeper stores both the erroneous configuration and the history of its correction.

Outcome record E records two confirmed results: the overall jump in the marks is explained by the synchronization command, the additional stroke A is consistent with the measured temperature characteristic. Time correction is a correction of the measurement path, not a neutralization of the physical time domain. After corrections, the new scale effect of more than 0.5 milliseconds per hour is not supported by this check. The conclusion does not apply to smaller effects, other modes, or missing intervals; the absence of a supported deviation does not translate into a statement of perfect clock coincidence.

The case is closed as an explained combination of two reasons. Re-opening is provided for when the balance exceeds the agreed comparison limit and remains after an independent check of the condition of the instruments. It will require a new series rather than restoring the event's previous name. The record preserves the connection between the original message, the two mechanisms found, and the corrected conclusions. Thus, analysis leads to positive knowledge about the system: it is known which process created each part of the discrepancy and with which observation this explanation can be verified again.

Chapter 56

# Case 2: A Stable Small-Force Residual

This is a completely fictitious case study; all forces, distances, characteristics and results are synthetic. Its purpose is to show the continuation of the investigation after the preservation of an unexplained remainder. On a safe laboratory bench, the movement of a closed research module is accompanied by a small deviation of the control body. The outer shell of the module and valid operations are checked in advance; the mechanism of the observed force is unknown. The word “residual” means the difference from the accepted model of known influences. It does not designate in advance a new fundamental force.

### Record A and measuring task

The case UCH-MV-02 receives the main MV label. The gravitational and electromagnetic versions are written as hypotheses rather than established source classes. The quasi-static force along a given axis between the module and the control body is studied. The torsional suspension angle is translated into force through independently tested stiffness and leverage. For a synthetic stand, the lever arm is equal to 50 millimeters, the torsional rigidity is $2.0\times10^{-7}$ N m/rad, the moment of inertia is $5.0\times10^{-6}$ kg m². The corresponding free period is approximately 31.4 seconds.

With a force of 10 nanonewtons, the expected angle is 2.5 milliradians. These values are consistent with the project in chapter 51. They are not characteristics of an actual device. Only established sections after the confirmed end of the transition are used in the case; a set of neighboring samples is not declared by a set of independent experiments. The repetition unit is a separate cycle of placement, control record and return to the starting position. All permutations remain within the permitted stand range.

### Plan B and Independence C

The first plan distinguishes between the displacement of the optical readout, the mechanical connection to the base, and the force acting on the reference body. The optical path is checked with known small turns; the movement of the base is recorded separately. The position of the module is changed according to a pre-prepared sequence, and the evaluator receives records without indicating the distance. A control layout with comparable geometry does not produce the same profile. This limits certain technical versions, but does not establish that all properties of the layout match the properties of the module under study.

Map C includes the shared table, air, geometry, and processing system. The second measurement therefore uses an independently calibrated elastic beam with separate readout and analysis code. Retaining the room and the module itself leaves shared electrostatic and thermal causes possible. Measuring two mechanical responses strengthens the force claim relative to the error of a single readout. It does not establish independence from every environmental influence or replace further checks of the source.

### Fit and test series

For the first series, the distance d is measured between certain geometric reference points. Research analysis suggests the empirical relationship $F(d)=A(50\ \text{mm}/d)^2$. The exponent two here is a chosen form of describing a limited range, rather than an inference about the nature of the interaction. The coefficient A is estimated from only three lines of the fit. The independent component of the standard uncertainty of each row is equal to 0.30 nanonewton; the total relative uncertainty of the scale is 1.5 percent. The latter does not decrease with the number of points.

The zero offset is assessed in a separate paired control cycle for each point. The indicated 0.30 nanonewtons include an independent component of the uncertainty of such a difference. The zero cannot

be freely changed simultaneously with the beginning of the distance and the degree of dependence, maintaining the appearance of a one-parameter model. With a few loose geometric adjustments, the same three numbers would be capable of much more explanation. Therefore, only A is adjusted here, and the reference points and processing remain unchanged. Their subsequent revision would mean a new version of the model, rather than a refinement of the previous prediction.

| Series | d, mm | Torsion path, nN | Elastic beam, nN |
|---|---|---|---|
| Fit | 40 | 15.80 | Not measured |
| Fit | 60 | 6.80 | Not measured |
| Fit | 80 | 4.00 | Not measured |
| New check | 45 | 12.50 | 12.20 |
| New check | 70 | 5.00 | 5.20 |

Minimizing the sum of squares over the first series gives A=10.068 nanonewton, rounded 10.07. The independent component of the coefficient uncertainty is approximately 0.171 nanonewton; after adding the overall scale, the result is about 0.23 nanonewtons. In this educational calculation, the error in specifying distances is negligible relative to these components. In a real project, such a simplification would have to be confirmed by geometric calibration. The resulting coefficient and formula are fixed until the opening of the next series.

For the new distances 45 and 70 millimeters, the forecast is 12.430 and 5.137 nanonewtons, respectively. The torsional path shows 12.50 and 5.00; the differences with the forecast are equal to 0.070 and −0.137 nanonewtons. The standard uncertainty of an individual beam result is 0.40 nanonewton. The beam data are consistent with the same magnitude of force. A separate background series without the studied module gives a nanonewton remainder 0.08 with standard uncertainty 0.30. All of these records are saved together, including featureless control loops.

### What is established when the residual persists

A limited positive result was obtained: in the tested configuration, the position of a particular module is related to the reproducible mechanical response of two dissimilar paths. The empirical dependence, selected on one series, withstood testing at two new distances. The output refers to the range 40–80 millimeters and the measured state of the system. Three points of fitting and two tests are not sufficient to establish the exact extent of the law or the single source of power. You should continue to work with this measured dependence, and not with the previous general word “deviation”.

At least three versions remain. Residual electrostatics may depend on the surface potential distribution, which is not fully described by external control. Communication through a gaseous medium may depend on weak temperature fields and surface conditions. An unaccounted interaction of a different nature is still an open hypothesis that requires its own discriminating prediction. The presence of a third line does not make it equally confirmed by the first two. The current data do not select between mechanisms capable of producing close distance dependence.

The next plan changes the condition on which these versions diverge. Within a qualified installation, pre-selected states of the gas environment are compared with the same geometry and recorded temperature

profile. A separate series examines the influence of an allowed conductive screen, controlling its mechanical and thermal contributions. These interventions are not combined into one experiment. For each mechanism, the permissible response range is calculated in advance; if there are no forecasts yet, the new stage remains exploratory. Improving accuracy without such a distinction would only clarify the previous ambiguity.

### Regime D and Outcome record E

The operator stops moving if position control is lost, suspension is damaged, an unplanned environmental change occurs, or the reading moves out of the qualified range. The coordinator allows only already tested operations; stronger impact is not a reward for interesting residue. Outcome record E noted that no neutralizing intervention was performed: force recording and limited predictive dependency were tested. The condition for revision will be the incompatibility of the new series with the fixed forecast or the discovery of a previously unaccounted for common cause. The case remains open, but now contains a measurable outcome and a specific next question.

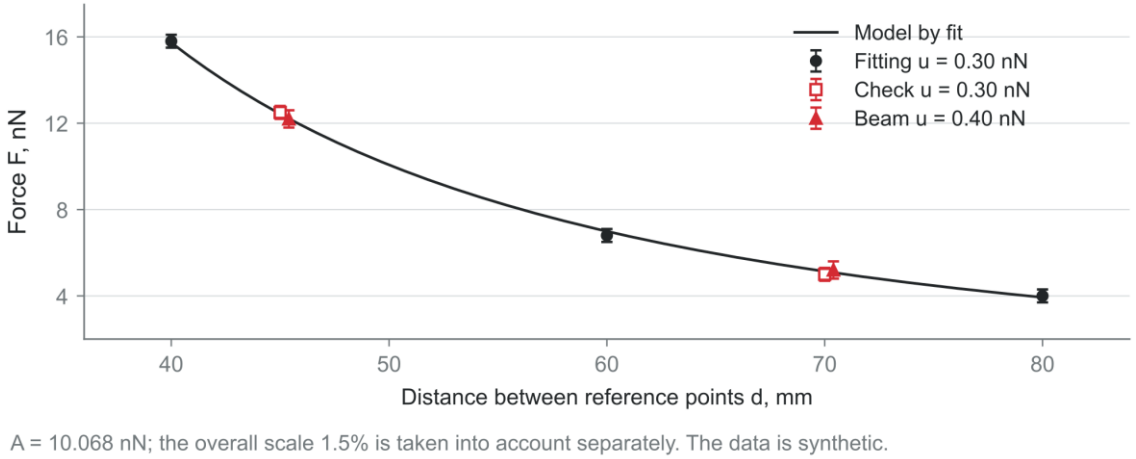



Figure 45. Force model and independent verification measurements. Synthetic data from case 2 and empirical model F = A(50 mm/d)², A ≈ 10.068 nN. The bars show independent standard uncertainty components: 0.30 nN for the torsional path and 0.40 nN for the beam. The overall relative uncertainty of the scale 1.5% is taken into account separately. The triangles are offset by 0.4 mm for readability only; actual distances are 45 and 70 mm. The model area is limited to 40–80 mm.

Chapter 57

## Case 3: Testing a Time Model with Clocks and Mechanics

All observations and numbers in this case are fictitious educational data; The set is completely synthetic. The conditional metric test is considered, rather than reporting the detected time domain. After comparing several autonomous frequency standards, the team obtains a small, stable spatial profile of temporal residuals. Correcting known conditions and testing the transmission line will not resolve it. It is tempting to call a coincidence with a beautiful formula an explanation. The point of the case is to test another necessary consequence of the same formula and to preserve the result even when it turns out to be inconvenient.

### Record A and scope of approval

The case UCH-TM-03 combines daily comparisons of four studied positions with a remote standard. The radial coordinate is specified relative to the selected geometric center; the remote reference is located at

R=100 meters. The position of the center is established in the exploration series and fixed until inspection. The TM label refers to measured differences, and the metric explanation has the status of a conditional model. Information about the mechanical channel is initially hidden from the analyst selecting the clock profile. This way, one group of data is not used invisibly to tune all subsequent forecasts.

The record separately states that local atomic frequencies, phase transfer and movement of supports have their own checks. The overall coordinate and environment error remains part of the budget. For educational analysis, the standard uncertainty of each daily residual is 3 picoseconds. This level is specified by the condition of the synthetic study; it does not promise that such precision will be available in random field deployments. The comparison times refer to the verified reference scale and the raw phases are retained before corrections.

For each position, it is verified that the daily value describes the accumulation of the difference, and not a constant shift in the initial phase. The original time series maintains an approximately linear course over the interval under consideration. The static profile remains a condition of the verified version: data from another state cannot be mechanically combined with this series. If only one-time final readings were recorded without an initial comparison, a strong inference about tempo would not be available even before the geometry was discussed.

### Plan B: fixed conditional metric

The group uses exactly the model from chapter 16: a static spherically symmetric metric with Euclidean spatial sections and a positive function $N(r)=1+\varepsilon \exp(-r^2/L^2)$. For stationary clocks $d\tau=N(r)dt$. Using two fitting points, the rounded parameters $\varepsilon\approx10^{-15}$ and $L\approx10$ meters are obtained. They are fixed until new radial positions are opened. The remote standard at R=100 meters for this profile practically corresponds to N=1. This approximation belongs to the model and is clearly involved in the calculation.

| r, m | Purpose | Predicted daily shift, ps | Synthetic observation, ps |
|---|---|---|---|
| 0 | Fit | 86.40 | 86.4 |
| 10 | Fit | 31.78 | 31.8 |
| 5 | New check | 67.29 | 67.5 |
| 20 | New check | 1.58 | 1.6 |

The new position data is consistent with the time profile under the specified uncertainty. This is a positive result of testing one group of consequences. It shows that the model is able to predict interpolation and clock residual decay over the tested range. But the coincidence of the profile does not determine the mechanism of its occurrence. The model simultaneously relates the clock to the propagation of light and to the acceleration required to hold a stationary body. The preliminary plan expressly prohibits completing the examination after one convenient table.

### Independence C and mechanical prediction

The mechanical channel measures the horizontal radial component of the fixed platform's proper acceleration after subtracting the verified normal background. Orientation, tilt, and base motion are recorded independently. The channel has separate power, read and process; its coefficient is not

determined from clock data. The coincidence of the measurement location remains the general physical relationship necessary for model comparison. Calibration was performed before and after the series under conditions not using the proposed new effect.

In the chosen metric, the magnitude of the holding acceleration is equal to $c^2|d \ln N/dr|$. For positive ε, the radial component is directed towards the center. For small ε, the maximum is located almost at $r=L/\sqrt{2}$, that is, about 7.07 meters. Substitution of the accepted parameters gives approximately 7.71 m/s². This is a large mechanical forecast, despite a daily clock shift of only tens of picoseconds. The reason is the spatial gradient multiplied by c². Checking only at the center would be unsuitable: there the gradient is zero.

$$a_{\max} \simeq \frac{c^2|\varepsilon|}{L}\sqrt{\frac{2}{e}} \simeq 7{,}71\ \mathrm{ms}^{-2}$$

The synthetic notation at r=7.07 meters gives the excess radial component +0.003 m/s² with standard uncertainty 0.010 m/s². The axis sign is directed away from the center. The model forecast is about −7.71 m/s². The function check confirms that such an acceleration could not be hidden in the range of the device or in its zero display. The difference is not comparable to the stated budget and is not corrected by rounding ε or L. Maintaining the clock profile does not compensate for this discrepancy.

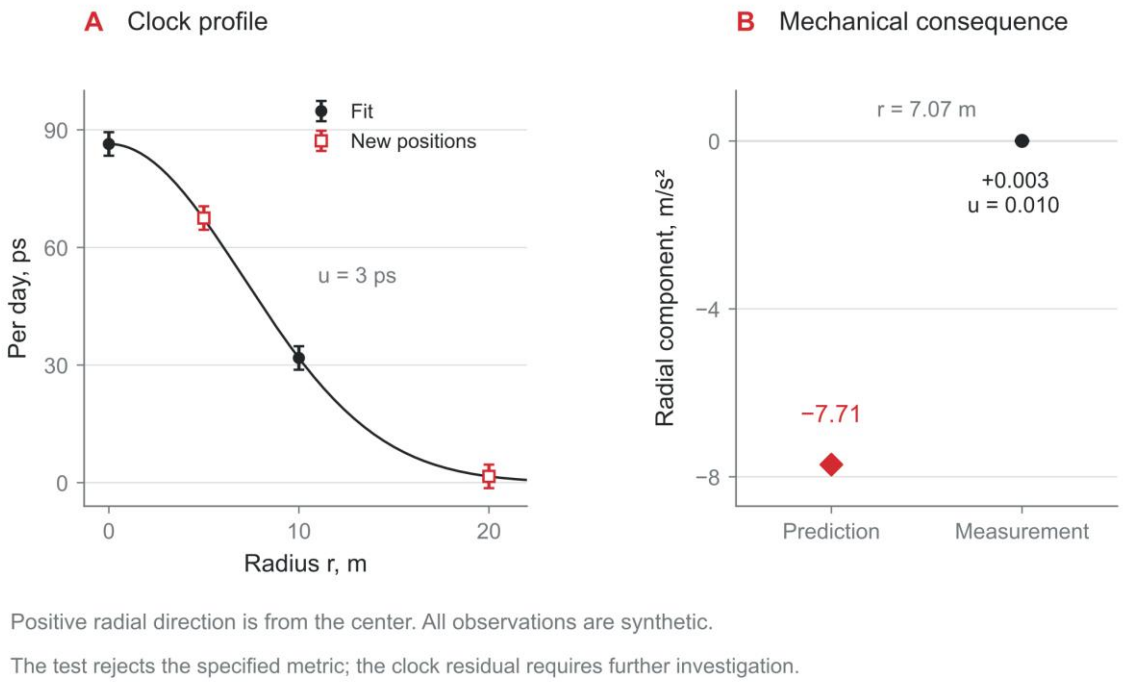



Figure 46. One metric withstands the clock and does not withstand the mechanics. Synthetic data from case 3. The conditional metric with $\varepsilon = 10^{-15}$ and L = 10 m is consistent with four clock readings, including two new positions, but predicts a mechanical component inconsistent with the measurement. For clocks, the standard uncertainty is shown u = 3 ps; for mechanical measurement u = 0.010 m/s². Its short interval is almost indistinguishable on the scale of a large forecast. The positive direction is from the center. The uncertainty of the model parameters is not specified here.

### Mode D and solution by model

The equipment is located in an already approved testing area; Mechanical data is captured remotely. The emergence of a hypothesis about high acceleration does not become a reason to send a person for a subjective test of gravity. The coordinator stops the movement if there is an unexpected load, loss of position, or failure of mandatory mechanical controls. The saved stationary record is sufficient for the

main fork. If the calibration of the mechanical channel were lost, the result would be that the test would be invalid rather than the timing model automatically being true.

In Outcome record E, a specific joint interpretation is rejected: a given metric with a fixed profile does not agree simultaneously with clock and mechanical data. This is not a refutation of any conceivable geometry, nor is it proof of the absence of a registered frequency residue. Changing the spatial part of the metric, introducing additional force on the platform, or revising the staticity would mean a new model with additional predictions. Such changes cannot be introduced after the result and then declare the previous test successful.

The clock remainder receives its own continuation of the study. Transitions with different sensitivities to the medium are compared, independent transmission lines are repeated, and the stability of the coordinate profile is investigated. If the cause turns out to be instrumental, it should reproduce the scale and form of observations. If the remainder holds, the new hypothesis must also explain the absence of the rejected mechanical consequence. The temporary case name no longer protects selected geometry from inspection.

The condition for reviewing the decision is written specifically: discovery of a significant defect in the mechanical record or a new series compatible with all fixed forecasts. No neutralizing intervention was carried out, so the report does not report elimination of the area. The scientific result is to narrow down the set of explanations while maintaining the original observation. The case shows how a positive match of one set of data and a negative comparison of another together produce a stronger conclusion than either one alone.

Chapter 58

# Case 4: Changing domain and loss of observability

All circumstances, maps and numbers of this educational case are fictitious; synthetic data. In a classroom, remote thermal imaging reveals an area of the surface that differs from a comparable background. The visible area gradually increases, while at the same time the quality of its registration deteriorates. Then the telemetry of the moving platform disappears. The team faces two different challenges: to understand the development of the recorded process and to maintain the validity of actions when part of the information is lost. The disappearance of the map from the screen is not taken as either the disappearance of the area or evidence of the destruction of the device.

### Record A: observation area and its border

The case UCH-TN-04 is assigned the label TH; the change in contour geometry is described as a characteristic of the observed surface. The reason for the thermal difference is not yet known. The limit is specified operationally: this is the contour of the temperature difference exceeding 0.8 kelvin in the selected measurement model. The threshold refers to the emphasis of a feature on a given record, not to human safety. For a real thermal interpretation, the properties of the surface and reflected radiation must be taken into account; in the training set, their checks are considered to be completed within the specified range.

The record includes source frames, reference temperature areas, camera position, mask of unusable pixels and information about the background. Instead of a single number “zone radius”, the greatest distance from a fixed benchmark to a suitable part of the contour is recorded. Non-visible areas retain a separate designation. The map of observed differences and the map of permitted placement of people are different documents. Merging these maps would create a false safety boundary where only the selected thermal property is measured.

### Plan B, Map C and Initial Mode D

The main question of the first series is whether the contour change is preserved with a stationary measuring path and a suitable background. The physical change version of the surface predicts a consistent pattern across independent views. The version of the changed measurement predicts an association with adjustment, position, or loss of a reference site. The plan establishes a constant processing and quality criterion: the ratio of the allocated contrast to its assessed uncertainty must remain at least four. This is a local condition for the distinguishability of training experiments, not a universal statistical or protective norm.

Map C identifies two cameras, but their initial independence is incomplete. They share a transmission channel, and one is mounted on a moving platform. Their local storage operates separately. A separate status channel confirms only that the platform has stopped; it does not replace scientific data. Matching screen displays therefore do not establish uninterrupted communication, while lost telemetry does not mean all original files have been lost. Before the run, the response to channel failure is specified: stop moving while maintaining the required functions. This mode has been tested beforehand for this site; it is not proposed as a universal response to every unknown environment.

| Time by support | Contour size, m | Contrast quality | Record status |
|---|---|---|---|
| 0 min | 0.8; interval 0.6–1.0 | 10 | Suitable |
| 4 min | 1.1; interval 0.9–1.3 | 7 | Suitable |
| 8 min | 1.5; interval 1.2–1.8 | 4.2 | Suitable at the regime border |
| 9 min | Not defined | Not defined | Loss of telemetry |
| 12 min | Not defined | 2.1 | Local file; the circuit is unusable |

### State change and stop command

The first three lines support the expansion of the registered contour given the accepted criterion. The difference between the central estimates is 0.7 meters per eight minutes, that is, 0.0875 meters per minute. This is a description of the movement of the threshold boundary, and not a stated rate of transfer of matter or energy. Changing the temperature profile can move such a circuit without moving a separate body. After the eighth minute, the pre-selected model already warns that it is approaching loss of fitness, so no further approach is allowed.

At the ninth minute, the operator receives a sign that mandatory telemetry has stopped. Local automation stops movement according to a previously tested condition; a separate status channel confirms the stop. The operator records the termination of the operation and the last valid configuration. The leader stops drawing conclusions about the current size of the area. The last measured contour, its interval and a clearly marked unobserved part remain on the general map. It is impossible to extend the previous curve for subsequent minutes at one average pace: the program has not yet established the law of process development.

The connection is later restored, and the local array is copied remotely. This allows us to obtain the twelfth minute line, but does not make it suitable for the previous geometric derivation. In it, the contrast is insufficient according to the fixed criterion. The custodian does not replace skip telemetry with a continuous contour line. At the same time, it saves the recording itself: it is useful for analyzing the loss of distinguishability. The successful receipt of a file and the suitability of the measurement it contains are subject to separate checks.

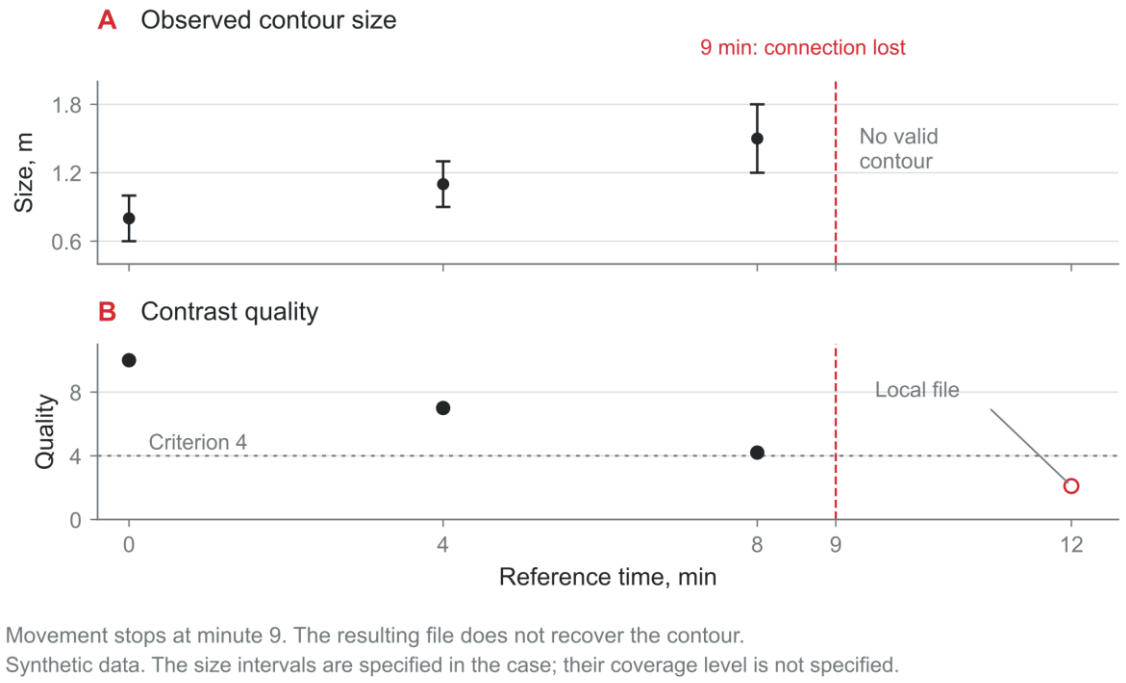



Figure 47. Growth of the measured contour and loss of measurement validity. Synthetic data from case 4. Three suitable size estimates are shown at the intervals specified in the case; their level of coverage is not specified, so they are not called standard uncertainties or confidence intervals. At the 9 minute, the loss of telemetry leads to a stop in movement. In the recovered file 12 of the minute, the quality is equal to 2.1, below the local criterion 4; The size for it is not determined. There are no lines drawn between the readings or through the gaps.

### Revision of mode instead of automatic return

The team is considering three explanations for the degradation: changes in the surface itself, changes in the background environment, and failure of part of the measurement link. A registered restart of the common transmitting node was found for hardware telemetry loss. This explains the lack of connection, but does not explain the growth of the contour before it. Likewise, low contrast does not establish source attenuation. Parsing preserves separate branches so that the found technical cause does not swallow up the unexplained physical sequence.

The new clearance provides for observation from already accessible external positions, an independent transmission path and additional reference areas. Data transmission is restored separately from the decision to move the platform. The coordinator requires confirmation of all prerequisites; The team does not consider the returned image to be a continuation of the previous resolution. If the updated scheme does not ensure the discernibility of the contour, a limited registration without an estimate of its size remains an acceptable result. Human entry to remove or reposition the device is not included in this mode.

In the subsequent synthetic series, two suitable still records give the size of 1.6 meters with the interval 1.4–1.8. They allow the description of the current state to be resumed, but not the unknown history

between the last usable frames. It cannot be concluded that the region remained within the new contour all the time. Several development options remain: further expansion with return, stabilization or change in shape. Each option is associated with a constraint on future output and a requirement for the next observation.

### Outcome record E and condition of revision

The report records the expansion of the observed sign in the first interval, the loss of mandatory control, the stop performed and the restoration of limited measurement suitability. Neutralization was not carried out. The final process status is observed difference with incomplete history, and the job status is passive registration in a revised configuration. Further transition is permitted only after obtaining suitable dynamics and checking its connection with environmental conditions. Repeated loss of support, growth of a blind area, or unforeseen change again terminates appropriate conclusions and actions.

The case shows the research life cycle next to the object life cycle. The source could continue to change while the group was losing observability; the state of the archive and the state of the surface do not have to match. The saved record makes it possible to distinguish these stories. The useful result is not a certain map at any cost, but a precise knowledge of where the measurement was valid, why the previous regime ceased to be valid, and what information made a limited continuation possible.

Chapter 59

## Case 5: Information dependence on new assignments

This is a fictitious educational study. All images, answers, numbers and installation properties are synthetic; they are not a message about the existence of an unusual intelligent source. The safety optical module produces one of two electrical pulses after the image is presented. Its detailed internal organization is not available to the group. Early observers call the responses understanding the picture. The study retains the narrower question of whether the output contains reproducible information about a predetermined relationship between the figures depicted and whether this relationship transfers to independently generated tasks.

### Record A: function instead of personality

Case UC-AG-05 receives the label AG as a test of apparent meaningful response and DI as a registration study. The installation does not control external equipment; its output is only recorded. The input represents a picture with a closed contour and a separate label. The target attribute is whether the label is located inside the contour. The two valid pulses are designated 0 and 1; all other outputs, no pulse, and ambiguous entries receive their own categories. The function measured does not imply consciousness, intent, or ability to understand any message.

An exploratory series of eighty images is used only to select the working format, response window, and a robust method of detecting pulses. It is excluded from the confirmatory results. Once it ends, the code, presentation duration, input-quality rules, and scoring criteria are fixed. Both values of the target feature are generated without a schedule accessible to the operator. The mean brightness and duration of the compared images are controlled, but the team does not claim that this eliminates all physical cues to shape. This limitation is part of the question of what the response means.

### Plan B: two confirmatory series

The first hypothesis assumes information available to the input about the location of the mark. It predicts an advantage on new images when the optical channel is open and its disappearance during a control presentation that does not carry the target feature. The remembered order version predicts deterioration after changing an independently generated set. The version of the reaction only to simple brightness requires a different dependence on stimuli matched on this basis. None of these hypotheses yet define the complete internal algorithm of the device.

The main indicator is the number of correct answers divided by all assigned attempts. Silence is not removed as “unwillingness to respond”, but is counted as failure to respond successfully. Correct, incorrect and missing answers are stored separately for each block. Control pictures have a target label only in the closed list of trials: the presented picture itself does not indicate which answer is considered correct. This allows you to evaluate guessing and possible leakage without replacing control by repeating pictures known to the device.

### Independence map C and execution of mode D

The list of tasks and the key are kept by the participant who does not manage the installation. The operator receives the presentation order without correct answers. The pulses are evaluated by the assigned decoder before the key is opened. The archive includes the original images, the actual optical recording of the presentation, electrical signals and a status log. Checking service files excludes the inclusion of the key in the transmitted metadata. The general generation program may still create a hidden clue, so the subsequent B series is prepared by a different group with a different implementation.

The approval allows only the tested lighting level, standard power supply and separate output registration. The operator stops presentations if there is an unexpected device command, registration overload, key disclosure or change of the set code. The scientific attractiveness of the answer does not allow expanding the channel of communication. After stopping, saved attempts receive status according to a predetermined rule; the ineligible series is not supplemented with selected successful responses from the other session. No clearance violations occurred in this case.

| Series and condition | All attempts | True / false / no answer | Share of success |
|---|---|---|---|
| A, input open | 200 | 150 / 42 / 8 | 75.0% |
| A, control without target information | 100 | 48 / 46 / 6 | 48.0% |
| B, new tasks, input open | 160 | 118 / 35 / 7 | 73.75% |
| B, control without target information | 80 | 38 / 38 / 4 | 47.5% |

### What did the independent series add?

Series B is formed after pinning the output from A. The new group does not use the previous list of images and does not know the previous output sequences. It changes the size, position and contour pattern within a pre-declared job class. A preliminary check confirms the unambiguity of the correct answer in each picture. No trial run B is used to reconfigure the decoder. Therefore, 118 of correct answers from 160

becomes a test of the transfer of the established function, rather than a continuation of the fitting of the first series.

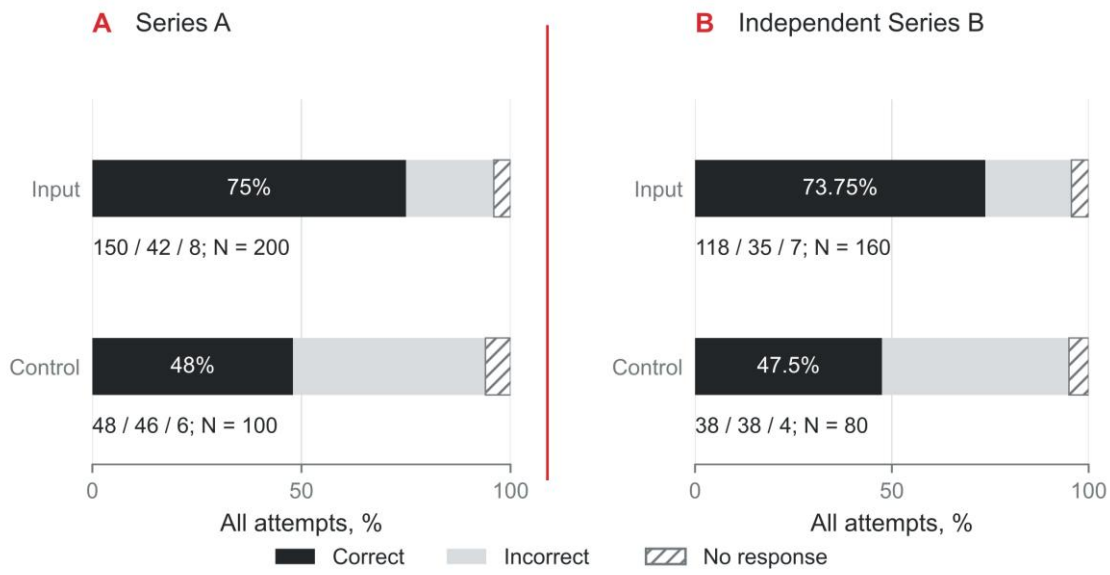



Figure 48. Transferring the result to an independent set. Synthetic data from case 5. Bands are normalized to all assigned trials, including no response; Below them are the original numbers and denominators. Series B uses an independent new set after the procedure is consolidated. Exploration images 80 are not included. The figure shows the transfer of a specific function, without confidence intervals, significance flags, or inference about the consciousness of the source.

The success rate on input open is 75.0 percent in A and 73.75 percent in B; the difference is equal to 1.25 percentage points. Control blocks do not show a comparable benefit. The table supports limited information dependence, but simply comparing percentages does not complete the statistical examination. Her model must take into account the distribution of conditions, the possible dependence of sequential responses and the chosen stopping rule. In four complete blocks A of fifty attempts each, 37, 38, 37 and 38 successes were recorded; in blocks B, forty trials each - 29, 30, 29 and 30. The effect is not concentrated in a single successful fragment.

The result does not require asserting that the module understands meaning in the same way as a human. Conventional image processing, sensitivity to geometric features, hidden electronic implementation of the rule, and some yet untested channels are quite compatible. Isolation of a visible network connector does not prove the absence of all technical connections. The unknown internal structure is a limitation in the description of the mechanism. At the same time, it does not cancel the measured function: on new tasks, the output contains information useful for this discrimination.

### Outcome record E and the following discriminating experiment

Outcome record E establishes a reproducible functional result for a given class of images and the tested channel. Neutralization and physical control of the source were not performed. No inference is made as to identity, benevolence, or intent. The next project is to distinguish between a simple geometric rule and a broader use of the assignment. For example, a separate pre-prepared format may require the opposite response to the same image through an independent rule specification. This format represents a new challenge and is not considered to have already been confirmed by the current numbers.

Technical examination of internal implementation remains an independent direction, subject to the permission of the owner and a safe procedure. If it explains the answers in the usual way, the functional observation will be preserved and its mechanism will become known. If the new series does not reproduce the dependence, the tolerance limits and possible hidden conditions are reconsidered. The condition for reopening an already closed output is a specific violation of the key, decoder, or task origin. The case demonstrates a positive informational outcome that can withstand new questions without becoming an arbitrary story about the interlocutor.

Chapter 60

# Case 6: Verification of the proposed neutralization

All events and levels in this case are fictitious and refer to a safe tutorial; synthetic data. Numbers do not define acceptable human exposure. A stable narrow-band acoustic signal is recorded in the controlled room. After a command called “suppression,” its graph drops sharply. The operator proposes to close the case as neutralized. Independent analysis reveals that an equally quiet screen is compatible with source termination, transmission limitation, and loss of measurement sensitivity. These outcomes are tested separately.

### Record A and predetermined statement

The case UCH-AS-06 receives the AC label. The main indicator is the level of root-mean-square sound pressure in a fixed band near the selected frequency, with a constant averaging technique. The main microphone M1 is located at the receiving point, the independent microphone M2 is closer to the technical source. Their coordinates are fixed. For both, source signals, settings and response testing are available. The measurement task is to establish the change in signal transfer to M1; the question of stopping the source itself requires additional evidence M2 and information about its condition.

All levels in the table are expressed in decibels relative to one accepted support. Correct matching requires the same frequency band and the same processing conditions. A local test feed to M1 tests sensitivity in this band without passing through the test path from the source. Therefore, it helps separate changes in reception from changes in distribution, but does not measure the effectiveness of the barrier itself. The standard uncertainty of suitable field comparisons in the training set is one decibel.

### Plan B: three results with different signs

When the source stops, the main signal should decrease at both microphones, while the control inputs will remain detectable. If transmission to M1 is limited, its value will decrease, M2 will remain at the same level, and local control M1 will remain usable. When changing the sensitivity or processing M1, both the test signal and its reference signal will decrease. These forecasts are consolidated until a new review. The absence of a suitable control gives the outcome “confirmation is insufficient”, even if the graph of interest turned out to be very low.

Form C identifies separate sensing elements, power, and storage for M1 and M2. They initially share a display application, so an independent analyst checks the raw data streams with separate code. Control-signal injection has its own log. The working map also includes mechanical transmission through the room's structure: reducing the airborne signal does not automatically characterize that path. The verification record must not extend a conclusion from the measured frequency band to every possible sound or vibration.

| Condition | M1, dB | M2, dB | Control M1, dB |
|---|---|---|---|
| Before intervention | 68.0 | 67.5 | 60.0 |
| After software “suppression” | 18.0 | 67.6 | 10.0 |
| After processing is restored | 68.1 | 67.4 | 60.1 |
| After a proven acoustic barrier | 54.0 | 67.5 | 60.0 |

### First fork: measurement disappeared

The second line does not confirm the neutralization. The studied and control indicators M1 decreased by the same fifty decibels, and M2 retained the same result. Checking the log shows that the command changed the processing of the selected main channel band and did not affect the emitter. The displayed value after this restructuring used the same designation, although the transfer characteristic became different. The stored raw signal allows the reconstruction of a comparable representation. The erroneous screen remains archived as part of the solution history.

The coordinator terminates the previous authorization because the required channel no longer performs its stated function. Stopping does not require turning off the source or erasing the filter without recording. The operator records the configuration, restores the qualified mode at the authorized stand and repeats the control. The third line shows the return of the previous scale. This explains the drop in the indicator, but the physical impact is not yet limited. Meter correction and source control are different tasks performed.

### Second fork: limited transmission

The new plan provides for a standard acoustic barrier on a pre-assessed section of the route. Its installation does not change the position of the microphones or obstruct essential ventilation or monitoring functions. Before work, a specialized specialist confirms the suitability of the design for this safe stand. The manager formulates a narrow goal: to reduce the selected air signal at point M1 while maintaining source registration. The cessation of radiation and the disappearance of all possible routes of exposure are not claimed.

After installation, the M1 level is 54.0 decibels, and M2 remains around 67.5. Control M1 retains 60.0. An additional independently calibrated microphone at an agreed receiving point gives 54.3 decibels with a standard uncertainty of one decibel. In allowed control permutations of the barrier, the result is reproduced without changing the software frequency band. This is significantly stronger than the original observation: now the reduction in the main signal is accompanied by a preserved ability to notice the control effect and independent spatial confirmation.

The difference between the initial and final levels M1 is equal to fourteen decibels. With this definition of level, the ratio of the mean squares of pressure is approximately 0.0398, that is, a decrease of approximately twenty-five times. This calculation applies to the selected band and receiving point. It does not determine the total energy of the source, does not establish attenuation outside the measured range, and

is not a universal safety criterion. A positive quantitative result must remain within the same boundaries as the original measurement.

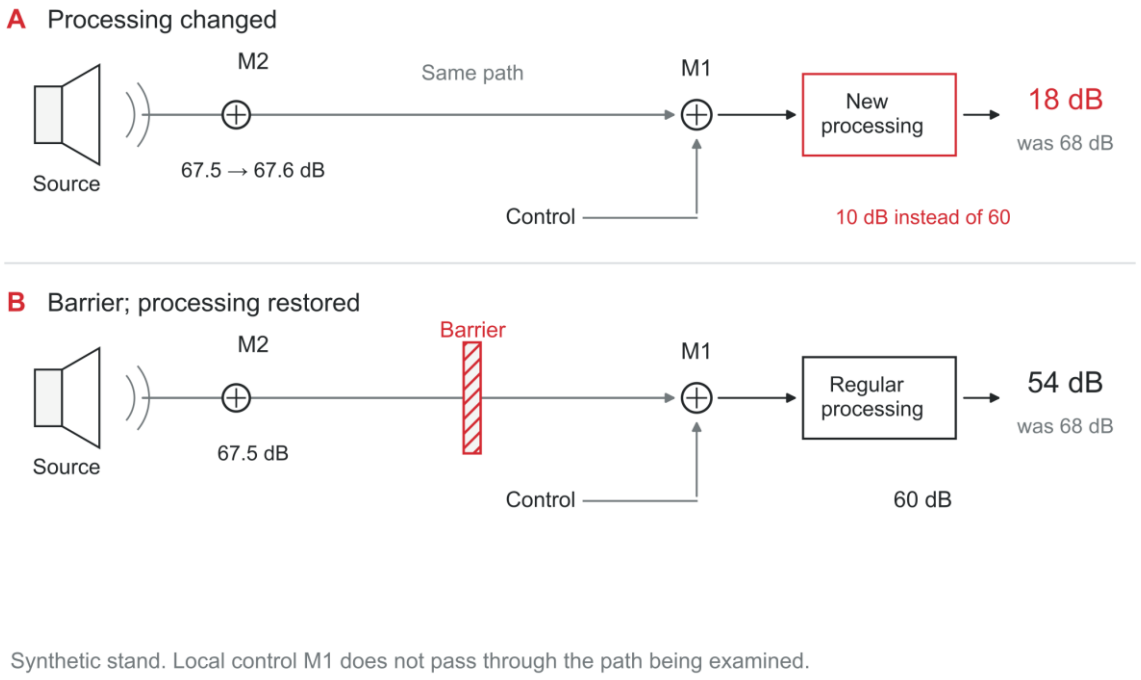



Figure 49. Suppression of readings and limitation of transmission. Scheme of two synthetic checks of case 6. After the processing change, both the M1 signal and its local control fall, so a decrease in the graph does not confirm physical suppression. After restoration of processing and installation of the barrier, M1 gives 54 dB, M2 - 67.5 dB, control M1 - 60 dB. The control is introduced after the path under study. The limitation of the selected transmission channel is shown, rather than the termination of the source. All levels refer to one specified lane and support; suitable comparisons have a standard uncertainty of 1 dB.

$$\frac{\langle p^2 \rangle_{\text{after}}}{\langle p^2 \rangle_{\text{before}}} = 10^{-14/10} \approx 0{,}0398$$

In four complete control cycles, the level difference is 13.8; 14.2; 13.9 and 14.1 decibels. The average is 14.0, but the small scatter does not cancel out the general errors in geometry and calibration. Therefore, the precision reported in the outcome record is not increased to hundredths of a decibel using one averaging. The evaluator receives designations of the barrier position after fixing the levels. This organization reduces the ability to select only convenient recording areas, preserving all the material of the cycles.

### Mode D and completed Outcome record E

Actions are stopped if control M2 is lost, the barrier is unintended, the equipment condition changes, or the agreed transition fails. The person in charge of the operation accepts the barrier with the conditions of maintenance and inspection. If its protective function depends on position and integrity, these signs are included in follow-up. Not having to immediately measure every sample does not mean there is no owner of the stored function. Dismantling is considered a separate change in conditions.

Outcome record E of the first operation states: change in processing, no evidence of physical neutralization. The second operation confirmed the limitation of the selected transmission channel under the tested conditions. The source continues to register; the general status “source eliminated” is not accepted. The unexplored mechanical path and other stripes are listed as output boundaries. The condition

for revision is a change in geometry, damage to the barrier, a new source mode, or failure of the control channel. The case ends with a useful limitation on the impact that does not require attributing a wider effect to it.

Chapter 61

## Case 7: Material with lost origin

All materials, documents and numbers of this educational case are fictitious; synthetic data. After an unusual light episode, the group receives a message that a small sample has appeared and its mass has decreased. The transmitting participant proposes to immediately send the material to the laboratory. Upon initial analysis, it turns out that photographs, symbols and weighing records do not form a continuous story. The laboratory refuses to accept the shipment in the form stated. The research challenge is now one of preserving available knowledge and limiting inference, rather than obtaining analysis at any cost.

### Record A: limit of connection between event and sample

The case UC-MT-07 receives the main MT label for reporting the substance. The very appearance after the flash remains a testimonial statement; neither the transformation nor the unusual mass loss has been confirmed yet. The package actually accessible to the group is assigned a new stable identifier P-07. It links further records to a given item, but does not certify its prior origin. The old designations A-17 and A-71 are retained as controversial information. They cannot be silently corrected to a convenient coincidence.

Until the acceptable route is clarified, no one opens the package out of curiosity or to get a beautiful photo. Responsibility for actual storage remains with the designated owner of the material in accordance with the procedure agreed with the relevant specialist. Transferring information for evaluation does not mean transferring the object itself. This distinction is significant: the laboratory can review the application and refuse physical acceptance, and the lack of consent should not turn into a no-one's submission at its door.

| Recording material | Claimed content | Accessible base | Limitation |
|---|---|---|---|
| Photo of scales 01 | Weight 17.42 g; A-17 | Exported image | Container and original log unknown |
| Photo of scales 02 | Weight 16.87 g; A-71 | Separate file | The identity of the object has not been established |
| Packaging photo | Same sample | Surviving copy | No continuous transmission history |
| Initial message | Appearance after a flash | Recording the words of the transmitting participant | Independent communication not confirmed |

### Plan B: Statement Origin First

The design tests three explanations for the discrepancy. This could be a change in one material, a difference in packaging, or an unintentional juxtaposition of different items. Each version requires different data: original scale log, packaging identification and transfer sequence. The difference between

the two numbers shown is 0.55 grams. The arithmetical correctness of this difference does not establish a change in the mass of the substance. Even working scales would measure a common object of weighing, which has not yet been defined and proven identical in two cases.

The Custodian requests original files and independent transfer documents. The operator restores when snapshots were taken, when they were exported, and when they were attached to a message. A specialized specialist assesses what information is needed to qualify the material and the ability to work with it. The main result of the first stage is limited in advance by the traceability map. Spectral or chemical testing is not intended to automatically reconstruct an event that preceded the current recording. This logic corresponds to the separation of composition and origin in chapters 27 and 31.

### Map C and the Irrecoverable Gaps Found

All submitted acknowledgments are initially traced back to a single transmitting party. Multiple forwarded copies do not create independent eyewitnesses. The moment of weighing is known only from words; calendar marks belong to export. Some of the intermediate messages were not preserved. Checking the available media does not allow us to determine whether A-17 and A-71 were typos or designations of different items. Neither the honesty of the participant nor the careful subsequent storage will eliminate this particular gap.

The first reliably documented state of P-07 begins with the joint external registration of the packaging and the appointment of a responsible person. The further chain can be made traceable. The backward extension of this reliability to the past is unacceptable. The record marks the beginning point of the confirmed history and the area that could not be reconstructed based on available materials. This is not a declaration of forgery: loss of provenance is compatible with honest error, incomplete recording, and other versions between which there is no distinguishing information.

### Laboratory refusal and decision on mode D

The receiving laboratory studies the description remotely and issues a reasoned refusal. Its stated competence and conditions of acceptance do not cover material of an unspecified type with an unknown packaging condition and unclear responsibility for the transfer. Moreover, the requested conclusion of “prove occurrence after the event” does not follow from a single analysis of the current content. Refusal does not mean that the material is considered dangerous or unusual. It means that a particular laboratory does not confirm the ability to perform this particular task under these input conditions.

The manager records the refusal as a completed approval result and does not send the sample under a changed name. The coordinator stops preparing the physical transmission until a suitable authorized route becomes available. The person responsible for the material confirms retention of ownership and terms of the current circulation. If these conditions cannot be met, the issue is transferred to the relevant service based on the actual properties of the situation. The book does not suggest arbitrary decontamination operations or packaging of unknown contents in lieu of such qualifications.

The scientific application is shared. The first problem concerns the origin and change in mass of the starting material; it remains unresolved by the available information. The second could relate to the properties of P-07 from a confirmed point in its history. It requires a new question, suitable competence, conditions of admission and the consent of the owner. Even a successful future determination of composition will characterize the submitted material rather than prove its formation during a flash. This separation preserves the potential value of the analysis without promising an impossible conclusion.

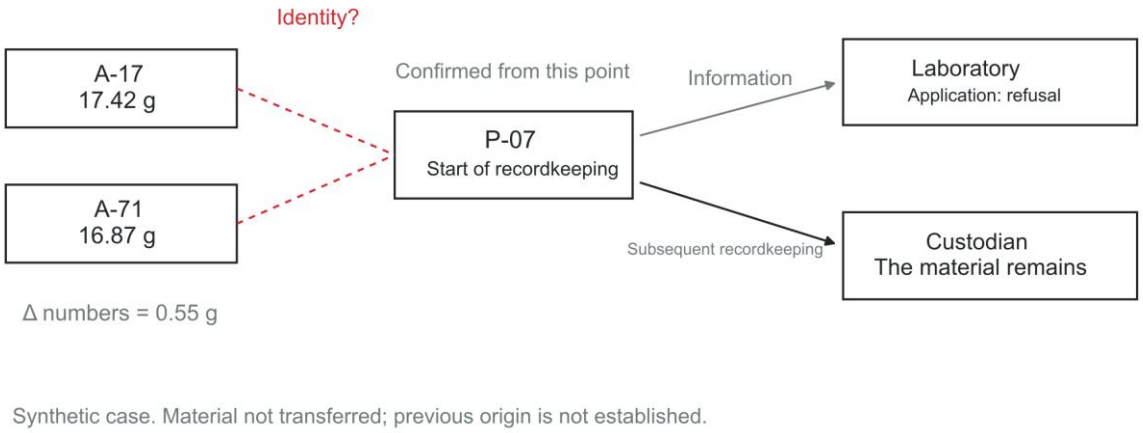



Figure 50. Boundary of confirmed origin P-07. Synthetic case traceability diagram 7. The connection between A-17, A-71 and the later registered package P-07 has not been established; the dotted line does not mean the transfer of the same item. 0.55 g is the difference between the numbers in the two entries, and not the confirmed mass loss. The confirmed history begins with the registration of P-07 and the appointment of a custodian. Information has been provided to the laboratory; after refusal, physical transfer of material is not completed.

### Completed Outcome record E and conditions for returning to the task

Outcome record E states that active exploration and neutralizing intervention were not performed. Acceptance of digital information, external registration P-07 and refusal of the selected laboratory have been confirmed. The difference 0.55 grams is stored as the difference between the two numbers provided, without assigning a physical reason to it. The original statement receives the status of insufficiently defined origin. A decision to terminate this application does not destroy the record or relieve the designated owner of responsibility for the material in his or her possession.

Re-opening the question of origin is possible with the appearance of a truly new independent document connecting objects and times, and not with the next retelling of a previous story. A new sample from the same intended location will be new material with its own chain and will not retroactively correct the history of P-07. To investigate a repeat event, a valid recording without unprepared contact should be prepared in advance. The result of the case is to accurately distinguish between what can still be investigated and what conclusion the available materials can no longer provide.

Chapter 62

## Case 8: Rare event, omissions and negative result

This is a completely fictitious educational case. All events, exposures and detection characteristics are specified synthetically. After one poorly recorded light episode, a ten-day observation was organized. No new matching events found. Such a result can be meaningful if we know how much time the system actually observed and what events it could have noticed. The main task is to calculate a limited negative result without stating that any possible anomalies have been checked for ten calendar days.

### Record A: event definition

The case UCH-OR-08 belongs to the OP class. The confirmation task concerns pulses with a duration of 40–80 milliseconds with a signal in a given calibrated range of 5–10 arbitrary units occurring within a fixed survey geometry. These numbers define a class of registration, not a universal boundary of a physical phenomenon. The original episode serves as the basis for the choice of location, but is not

included in the future series: its quality does not allow the same criterion to be applied to it. All new attempts are taken into account from the moment the plan is secured.

The record contains a spatial mask, frequency and time bandwidth of paths, processing versions, background and unsuitability rules. A pulse outside the mask or outside the specified duration is a separate observation and not a negative response to this test. The moment the file appears and the time it is saved varies. The source stream and status log allow you to determine the actual omissions. The program does not replace lost intervals with zeros and does not count them as time during which no events were confirmed.

### Plan B and measurement independence C

In the synthetic model, events of the selected class occur stationarily with intensity λ per day and form a Poisson process. At suitable intervals, each such event is independently detected with probability ε=0.50. This is a given condition of the training model, rather than an exact performance inferred from a small calibration set. Separately, it is assumed that the reasons for omissions do not select moments of increased intensity. If these premises are incorrect, the resulting boundary does not have the same meaning.

Before observation, fix the event criterion, calendar horizon, and stopping rules. The claim under test is whether zero detections are compatible with a constant rate of at least one event per day for the selected class. Detector tuning has been completed using separate material. Control signals test the measurement chain but are not mixed with natural candidates. Map C is compiled for cameras, timing, power, and code; duplicating one data stream in two programs does not add a second equal interval of exposure.

The two available records help verify the candidates and the condition of the equipment, but matching their operating geometry does not double the observed area. For the overall procedure, one consistent detection efficiency is used. It cannot be multiplied or added with the characteristics of individual channels without a joint solution model. In this case, ε already refers to the completed chain from the event of the established class to its inclusion in the final count. False candidates are analyzed according to pre-established rules, and the number of accepted events is zero.

| Calendar interval, day | Suitable time, day | ε at suitable time | Effective exposure, day |
|---|---|---|---|
| 0–2,5 | 2.4 | 0.50 | 1.2 |
| 2,5–5,0 | 1.6 | 0.50 | 0.8 |
| 5,0–7,5 | 2.0 | 0.50 | 1.0 |
| 7,5–10,0 | 2.0 | 0.50 | 1.0 |
| Total | 8.0 | 0.50 | 4.0 |

### Calculation with preserving prerequisites

Eight out of ten days are suitable, that is, a share of 0.8. After taking into account the given efficiency, the effective exposure is T_eff=10×0.8×0.50=4 days. It is measured by time, not by the number of frames or the volume of the archive. For unequal efficiency across intervals, a sum of the corresponding products would be required; in continuous notation - integral. Uniform replacement of all intervals by the average

value is permissible here only because the model intensity is constant and the efficiency conditions are explicitly specified.

$$T_{\mathrm{eff}} = 10 \times 0{,}8 \times 0{,}50 = 4 \text{ days}$$

With the adopted model, the expected number of registered events is equal to λT_eff, and the probability of not registering a single one is exp(−λT_eff). A one-sided upper confidence limit of the level 95 percent for a zero count is obtained by equating this probability to 0.05. The result is −ln(0.05)/4≈0.749 events per day. This is a frequentist confidence procedure under the listed prerequisites. It does not mean that the true intensity with a probability of 95 percent lies below the indicated number.

$$\lambda_{95} = \frac{-\ln(0{,}05)}{T_{\mathrm{eff}}} \simeq 0{,}749 \text{ d}^{-1}$$

If the intensity really equaled one event per day, four registrations would be expected, and the probability of a zero count would be exp(−4)≈0.0183. Therefore, the zero series limits precisely this predetermined statement with the adopted model. It does not exclude rare events of lower intensity. Impulses outside the selected geometry, a different amplitude range, or processes that occur only under conditions that did not exist in the suitable part of the series are also not excluded.

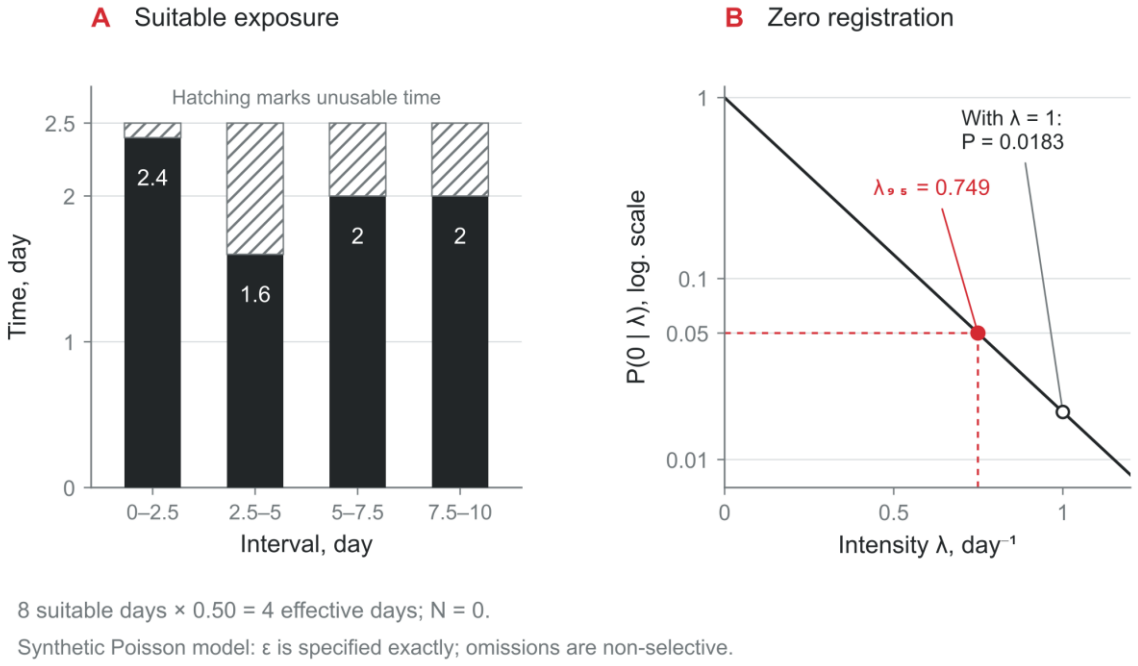



Figure 51. From calendar time to the event-rate limit. Synthetic calculation of the case 8. On the left are the total suitable and unsuitable durations in four calendar intervals, without indicating the location of the gaps within them. Eight suitable days with a precisely specified efficiency ε = 0.50 give four effective days. On the right is P(N = 0 | λ) = exp(−4λ), the probability axis is logarithmic. For a zero count, the upper one-sided 95% confidence limit is equal to 0.749 day⁻¹ under stationary Poisson process, independent detection, and nonselective passes. The curve is not the probability distribution of the true λ.

### Mode D and checking a negative result

The scientific mode remains passive observation with permitted equipment checks. In case of loss of support, saturation or unknown state of the obligatory channel, the corresponding interval is excluded from the suitable exposure according to the established rule. The operator stores the reason and moment of the restriction. If the event itself is capable of turning off the equipment, such omissions can no longer be

considered independent; then this Poisson estimate does not close the hypothesis. Recording failure itself becomes a separate outcome of interest with a different follow-up model.

In a real study, the effectiveness of 0.50 would have uncertainty and could depend on the distribution of amplitudes, durations and position. Then it cannot be presented as accurate just because half of the limited set of control signals is detected. A joint assessment or a reasonable conservative boundary with a clearly defined level of coverage is required. In the educational case, this task is separated by a condition to show the arithmetic of exposure. It is this restriction that should accompany the finished number in the act.

### Outcome record E and condition of revision

Outcome record E records the absence of accepted events for four effective days and the specified upper limit for the selected stationary flow. Neutralization was not carried out, the security of the entire territory was not established, the original isolated episode was not declared refuted. The scientific task of this series is completed: the intensity of the order of one event per day is not supported under its conditions. The report contains the gap mask, selection rules, initial candidates and prerequisites, without which the final figure would be devoid of subject matter.

A new program is started when a suitable event occurs, evidence of a dependency on another condition, or a significant performance error is identified. If the task requires limiting the intensity much lower than 0.749 per day, the required effective exposure is calculated in advance and resources are assessed. It is impossible to extend the previous record only until the desired result without a new rule. The matter ends with quantitative knowledge about the boundary of the test performed: the absence of detection becomes useful precisely because its scope is named and calculated.

# Appendices

Appendix A

## Case Record Form

The form is intended to be copied into a work journal. The fields are filled in as information becomes available. A missing value is indicated by the words “not found” and the reason. An empty field is not considered a negative result. The case ID is saved when changing the hypothesis.

### Registration entry

• Case ID and record version.

• Date and method of registration. The author of the entry and his role.

• Event time or allowable interval; basis of time reference.

• Location or boundaries of the survey; acceptable localization accuracy.

• Source of the message; rules for access to personal information.

### Observed material

• Minimal statement without causal explanation.

• List of source files, readings, evidence and samples with individual identifiers.

• Instruments, settings, units, recording frequency and known limitations.

• Gaps, saturation, configuration changes, and unset parameters.

• Association of each classification label with a specific basis.

### Hypotheses and solutions

• Current explanations and their differing predictions.

• Tested alternatives and limits of tests performed.

• Hazard profile along eight axes; data and assumptions for each estimate.

• Assigned mode, responsible persons, grounds for admission and stopping criteria.

• Next question and data that may change your decision.

### History and transmission

• Operations with files and samples; date, performer, goal and result.

• Processing versions and connection of final materials with the original ones.

• Changes in explanation, classification and mode with justification.

• Transfer to another group: list of materials, restrictions and confirmation of receipt.

• Completion status or next review date.

The record is checked for consistency: each conclusion must have a basis, each action must have a performer and conditions, each omission must have an explicit designation. If these links cannot be

restored, the result is limited to those statements for which the link is preserved. The detailed procedure is given in chapter 8.

### Connections between the record and work forms

In the current status section, indicate the identifiers of the current card G1, open response cards G2, coordination of control G3 and outgoing items G5. Having a form means having a record, not a positive decision. For each connection, indicate the version and the last confirmed action; save canceled versions in history.

Appendix B

# Plan for a Discriminating Experiment

This form sets the structure of the author's plan. It is not a substitute for assessing the acceptability of a particular operation. Before starting the experiment, participants must have the same understanding of the main question and the sequence of stopping the work.

### Question and predictions

• One basic verifiable statement.

• Hypothesis H1 and expected observed result.

• Hypothesis H2 and result different from prediction H1.

• Other reasons that could create a similar response.

• Conditions under which the outcome will be non-discriminative or non-interpretable.

### Measurement scheme

• Quantity being measured, unit, range and required uncertainty.

• Chain from the object to the original record; separate processing chain.

• Calibration, background, control series and confirmation of sensitivity.

• Shared dependencies of channels and measures of their discrimination.

• Time sequence, delays, skip intervals and matching conditions.

### Changeable condition

• What the experimenter physically changes; accompanying heat, light, sound, motion, power input, or matter.

• What conditions must remain comparable and how this is checked.

• Why the chosen action is suitable and acceptable.

• Responsible for start permission and independent stop function.

• Actions to take when communication, control, or completion are lost.

### Analysis and output

• The main indicator and evaluation rule fixed before the main series.

• Data volume or other reasonable termination rule.

• Rules for excluding records; working with missing data.

• How to save sources, code versions and logs.

• What conclusion does each outcome allow and what will require new experiment.

If the plan changes after reviewing the data, the new version is saved separately. The material already reviewed may serve as an exploratory basis, and subsequent verification requires an independent series or a clear limitation of the conclusion. See chapters 4 and 39.

### Addendum to the confirmatory series plan

Hypothesis version and date of preregistration: _____. Set used to select model: _____. Verification set and method of restricting access until the analysis is recorded: _____.

Event unit and denominator: _____. Suitable time or number of attempts: _____. The rule for combining triggers is: _____. Registration efficiency and its uncertainty: _____.

Viewing moments and ending rule: _____. Outcome table for chapter 4: _____. Actions for software correction after opening data: _____. Independent repetition condition: _____.

### Command execution conditions

• Prerequisite from register G1: _____. How to check before action: _____.

• Command and entry G3: _____. The different stages of execution are: _____.

• What happens when redelivery occurs: _____. How it is tested: _____.

• Completion resource for G4: _____. Conditions for banning a new block: _____.

Appendix C

## Measurement independence map

The map is filled in for a pair of channels or for the entire network. The word "independent" always refers to the specified error type. Different instances of a device may retain common physical and software dependencies.

| General addiction | Question to check | What to record |
|---|---|---|
| Time standard | Where does each channel get its original scale from? | Generator, synchronization, offline mode |
| Power supply | Can one change affect multiple channels? | Power supply diagram and recording its status |
| environment | Is there a common temperature, mechanical or field factor? | Placement and auxiliary measurements |
| Construction | What identical sensing elements are used? | Technology and known response mechanisms |
| Processing | Is there a common code or algorithm being used? | Library versions, settings and independent implementation |
| Communication | Does data pass through a common channel? | Buffering, Loss, and Offline Recording |
| Selection | Does one trigger trigger saving all threads | Event background and launch criteria |
| Operator | Can expectation influence outcome choice? | Roles, blinding and access order |
| Sample | Do the analyzes refer to truly comparable material? | Selection, partitioning, storage and state changes |

For each line, indicate the installed dependency, the check performed, and the remaining constraint. The absence of a found common cause is not the same as proof of complete independence. The map shows which versions are still compatible with the agreed result. Basic explanations are given in chapters 10 and 47.

Appendix D

# Mode and stop decision

The form accompanies a specific action, rather than permitting an indeterminate set of future work. The decision is reviewed if the specified conditions change.

### Before action begins

• Research purpose and connection to the current case report.

• Mode: enrollment, remote passive observation, limited study or controlled intervention.

• Responsible roles and available communication; deputy during shift transfer.

• Known harm scenarios, uncertainties and basis of acceptability.

• Proven monitoring, protection and self-termination functions.

• Conditions that must be maintained throughout the operation.

### Stop command

• Who can give a command and how it is transmitted.

• Which observed events require stopping.

• What exactly does each operator do after the command.

• What functions must be preserved for completion and registration.

• How actual termination is confirmed.

### After stopping

• Command timing, reason and actual execution sequence.

• Condition of people, environment, equipment and data.

• Loss of control channels and unknown consequences.

• Conditions required for restart consideration.

• Decision of those responsible and a new version of the permit.

Restarting is not a continuation of the previous default resolution. It is necessary to confirm the restoration of essential conditions and understand the reason for the stop to the extent necessary for the next action. See chapters 7, 9 and 37.

### Communication solutions after stopping

Attach the current G1 and G3, and for affected people - G2. To change the mode, indicate security according to G4, unfinished handling of items according to G5 and role-related restrictions G6. In the decision act, list exactly the restored grounds; an empty field and an unconfirmed stage are not converted into permission by a signature.

Appendix E

## Record of Verification of an Intervention's Outcome

The act is applied after any action to which a neutralizing result is attributed. Its structure forces a separate check of the process under study and the suitability of the measurement.

1. The original impact claim and the data on which it is based.
2. Established or intended channel of intervention.
3. The operation performed, performer, time and actual conditions.
4. Observed changes in the main and control channels.
5. Checking that the devices maintain the required sensitivity and range.
6. Comparability of the state before and after; background and configuration changes.
7. Result status for chapter 44: source eliminated; the channel is limited; condition is stabilized; the object is isolated; the effect is not observed; confirmation is not enough. The status is set separately for each impact. Correction of the measurement artifact is recorded separately: it changes the reliability of the observation and does not in itself confirm neutralization of the source.
8. Remaining restrictions, secondary changes and possible return scenarios.
9. Monitoring plan responsible for review and resumption criteria.
10. Conclusion of an independent reviewer and a list of disagreements, if any.

An empty sensitivity check limits the conclusion that the effect has disappeared. The unconfirmed state of the source limits the conclusion about its elimination. If only isolation is achieved, the act specifies the conditions for maintaining the barrier. See chapters 42–45.

Appendix F

# Terms and abbreviations

Definitions are used as the working language of the treatise. In a specialized chapter, the meaning is clarified by the conditions of the corresponding method. Class designations are given in chapter 6.

Anomaly. Deviation of observations from an explicitly stated expectation, requiring separate verification. The term does not define the cause.

Artifact. A feature of a result that arises in measurement, storage or processing and is capable of simulating a property of the object under study.

Validation. Confirmation of the suitability of a system or procedure for a specific purpose and conditions of use.

Verification. Verification of implementation compliance with specified requirements; does not in itself establish the suitability of the requirements for the task.

Hypothesis. A testable explanation from which observable expectations and revision conditions follow.

System boundary. The selected separation of object and environment, which determines the consideration of matter, energy, signals and external influences.

Drift. Changes in the characteristics of the measuring channel over time, requiring evaluation under application conditions.

Isolation. Limitation of the established channel of influence while maintaining the specified barrier conditions.

Calibration Establish a relationship between indications and reference values with associated conditions and uncertainties.

Control series. Observations organized to test a particular alternative, background, or performance of a procedure.

False alarm. Triggering of the detection criterion in the absence of a specific target event under the conditions of the accepted test.

Measurement model. The relationship between the original signals, input quantities, corrections and the reported result.

Saturation. A mode in which the increase in input influence is no longer reflected in the normal way in the output signal.

Independent confirmation. Confirmation with a reasonable distinction of the significant causes of the error, and not just a different name of the experimenter or device.

Uncertainty. Characteristics of the incompleteness of determining the result within the framework of the adopted measurement model; requires a description of the influences covered.

Neutralization. A general designation for impact management, which in conclusion must be clarified based on the actually confirmed result.

Inverse problem. Restoring the properties of a source or system based on observed consequences; the solution may not be unique.

Common cause. A factor that can consistently influence multiple channels, elements, or observations.

Case record. A related record of inputs, conditions, hypotheses, solutions, limitations, and the history of changes in conclusions.

Detection limit. The condition relative to which the procedure’s ability to isolate a given signal from the background is established.

Pre-registration. Fixation of the analysis plan and rules before obtaining or reviewing the corresponding verification data.

Traceability. A documented chain of relationships that allows the origin of material, transformations, or reference values to be established.

Discriminating experiment. An experiment in which compared hypotheses predict outcomes that are discernible given the available uncertainty.

Stabilization. Maintaining selected parameters within reasonable limits; may require a continuously operating system.

Conditional model. An investigation of the consequences of an explicitly introduced assumption that is not presented as an established property of nature.

Training scenario. A fictitious example intended to illustrate actions and inference logic; not empirical evidence.

Background. Observations or state model relative to which the effect in question is distinguished; the conditions of comparability must be determined.

File integrity. Correspondence of the saved version to a certain state of the data; not independent proof of the truth of the recorded scene.

The observer effect. System change associated with a specific interaction process during observation; the physical mechanism requires a separate indication.

extrascience. The book's program for investigating unusual phenomena with testable models, traceable data, and revised procedures.

Effective exposure is the usable amount of observation weighted by the probability of detecting a particular family of signals. For a different signal shape, exposure may differ.

Confidence sequence is a sequence of confidence sets with declared simultaneous time coverage when the conditions of the selected method are met.

State history - information about previous influences and transitions that can influence the current response of the system.

Hysteresis is the dependence of the observed state on the path of changing conditions; Forward and reverse transition thresholds may differ.

Partial order is an established precedence relationship that allows some pairs of events to remain unordered.

An idempotent command is an operation whose repeated execution in the provided model has the same result as a single execution. This property requires checking for a specific interface and state.

State reconciliation - Restoring a confirmed overall installation description after a communication failure, restart, or log discrepancy.

Observability map - a description of places, intervals and channels for which registration suitability and sensitivity have been established.

Validation set - data not used when selecting the model to be tested and the procedure for its evaluation within the framework of the stated plan.

The null energy condition requires the stress–energy tensor, contracted twice with any null vector, to be nonnegative. Its use in this book is limited to explicitly specified gravitational models.

An empirical model is a mathematical description of the established relationship under specified conditions; it may leave the physical mechanism open.

Portability is the preservation of a certain result under a previously described change in conditions, operator, device instance or research material.

Appendix G

## Working forms of the organization

Forms G1–G6 link the map, people, teams, resources, items, and group preparation with a single case identifier. The entry “unknown” is acceptable if the dependent constraint and the person responsible for the next decision are indicated next to it. The entry “not applicable” requires a brief reason. An empty field does not mean there is no danger. For local sequence, the node ID, session, and number are used; physical time is given only with a known meaning of the label.

All completed examples below relate to the fictitious case UCH-OP-01 at the stage of analyzing the training stop. Impacts, loss of contact and resource are modeled with cards. All real participants are in a safe environment known to the organizer; the external service is played as a separate role. The examples show unfinished solutions and therefore do not constitute permission for actual work.

### G1. State, map and background

| Field | Blank form |
|---|---|
| Case; version; compiler | _____; _____; _____ |
| Status and previous version | S____; background and unknown intervals: _____ |
| Linking maps and records | Substrate/system: _____; node/session/number or interval: _____ |
| Layer D | Sign; places of registration; negative observations and sensitivity: _____ |
| Layer N | Suitable channels; blind areas; review changes: _____ |
| Layer P and routes | Permitted action; plot; base; review date or event: _____ |
| Transition and return | What has changed; new condition; return sign; admissibility of verification: _____ |
| Register of prerequisites | Premise; certificate; status; dependent decision; responsible: _____ |
| Next solution and connections | Question: _____; G2/G3/G4/G5: _____; confirmed: _____ |

Completed training example G1-UCH-01, version 3.

| Field | Completed example |
|---|---|
| Case and condition | UCH-OP-01; S2; compiler M1. Previous map M02; Before the connection was lost, the exposure of camera B was changed. |
| Binding | Study room plan, map M03. Local record A/R1/40; there is no common timeline. |
| D | The light mark was registered in the western sector. The absence of an eastern marker has not yet been established. |

| Field | Completed example |
|---|---|
| N | Camera A is suitable for its sector; B does not give current data. The eastern sector is not observed. |
| P | Only writing from a confirmed position is allowed. The base of the R-East route is lost along with the B channel. |
| Transition and return | S1 → S2: loss of observability. Restoring the image is not enough; Suitable ongoing surveillance and route revision is required. |
| Premise | The current position of the platform has not been confirmed. Dependent movement is not permitted; the check is coordinated by M1 and K1. |
| Connections and Solution | G2-UCH-01, G3-UCH-01, G4-UCH-01, G5-UCH-01. The next question is the confirmable current state; the card was accepted by P1 and K1. |

### G2. People and transmission response

| Field | Blank form |
|---|---|
| Case; version; liaison | _____; _____; contact: _____ |
| Transition base | Observable fact; source; time of receipt: _____ |
| People counting | ID; confirmed position/contact; source; unresolved: _____ |
| Last confirmation | Local recording or interval; map version; uncertainty: _____ |
| Conditions of the place | Confirmed danger signs; unappreciated; lost route bases: _____ |
| Stored Functions | Function; state; consequences of violation; responsible: _____ |
| Transfer | To; on what channel; what is conveyed; acceptance confirmation: _____ |
| Directions and updates | Instructions received; executor; next update reason: _____ |
| Current total | Who took over what functions; open questions; limitations of the study: _____ |

Completed training example G2-UCH-01, version 1.

| Field | Completed example |
|---|---|
| Case and Connector | UCH-OP-01; connected C1. The external service is played by organizer C2. |
| Foundation and accounting | Participant P2 does not respond to the card. P1 and P3 are taken into account at the post; position P2 for the research team has not been confirmed. |

| Field | Completed example |
|---|---|
| Last confirmation | Entry A/R1/31, map M02: P2 reported being at the training post. This is not a current confirmation. |
| Conditions of the place | M03: the eastern sector is not observed; the basis of the route has been lost. No physical obstacle identified. |
| Stored Functions | Access control and accessible local recording; K1 monitors conservation. General shutdown has not been assigned. |
| Transfer and instructions | C1 conveyed the facts to C2; reception confirmed in A/R1/42. The direction of the exercise is to continue the available accounting and report changes. |
| Bottom line | S2 assumed the role of instructional response leader; S1 is updating. The research series has not been renewed; G3 remains open. |

### G3. Command and control coordination

| Field | Blank form |
|---|---|
| Case; version; operator | _____; _____; managerial post: _____ |
| Team | ID; meaning; destination; session; configuration: _____ |
| Repeat | Does repetition change the outcome; property conditions; re-delivery check: _____ |
| Sent/received | Certificate of dispatch: _____; reception: _____ |
| Completed / result observed | Certificate of execution: _____; suitable observation: _____ |
| Rupture and recovery | Last valid entry; new session; outdated packages; unknown: _____ |
| Current management | Autonomous functions; queue; current post; supported functions: _____ |
| Position and next step | Position/route basis; permitted action; inspector: _____ |
| Solution | What is agreed upon; which is not confirmed; supervisor; operator; links G1/G4: _____ |

Completed training example G3-UCH-01, version 1.

| Field | Completed example |
|---|---|
| Case and command | UCH-OP-01; O1; K7 - relative turn by one step, platform B, session R1, configuration C1. |

| Field | Completed example |
|---|---|
| Repeat | May cause a second step; automatic retry for an incomplete command is not allowed. |
| Four stages | Sent to: Journal A. Accepted: B/R1/24. Execution: unknown. Physical result: not confirmed. |
| After the breakup | Current session B is R2; Archive B/R1/23 was delivered first. This frame does not describe the current position. |
| Management | The research queue is suspended. The supporting record is retained; The current post is O1, the role is transferred through G4. |
| Next step | Obtain a usable certificate of condition without a new move. R-east is not allowed according to G1; checks M1. |
| Solution | P1 and K1 left the research sequence incomplete. O1 confirmed the prohibition of automatic replay; lost stages are not recovered by guessing. |

### G4. Resources and shift handover

| Field | Blank form |
|---|---|
| Case; version; shift | _____; _____; transmitting: _____; Receiver: _____ |
| Current mode | State; configuration; versions G1 and G3; supported functions: _____ |
| Resource line | Function; resource; remainder; method of assessment; consumption of the next block: _____ |
| Completion and uncertainty | Need for completion; uncertainty; basis of sufficiency: _____ |
| Replenishment | Valid operation; replacement compatibility; necessary re-checks: _____ |
| Open obligations | Teams; malfunctions; temporary changes; restrictions; items G5: _____ |
| Next action | What to do and at what event; who performs; contact: _____ |
| Transfer | The receiver repeated the restrictions: _____; accepted functions: _____; confirmation time: _____ |
| If the transfer does not take place | Who retains the role; ensured residual mode; next addressee of the decision: _____ |

Completed training example G4-UCH-01, version 1.

| Field | Completed example |
|---|---|
| Change and condition | UCH-OP-01; O1 transmits to O2. S2, C1; G1 version 3, G3 version 1. The research queue does not work. |
| Resource line | Registrar training energy: balance 8; series 4; completion 3; taken into account spread 2 conventional units. |
| Resource decision | 4 + 3 + 2 = 9 > 8: series not allowed. For the intended completion, 5 units are sufficient in the exercise model. |
| Replenishment | Compatible replacement not confirmed; replenishment is not included in the available resource. |
| Open | K7: execution unknown. Channel B has not confirmed the current position. D1 remains with the keeper for G5. |
| Transfer and action | O2 reiterated the restrictions and accepted only observation and stipulated termination. Confirmation A/R1/44; O1 conveyed the status, not permission to continue the series. |
| Reserve order | If confirmation O2 is missing, the role retains O1 within the secured transition; P1 will organize further responsibility. |

### G5. Output item and final custodian

| Field | Blank form |
|---|---|
| Case; version; unit | _____; _____; Item ID: _____; keeper: _____ |
| Origin | Source ID; place of use; child parts; related samples: _____ |
| Contact and status | Established/Inferred/Not Estimated; evidence; significant changes: _____ |
| Current location | Confirmed entry; completeness; terms of circulation: _____ |
| Relocation plan | Goal; route and map; operations that change state: _____ |
| Recipient | Competent party; consistent configuration; acceptance confirmation: _____ |
| Inconsistency | Refusal of acceptance/shortage/loss of entry; last confirmation; next analysis: _____ |
| Final status | Transferred/remains/processed/location not established; base: _____ |
| Connections and Responsibility | G1/G4; transmitting; the receiving or current custodian; open question: _____ |

Completed training example G5-UCH-01, version 1.

| Field | Completed example |
|---|---|
| Unit | UCH-OP-01; holder D1; keeper X1. Academic subject, parts are not formed. |
| Origin and condition | Used in the O3 operation model; linked to sample card P1. D1 status for the intended recipient has not been assessed. |
| Location | Training rack Q, completeness confirmed X1; transfer to transport packaging has not been completed. |
| Transfer and recipient | It was planned to transfer to the L1 side together with P1. L1 approved only P1 and did not confirm the acceptance of D1. |
| Inconsistency and status | Discrepancy between the application and the actual kit. D1 remains under the responsibility of X1; no alternative address has been selected. |
| Next solution | Clarify the information and conditions of a separate appointment or another reasonable method of contact. The open line was transmitted via G4; ending the session does not close it. |

### G6. Training and confirmation of readiness

| Field | Blank form |
|---|---|
| Exercise; version; roles | _____; _____; participants: _____; organizer: _____; appraiser: _____ |
| Safe environment | Paper/model/tested stand; real impacts; termination method: _____ |
| Introductory | Initial documents; reported deviation; moment of presentation: _____ |
| Expected actions | Observed actions and documents; critical errors: _____ |
| Actual sequence | Who did what; confirmations; tips; saved materials: _____ |
| Score for each action | Independently/after prompting/not completed; certificate: _____ |
| Correction | Reason for breakup; instruction/system change; responsible: _____ |
| Recheck | Changed introductory; affected roles; result; appraiser: _____ |
| Tolerance and limits | Confirmed tasks; remaining bans; manager's decision; configuration: _____ |

Completed training example G6-UCH-01, version 1.

| Field | Completed example |
|---|---|
| Exercise | UCH-OP-01; training exercise 4 version T1. O1 - operator; M1 - metrologist; K1 - coordinator; appraiser U1. |
| setting and scenario | Software model without connected drives. K7 accepted; execution unknown; R2 shows archive footage. |
| Waiting | Do not repeat the relative step; separate stages; save the old package as an archive package; fill out G3. |
| Fact and assessment | O1 suggested a repeat; the command in the model was not executed. After a prompt, the operator completed G3 correctly. The critical decision was not carried out independently. |
| Correction | O1 and the interface developer clarify the display of the session and the incomplete command; K1 checks the modified instruction. |
| Recheck | A new input has been assigned with the end state specified; has not yet been carried out. |
| Tolerance | The readiness of O1 to independently resolve repetitions has not been confirmed. The form completed after the prompt is not considered a positive result of the training. |

When copying a blank form, its name, case identifier and version are saved. If the volume of the table is not enough, add a continuation with the same notation; Do not reduce unknown or inconvenient information for the sake of placement on one sheet. Changes in status in one form are checked by connections: confirmation of the position can update G1 and G3, but does not automatically close G2, the resource limitation G4, or the incomplete transfer G5.

Appendix H

# Source for an Illustrative Static Time Region

This appendix presents the author's calculation for the metric in chapter 16. Its purpose is to derive source requirements from an already introduced geometric assumption. The calculation does not describe the created installation and does not prove the existence of the desired state of matter. The signature (−, +, +, +), coordinate $x^0 = ct$, positive function N(r), staticity, spherical symmetry and zero cosmological constant are accepted.

### Metric and curvature convention

$$ds^2 = -N(r)^2(dx^0)^2 + dr^2 + r^2 d\theta^2 + r^2 \sin^2\theta d\varphi^2$$

The convention used is that the Ricci tensor is constructed from the derivative of $\Gamma a_{ij}$ with respect to the xa coordinate, subtracting the derivative of $\Gamma a_i a$ with respect to xj, and the corresponding two quadratic connection terms. Together with the equation $G\mu\nu = 8\pi G\, T\mu\nu/c^4$ this fixes the signs below. The prime indicates the derivative with respect to r. The symbol G without indices denotes the gravitational constant, with indices the Einstein tensor.

$$R_{\mu\nu} = \partial_\alpha \Gamma^\alpha_{\mu\nu} - \partial_\nu \Gamma^\alpha_{\mu\alpha} + \Gamma^\alpha_{\mu\nu}\Gamma^\beta_{\alpha\beta} - \Gamma^\beta_{\mu\alpha}\Gamma^\alpha_{\nu\beta}$$

The essential connection coefficients are listed below; subscripts are symmetrical. The first two components contain the clock function. The rest arise when using spherical coordinates for a flat spatial part. Their preservation is necessary: omitting the geometric terms would give incorrect pressures.

$$\Gamma^0_{0r} = \frac{N'}{N}, \Gamma^r_{00} = NN'$$

$$\Gamma^r_{\theta\theta} = -r, \Gamma^r_{\varphi\varphi} = -r\sin^2\theta, \Gamma^\theta_{r\theta} = \Gamma^\varphi_{r\varphi} = \frac{1}{r}$$

$$\Gamma^\theta_{\varphi\varphi} = -\sin\theta\cos\theta, \Gamma^\varphi_{\theta\varphi} = \cot\theta$$

### Curvature and the Einstein tensor

Direct substitution gives the diagonal Ricci tensor. The azimuthal component differs from the polar component by the factor $\sin^2\theta$. Non-zero expressions and the curvature scalar have the following form:

$$R_{00} = N\left(N'' + \frac{2N'}{r}\right), R_{rr} = -\frac{N''}{N}$$

$$R_{\theta\theta} = -\frac{rN'}{N}, R_{\varphi\varphi} = \sin^2\theta R_{\theta\theta}$$

$$R = -\frac{2}{N}\left(N'' + \frac{2N'}{r}\right)$$

After subtracting half the curvature scalar multiplied by the metric, the time component of the Einstein tensor becomes zero. This is an exact reduction for the adopted metric, and not an approximation based on small ε. The spatial components remain non-zero:

$$G_{00} = 0, G_{rr} = \frac{2N'}{rN}$$

$$\frac{G_{\theta\theta}}{r^2} = \frac{G_{\varphi\varphi}}{r^2 \sin^2\theta} = \frac{N'' + N'/r}{N}$$

**Physical Source Components**

The coordinate component itself is not yet equal to the reading of the local observer. Its unit basis vectors are proportional to $N^{-1}\partial_0$, $\partial r$, $r^{-1}\partial\theta$ and $(r \sin\theta)^{-1}\partial\varphi$. Therefore, when moving to an orthonormal frame, the time component is divided by $N^2$, and the angular components are divided by the squares of the corresponding radial factors. In this frame, the covariant components of T have a diagonal (ρE, pr, pt, pt).

$$\rho_E = 0, p_r = \frac{c^4}{4\pi G}\frac{N'}{rN}, p_t = \frac{c^4}{8\pi G}\frac{N'' + N'/r}{N}$$

ρE denotes energy per volume, not mass density. The absence of energy flow follows from diagonality and staticity. In general, pr and pt are different: the required source is anisotropic. Replacing it with an ordinary ideal fluid with one pressure would be a new assumption that is not yet compatible with the calculation. The geometric identity of the covariant divergence of the Einstein tensor provides a formal balance of such T, but does not provide a microscopic model of matter or a method for its formation.

**Gaussian profile and regular center**

$$N = 1 + \varepsilon e^{-r^2/L^2}, N' = -\frac{2\varepsilon r}{L^2} e^{-r^2/L^2}$$

$$N'' = \varepsilon e^{-r^2/L^2}\left(-\frac{2}{L^2} + \frac{4r^2}{L^4}\right)$$

$$p_r = -\frac{c^4 \varepsilon e^{-r^2/L^2}}{2\pi G L^2 N}, p_t = \frac{c^4 \varepsilon e^{-r^2/L^2}}{2\pi G L^2 N}\left(\frac{r^2}{L^2} - 1\right)$$

The seemingly problematic ratios N′/r have a finite limit because N′ is proportional to r. At the center the pressures coincide, as required for a smooth spherically symmetric source. For a fixed ε greater than −1, the denominator is positive, and all reduced components are finite. The coordinate singularity of spherical angles at r = 0 is not a physical singularity of this profile.

$$p_r(0) = p_t(0) = -\frac{c^4 \varepsilon}{2\pi G L^2 (1+\varepsilon)}, R(0) = \frac{12\varepsilon}{L^2(1+\varepsilon)}$$

Regularity for fixed parameters does not mean uniform boundedness when passing to the forbidden boundary ε = −1. As you approach it, the central expressions can grow without limitation. Far from the center, N tends to unity, and pressure and curvature disappear. When ε = 0 all source components disappear: this is a useful check of the formulas.

**Null energy condition**

For a diagonal source without energy flow, the condition $T_{\mu\nu}k^\mu k^\nu \geq 0$ for any null vector is equivalent to the non-negativity of ρE + pr and ρE + pt. In our case, the energy density is zero. When ε is greater than zero, pr is negative. For $-1 < \varepsilon < 0$ the radial pressure is positive, but pt becomes negative beyond radius L. Therefore, any non-trivial profile of this family requires violation of the null energy condition in some region.

This is the derivation within the chosen equations and the complete set of geometric assumptions. It excludes the interpretation of the profile through the source, which must satisfy the specified condition throughout. It does not prove that all quantum states satisfy it, nor does it obviate the need to explore more stringent constraints on a particular quantum source. The formal admissibility of a separate negative contribution also does not provide the required distribution, duration and stability.

### Numerical cross-check

For training $\varepsilon = 10^{-15}$ and $L = 10$ m, the central advance for 86 400 s relative to the asymptotic standard is equal to 86.4 ps. At small $\varepsilon$ the maximum value of $c^2|N'/N|$ located approximately at $L/\sqrt{2}$ and is $c^2|\varepsilon|\sqrt{(2/e)}/L$, that is, about 7.71 m/s². The central pressure is approximately $-1.9 \times 10^{26}$ Pa; the curvature scalar at the center is of order $1.2 \times 10^{-16}$ m$^{-2}$. Large pressure size and small curvature are compatible due to the sizing factor $c^4/G$ in relation to the source geometry.

All numbers in this reconciliation are calculations of a conditional model. Experimental inference would require measured parameters, their joint uncertainty, and testing of the remaining predictions. The reader can use the appendix as an example of the discipline of model building: select a geometry, derive a source, check for regularity and energy conditions, then match the associated consequences to the data. Only after these steps does a meaningful question arise about creating or changing such a state.

Appendix I

## Register of cases and unresolved issues

Below is the author's registry diagram. It links the individual case record with usable data, verified statements, and continuation conditions. The study record and the physical event record have different identifiers. All examples completed are from fictional cases in this book.

| Field | Record content |
|---|---|
| case_id and revision | Persistent case identifier, version number, date and author of the change |
| event_id and message_id | Event and initial messages; grounds for merger or division |
| claim_id | One verifiable statement, its value and conditions |
| data_refs | Source files, their checksums, origin and access conditions |
| configuration | Device identifiers, processing versions, shared dependencies |
| coverage | Places and suitable intervals, family of signals, effectiveness and its uncertainty |
| models | Tested versions, parameters, predictions and discrimination results |
| status | The cause has been determined; remainder; limitation; insufficient data; invalid check; stop |
| open_question | An unresolved question formulated through a distinguishing feature |
| reopen_condition | A specific new measurement or material that allows you to revise the outcome |
| custody | Owner of further observation, materials and retained restrictions |
| dependencies | Shared sources, forwarded copies, related series and previous versions |

| Educational record | Limited conclusion | Continuation condition |
|---|---|---|
| Case 1 | Explanation for reported clock discrepancy established | Other balance after eliminating verified causes |
| Case 2 | The residual relationship was confirmed under the tested conditions; the mechanism is open | Configuration with differing projections of remaining versions |
| Case 3 | Specific metric model is inconsistent with shared channels | Another explicit model or independent new data |

| Educational record | Limited conclusion | Continuation condition |
|---|---|---|
| Case 4 | Survey and restrictions revised after loss of observation | Confirmed status of nodes, map and basis of the new regime |
| Case 5 | Information dependence within presentation and new tasks was assessed | Pre-arranged independent procedure transfer |
| Case 6 | Intervention status is determined along with sensitivity testing | Comparable registration of remaining channels |
| Case 7 | The history of the material is insufficient to support the stated conclusion. | New material with proven origin |
| Case 8 | The frequency limit of the selected signal family is obtained | Increased reasonable coverage or new event model |

### Update procedure

1. Save the original version of the card and the reasons for its previous output.
2. Add new material with its origin; do not quietly replace the old recording with it.
3. Indicate which statement is being revised and which remain valid.
4. Recalculate comparables if event aggregation, suitability, or performance have changed.
5. Write down the new status, the unresolved issue and the person responsible for preserving the materials.

When publishing, select a level of detail that is sufficient to verify the conclusion and is acceptable to those affected. If access to the underlying data is limited, this limitation is included in the assessment of the feasibility of independent verification. The presence of a checksum confirms the connection with a certain file, but not the truth of the description contained in it.

Appendix J

# Subject and situational indexes

Signposts lead from the term or source story to the measurement task. Names from everyday speech serve as navigational inputs and do not establish the mechanism of the event. The numbers correspond to the chapters of the book.

### Subject index

| Concept | Main chapters |
|---|---|
| Agency and meaningful response | 36 |
| Barrier and Exposure Limit Test | 42, 44 |
| Time scale and frequency | 12, 13, 50 |
| Genesis and source | 11, 16, 23 |
| Geometry and connectivity | 17, 18, 21 |
| Data and origin | 8, 31, 40 |
| Moving Front | 13, 17 |
| Differential measurement | 48, 52 |
| Confidence procedures and stopping analysis | 3, 49 |
| Life cycle and background | 10, 11 |
| Change of substance | 27, 31 |
| Information dependence | 15, 35, 36 |
| Calibration and qualification | 48, 49 |
| Observability map | 7, 38 |
| Small forces and additional interactions | 19, 20, 51 |
| Neutralization and its status | 43, 44, 45 |
| Zero result and search coverage | 49, 62 |
| Samples and portable equipment | 31, 38 |
| Memory and inconsistent evidence | 32, 46 |

| Concept | Main chapters |
|---|---|
| Injured or unaccounted participant | 9, 37 |
| Prerequisites for the procedure | 10, 14, 18 |
| Test set | 4, 39, 53 |
| Register of unresolved cases | 8, 54 |
| Resources and shift handover | 37, 45 |
| Control coordination | 38, 40 |
| Stabilization and delay | 43 |
| Team training | 37 |
| Refutation conditions | 4, 39 |
| Partial order of events | 40 |
| Energy balance | 23, 25, 11 |

### From initial description to verification

| Description | First research question | Chapters |
|---|---|---|
| Ghost or figure | Which optical, acoustic and perceptual channels registered the event | 17, 23, 32, 33 |
| Poltergeist | What forces and movements are actually measured, how the base and the object are connected | 24, 26, 51 |
| Missing time | Memories, interfaces or physical scales have diverged | 12, 13, 32 |
| Time loop | What states and records are retained between intended iterations | 14, 40 |
| Portal | How route, optical propagation and spatial connectivity are verified | 17, 18, 21 |
| Endless corridor | What method is used to restore the geometry, repeatability and position of the observer? | 17, 18 |

| Description | First research question | Chapters |
|---|---|---|
| Materialization | Where is the system boundary and has the origin of the material been established? | 27, 31 |
| Disappearance of an item | What trajectories, observation zones and transfer paths were available | 8, 17, 27 |
| Omen | Were the prediction rule and deadline written down before the outcome? | 3, 15 |
| Cursed place | Has the frequency of certain events changed to reflect coverage and normal environment? | 3, 7, 34 |
| Ball lightning or luminous object | What are the spectrum, recording geometry and energy model | 22, 23, 25 |
| The object is suspended in the air | How the supports are installed, the movement of the medium and the holding forces | 19, 26 |
| Text responds or understands | Are the answers, semantic categories and leakage paths predefined? | 35, 36 |
| History has changed | What independent traces are available and what prediction distinguishes between versions | 14, 32, 40 |
| The device has gone crazy | Are the original signal, power, support and failure symptoms intact? | 35, 47, 49 |

When moving from a story to a study, the original words of the witness are preserved and the working formulation is recorded separately. This allows you to refine the model without changing the primary material. To start any business, record A, plan B and decision on mode D are used; special working forms are collected in Appendix G.

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