Electrical Engineering and Computer Science Dept
College of Engineering

ELICITATION TECHNIQUES

Prepared by Prof. Dr. Christopher Shneider Cerqueira

2025

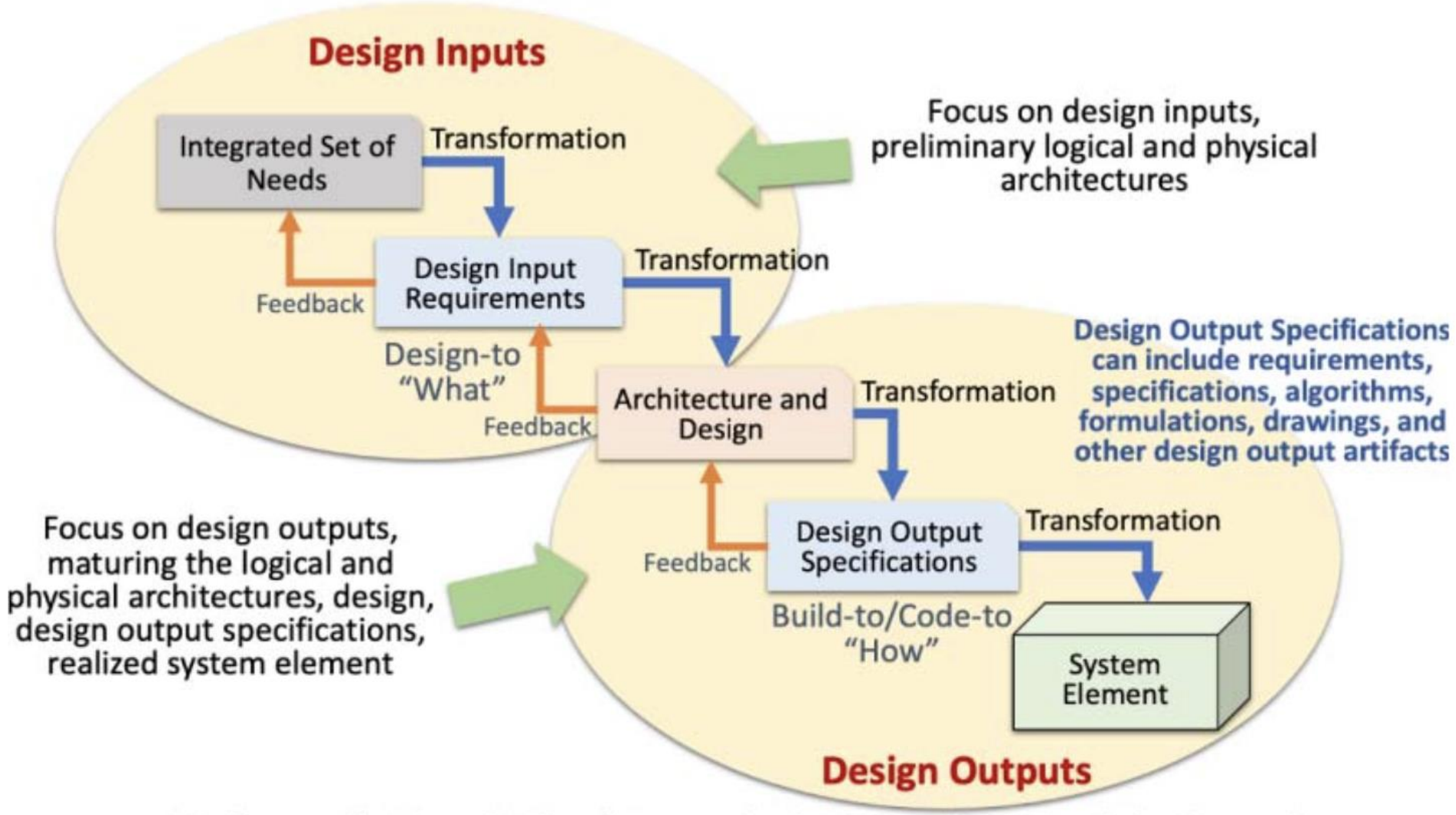


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W	Dates	Topic	Ref	Activity
35	26-Aug	Course Introduction Systems Engineering Review Requirement Engineering (Generic Process)	[1][6] [7][9]	Groups & Names
36	2-Sep	Lego exercise 01 - First assessment	[2] [10]	Exercise Report
37	9-Sep	Definition and Structure of Requirements Functional and non-functional Requirements	[8][6] [10]	Exercise List
38	16-Sep	Elicitation Techniques (Interview / Rich Picture / use Cases)		Group Project Delivery
39	23-Sep	Rules for need and requirement statements	[2][3]	Exercise List
40	30-Sep	Attributes of need and requirement statements Boilerplates/patterns	[2]	Exercise List
41	7-Oct	[Carrer Explo]		* Reading activity
42 *	14-Oct	Midterm Session		Self-paced concept questions
		[Fall break]		

W	Dates	Topic	Ref	Activity
43	21-Oct	MBSE Trends	**	Group Project Delivery
44	28-Oct	Traceability - Organization	[5][	Group Project Delivery
45	4-Nov	Metadata: Rationale + Verification and Validation (Success Criteria)	[2][4]	Group Project Delivery
46	11-Nov	[Veterans Day]		* reading activity
47	18-Nov	Lego Exercise 02	[2] [10]	Exercise Report
48	25-Nov	System Requirement Review Presentation (G1-G4)		
		[Thanksgiving]		
48	2-Dec	System Requirement Review Presentation (G5-G8)		
49	9-Dec	Finals		Self-paced concept questions and a small case

"Traditional" ISO/IEC/IEEE 15288 sequence



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Need/Requirement Elicitation



Design Inputs

Integrated Set of Needs

Transformation

Design Input Requirements

Feedback

Design-to "What"

Transformation

Architecture and Design

Feedback

Transformation

Design Output Specifications

Feedback

Build-to/Code-to "How"

Transformation

System Element

Design Outputs

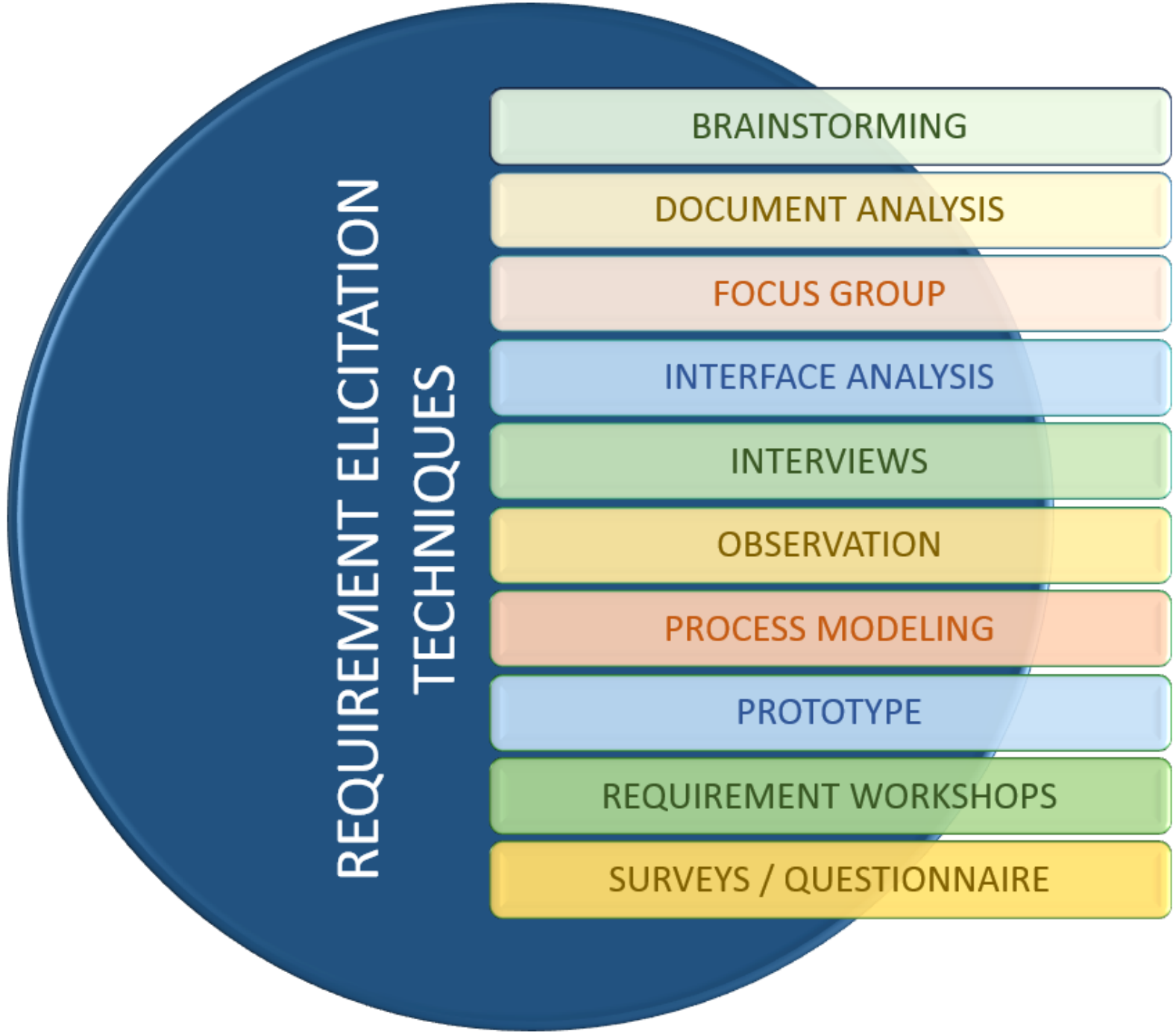
Focus on design inputs, preliminary logical and physical architectures

Design Output Specifications can include requirements, specifications, algorithms, formulations, drawings, and other design output artifacts

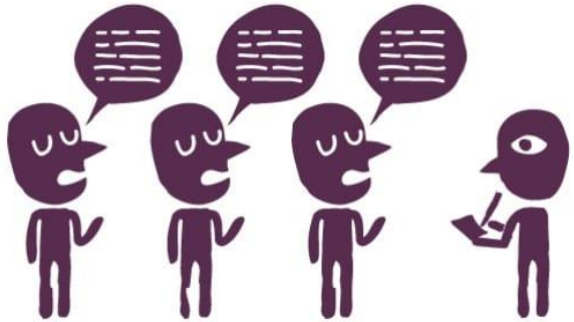
Focus on design outputs, maturing the logical and physical architectures, design, design output specifications, realized system element

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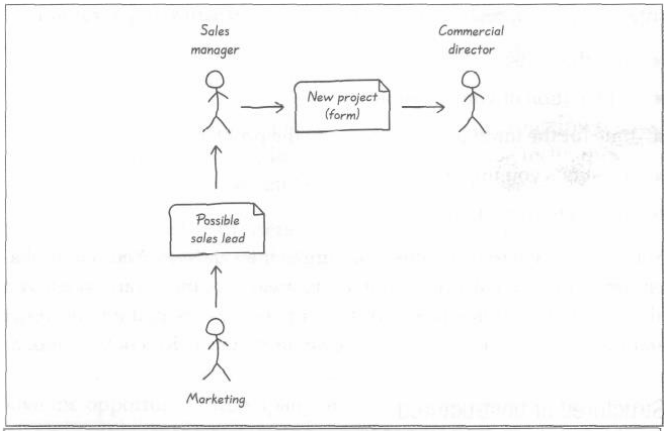
REQUIREMENT ELICITATION

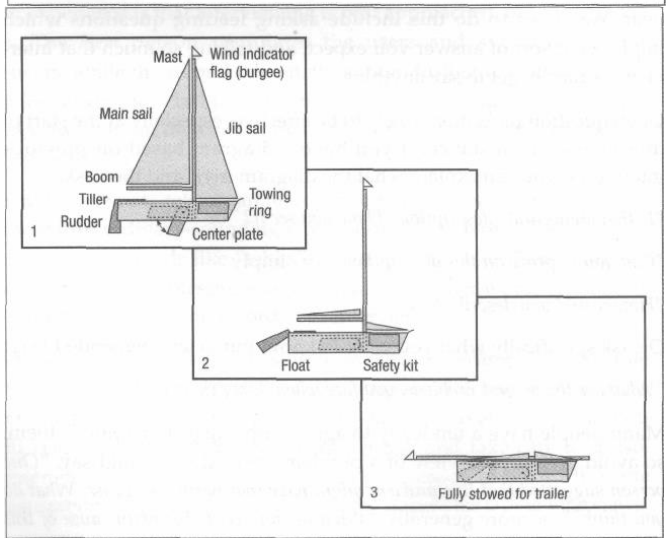

REQUIREMENT ELICITATION TECHNIQUES
BRAINSTORMING
DOCUMENT ANALYSIS
FOCUS GROUP
INTERFACE ANALYSIS
INTERVIEWS
OBSERVATION
PROCESS MODELING
PROTOTYPE
REQUIREMENT WORKSHOPS
SURVEYS / QUESTIONNAIRE

Interviews



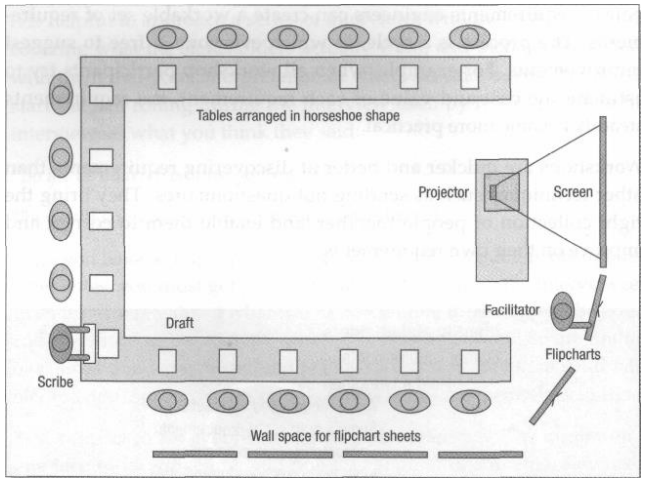
- Interviews can be an excellent source of requirements, provided **users are given room to speak**.
- You need to decide in advance how much **structure you will provide, and what style of interviewing** you will use.
- **Structured interviewing with a script of questions to ask is sometimes helpful** for checking specific points, but it prevents the sort of free discussion which often brings new requirements into the open. The old kind of "structured interview" tended to limit what the user could say to what the developers thought would be important.

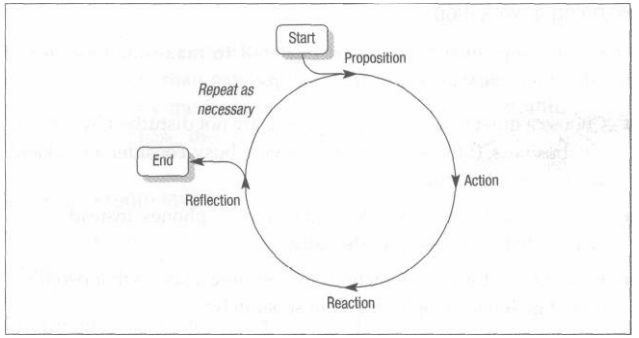




Workshops

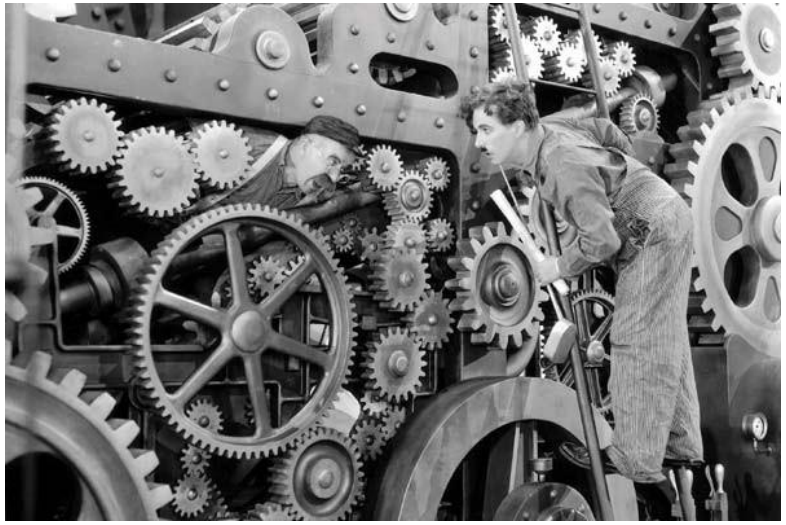
- A workshop requires more preparation and is a larger occasion than an interview, but it is **inherently more interactive and offers an unparalleled opportunity for stakeholders to propose, evaluate, and agree** their requirements.
- In 2-5 days, a group of stakeholders facilitated by a pair of requirements engineers can create a workable set of requirements.
- The process is a cycle, in which **everyone is free to suggest improvements**. For example, when all workshop participants try to estimate the cost and value of each requirement, the requirements steadily become more practical.





Experiencing life as a user

- A direct way to gather requirements is to **experience the user's work** for yourself.
- This is only possible when the **work is not too complex or too dangerous to be undertaken by non-experts**. If users are involved in electronic engineering, for example, it is possible that one of your colleagues may have a background in that field.
- That person could be **assigned to go and work directly with users for a period** - perhaps a month - and then help the users to write the requirements.



Observing users at work

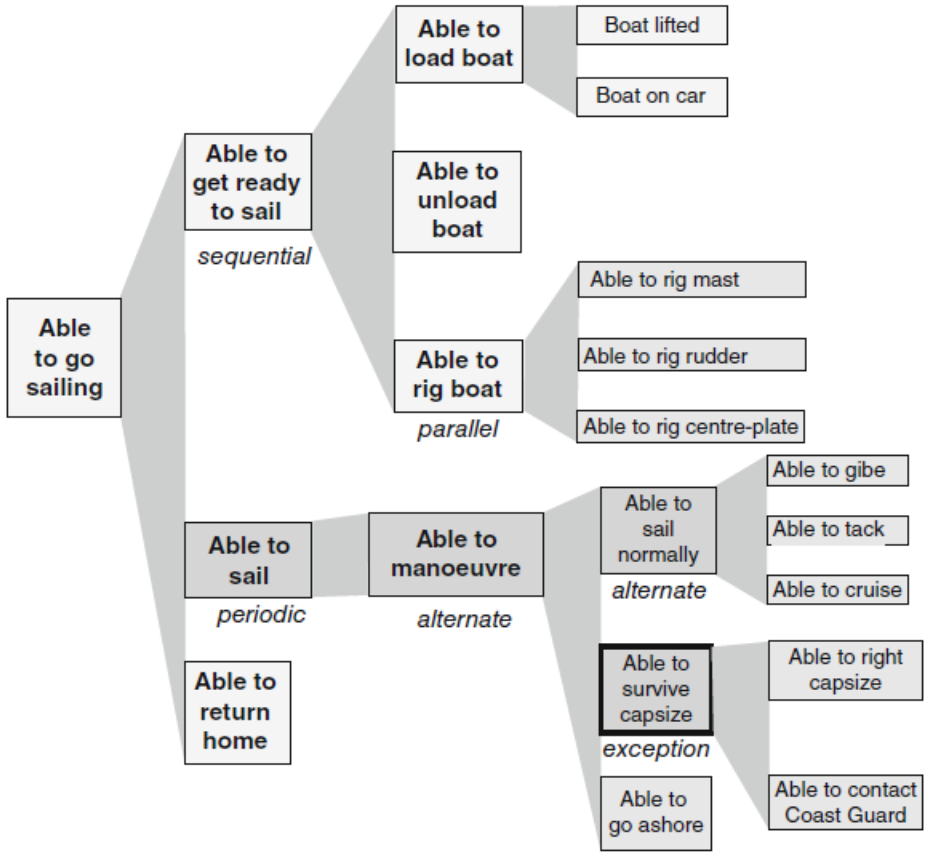
- Where the work cannot easily be experienced directly, it **may still be possible to do better than just sit quietly and watch**. There are many documented techniques for gathering requirements by observing.
- These may be unfamiliar to many systems engineers, but are well known to **human-computer interaction designers**.
- A few photographs may be useful, both for explaining the context to system designers, and for prompting users for requirements later: "What do you need to do in this situation?"





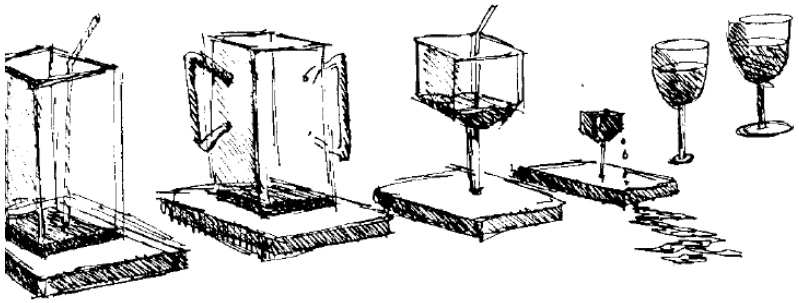
Acting out what needs to happen

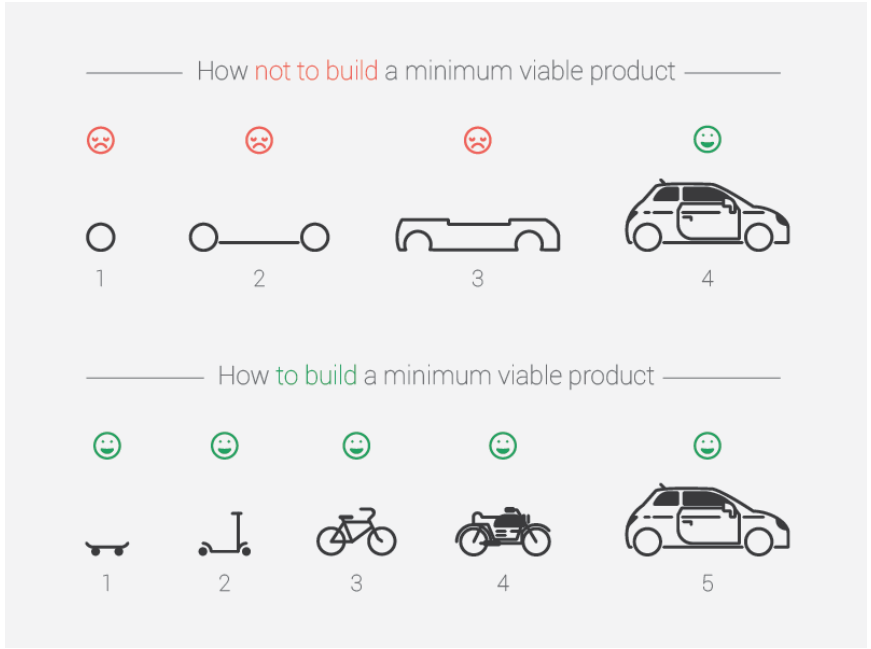
- Where the work involves complex transactions between different users, there may be so much happening that it is difficult for the engineer to understand the situation - air traffic control is an extreme example.
- **Decisions may be made on the basis of different pieces** of evidence; parts of a transaction may be **conducted simultaneously by different users**; different conditions may lead to **many alternative paths**. You can **disentangle the threads by looking at one scenario at a time**.



Prototypes

- A simple prototype can **provoke users into giving good requirements or into changing their minds about existing requirements**. However, make it clear that your **prototype just demonstrates some ideas**, and is not a finished product or even a decision about the approach - the way you present a prototype is crucial.
- They can illustrate **how an approach might work**, or give users a glimpse of what they might be able to do.





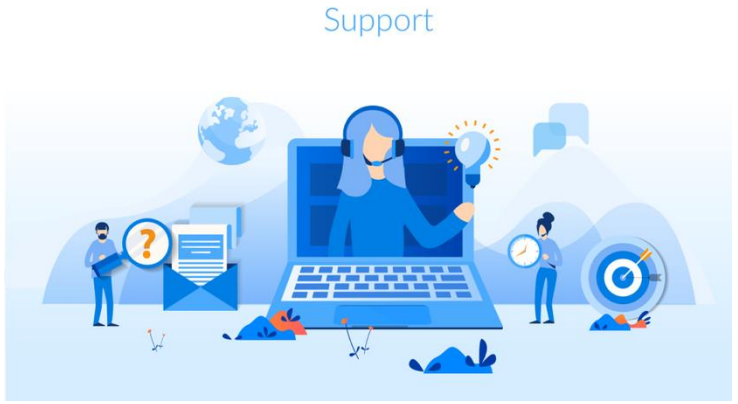
Problem reports

- Problems reported by users can often be turned around into requirements. **Efficient organizations have a form for reporting problems or software bugs**. You can ask to look through these reports.
- Product and service organizations have a helpdesk which keeps a **log of problems and fixes, and a support team who do the fixing**. Many organizations have similar facilities to support their own operations. Talking to the helpdesk staff and the support team may give you good leads into the requirements, and save you time.
- Another good source of requirements is a **list of suggestions and complaints made by customers**. The best of these are practically requirements, such as when a customer asks why a mass-market product couldn't do something that the customer wanted.



Trainers and consultants

- Take the time to talk to your training team and consultants. **They have intense contact with your clients and a clear view of what users find difficult**.
- Prime both groups to collect requirements continuously: this is interesting for them, stresses their value to the organization, and ties them into development.
- Make sure they hear what happens to their suggestions.





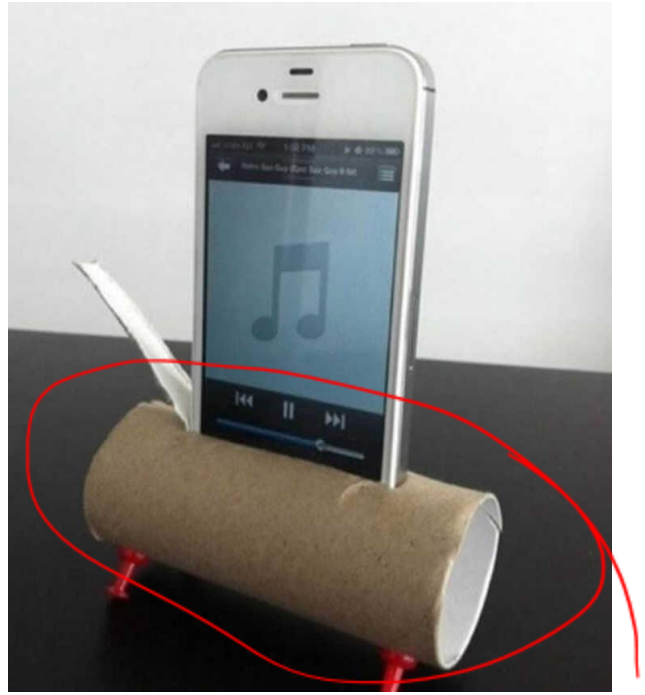
Improvements made by users

- **Improvements made to products by their users are an excellent source of requirements.** Users of a standard company spreadsheet may have added a few fields, or related different sheets together, or drawn a graph which exactly meets their individual needs.
- You need only ask "what is that for?“ or "why did you add that?" to get to the actual requirement.
- This applies equally to hardware and non-computer devices. For example, a lathe operator may have manufactured a special clamp, or an arm that prevents movement of the tool beyond a certain point.
- Any such modification points to a requirement for the new version.



Unintended uses

- **Users are immensely creative in the way that they actually use systems**. Look out for usage which was never intended.
  - Mr Uzi, a weapon designer, was surprised to see soldiers using the carefully designed foresight of his gun to open bottles of beer. Horrified, Uzi went back to his office and thought about how to keep the foresights in good condition. Built into the stock of every gun, there is now a can and bottle opener.
  - The same can happen for software. An observant product manager noticed that an engineer was staying in the office late to use an advanced computer-aided design system to design a new kitchen layout for his home. This opened up a market for inexpensive commercial products, with names such as "Kitchen Designer," for home use.





Comparable products

- Existing products often contain **working versions of good ideas** for solving your users' problems.
- You can avoid "reinventing the wheel" by looking at what is already on the market, whether installed at the users' site or products made by rival organizations/Even if they are trying to solve slightly different problems, they often give valuable clues to what you should be doing.
- You can carefully show some such products to users (as with prototypes), explaining that this idea is from another area but contains an interesting concept: would it help them?
- However, not **all users can make the imaginative jump from one kind of product to another, so this approach has to be handled cautiously**.



Old designs and specifications

- **Extracting user requirements from documents written for other purposes is far from easy**.
- The text may be out of date; it may represent a particular point of view with which other users disagree; or it may use specialized language that users will have to explain to you.
- In all of these cases, there is a risk that, unless you discuss what you take from the document with users, you will be inventing a requirement that does not exist.



Marketing department

- In product organizations, then, the marketing **department is the natural home for user requirements**. Systems engineers have to rely on the marketing team, who can do **surveys, commission prototypes, launch trial products, look at the success of competitors, and monitor market reactions to find out what will sell**. Unfortunately, in many firms the relations between systems engineers and marketing are not especially good.
- **Turning market reports into requirements**
  - Information collected by marketing is often not organized well enough to be useful to developers. Developers in turn have little respect for the faint voice of the customer that manages to come through. This is a pity as market requirements are necessary for products. Product managers can bridge this gap by transforming marketing knowledge into definite requirements.





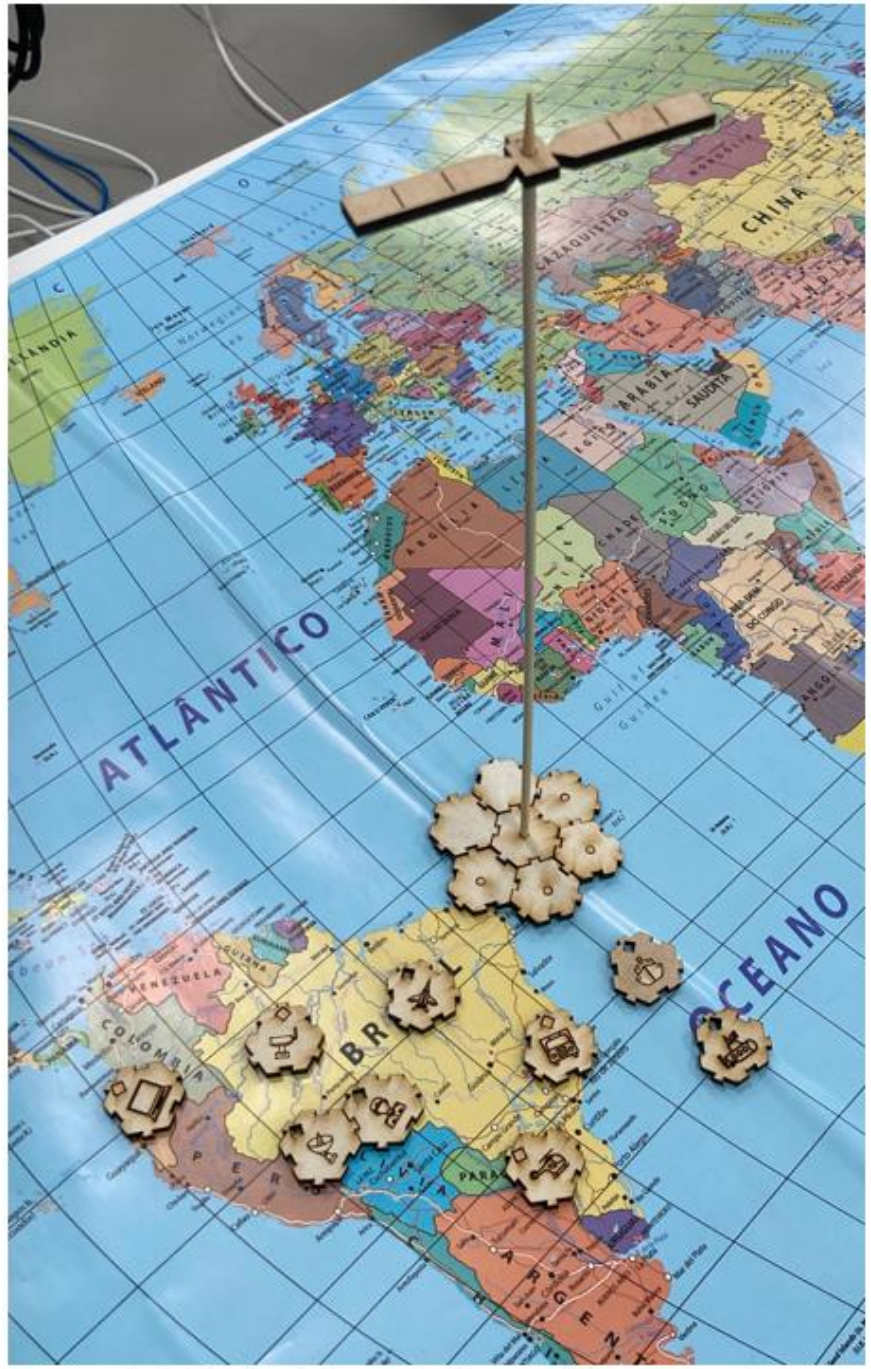
One of mine experiences: use of D&D game estrategy

We were assisting the technical management of a Geostationary Satellite Acquisition workgroup to aid military organizaations describe their requirements.

Initialization

- One month before we requested a 5W2H (What/ Why/ Where/ When/ Who/ How/ How Much) of each need to each stakeholder.
- Created the game vocabulary and mechanics based on D&D (Dungeons and Dragons).
- From the use description we planned the situations and pre-wrote the requirements
- During the application
  - One day reviewing the needs and harmonizations proposal
  - Two days running the situations. (overnight reviewing and rewriting)
  - One day reviewing the “finalized” requirement wording.

- Disclaimer: was a system of systems level exercise to find system requirements



(a) Global Level Scene Placement



(b) Country Level Scene Placement



(c) Local Level Scene Placement



(a) Game Controller



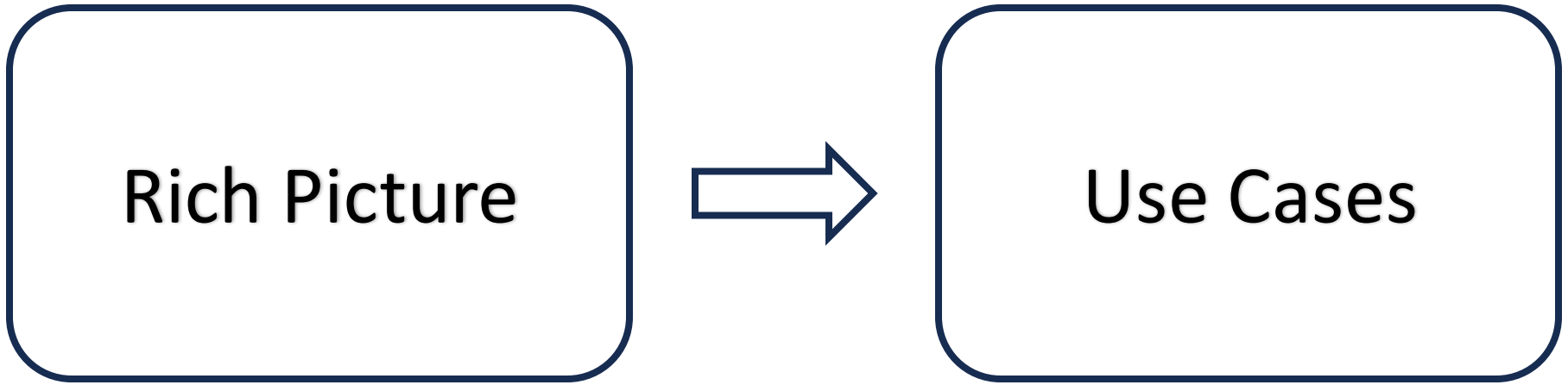
(b) Game Facilitator

We got all forces into the same room and through a multi-domain mission exploration that would require satellite link we explored the uses to

Let's learn two “engineering” techniques

Techniques catalog

- Systems Theory
  - Operational Research (OR)
    - Soft Systems Methodology (SSM)
      - Rich Picture
  - Systems Engineering
    - Use Cases

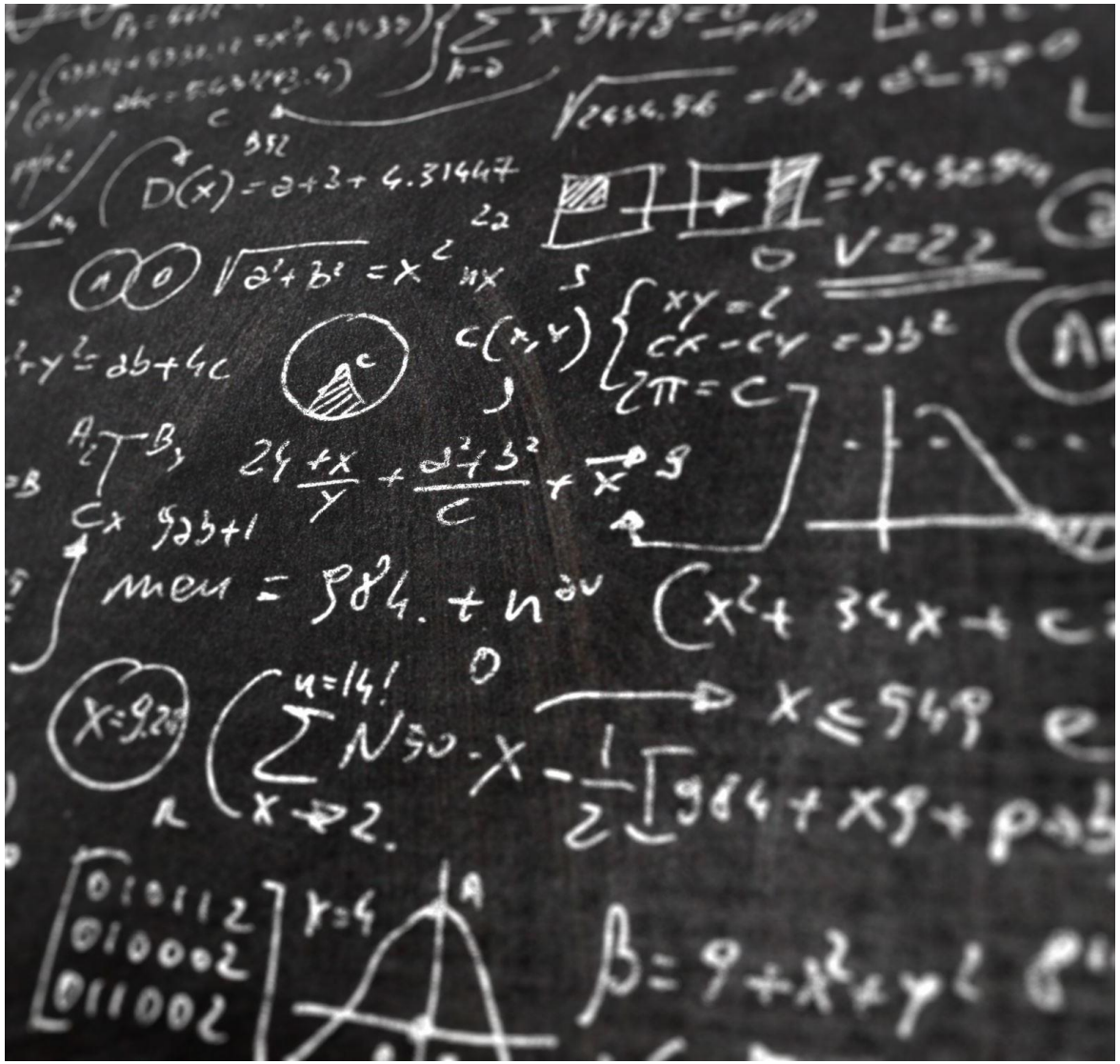


Before jump into the SSM

What is Operational Research?!

SSM – Soft Systems Methodology

Operational Research



- Operational Research applies analytical methods to **improve decision-making**.
- It uses mathematical modeling, statistics, and algorithms for **problem-solving**.
  - OR helps optimize complex systems in industries like logistics and manufacturing.
  - It supports resource allocation, scheduling, and process improvement.
  - The goal is to achieve efficient and effective operations.

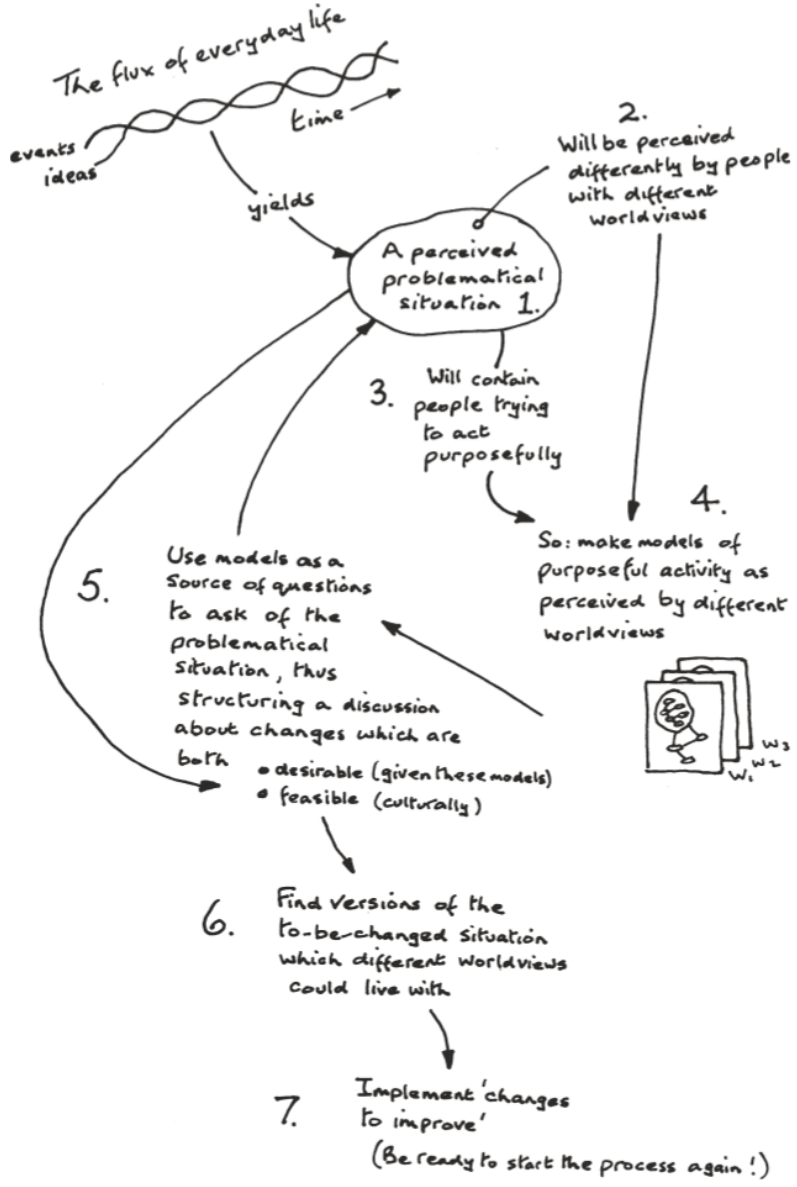
Soft Operational Research

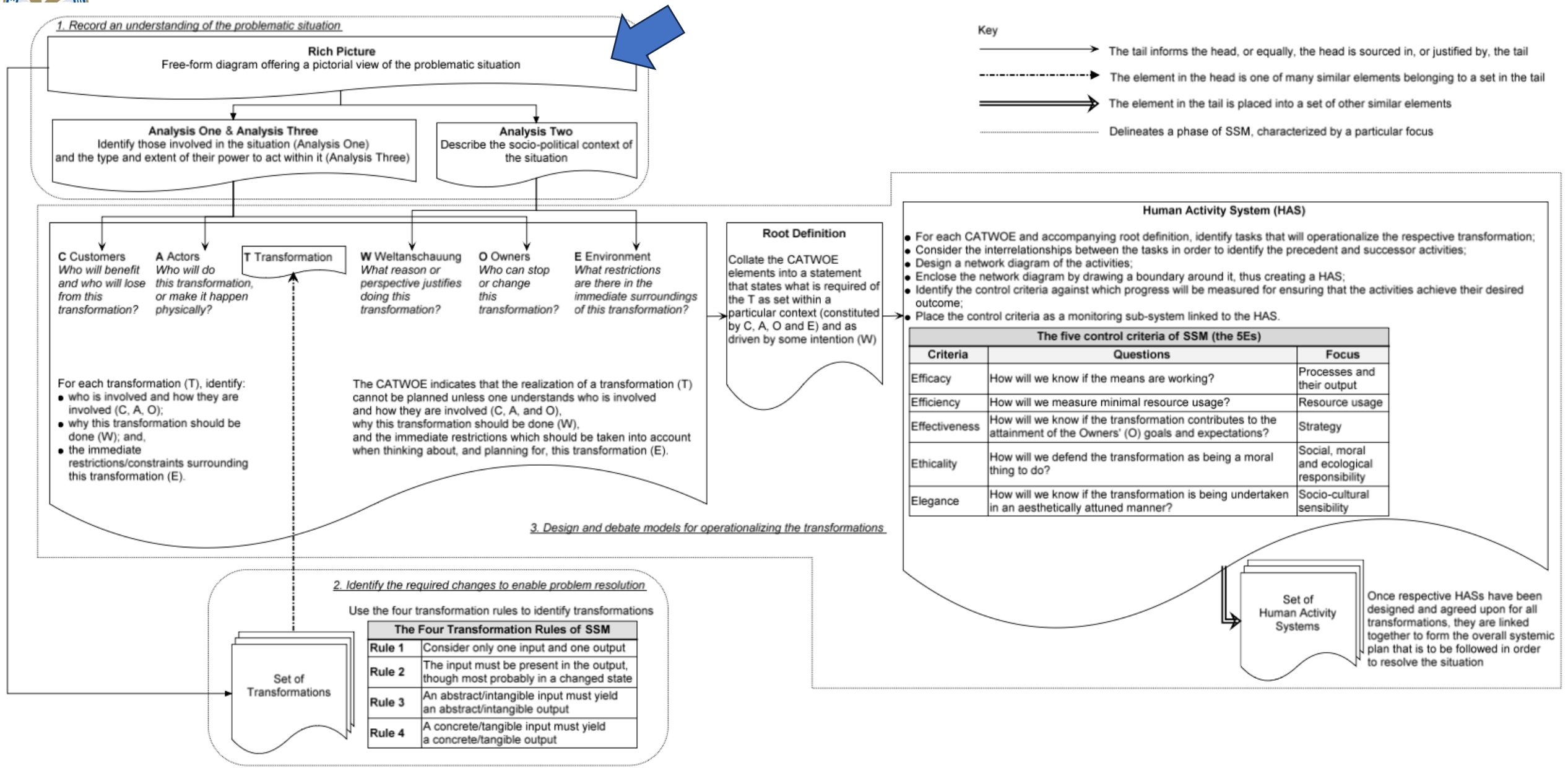


- **Soft Operational Research addresses complex, unstructured problems**.
- It focuses on qualitative data and **stakeholder perspectives**.
- Soft OR uses methods like **Soft Systems Methodology (SSM).**
- It helps **understand human** and organizational factors.

Soft Systems Methodology (SSM)

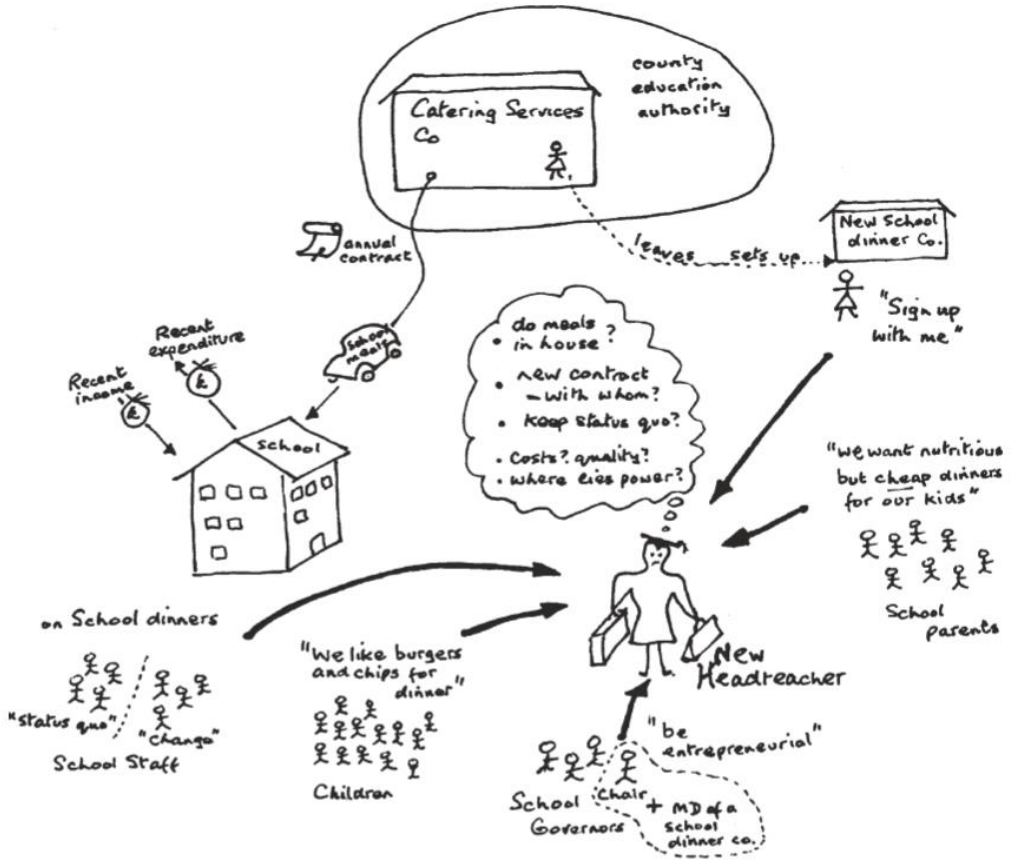
- SSM is an approach to tackle **complex, ill-structured problems**.
- Developed by Peter Checkland to explore **human activity systems (HAS)**.
- Focuses on **learning, stakeholder perspectives, and iterative modeling**.
- Uses **rich pictures** and conceptual models to analyze situations.
- Helps improve organizational processes through **structured inquiry**.



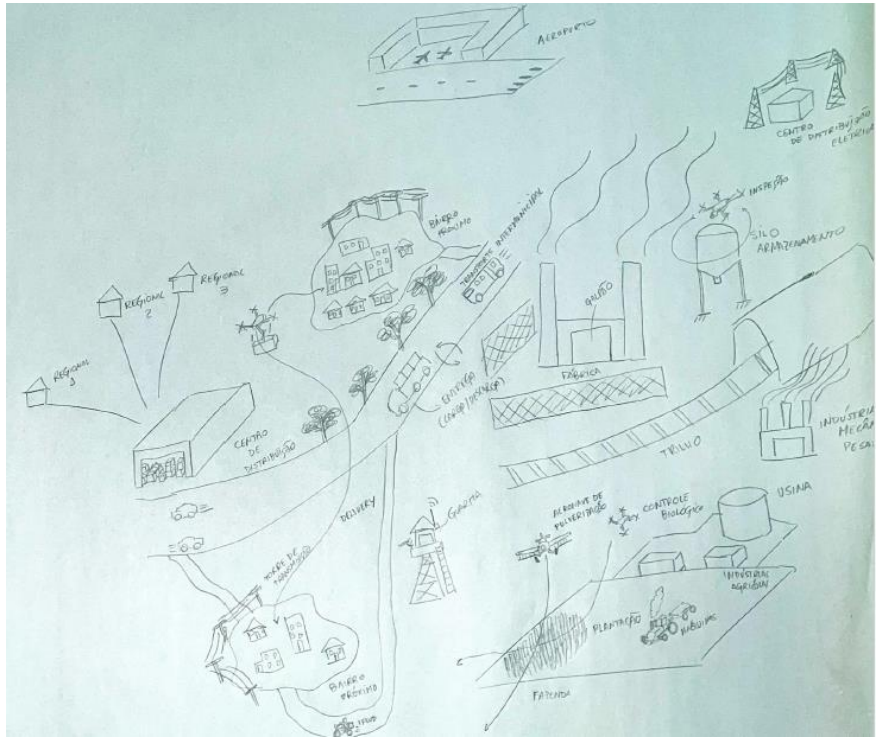

1. Record an understanding of the problematic situation
Rich Picture
Free-form diagram offering a pictorial view of the problematic situation
Analysis One & Analysis Three
Identify those involved in the situation (Analysis One) and the type and extent of their power to act within it (Analysis Three)
Analysis Two
Describe the socio-political context of the situation
Key
The tail informs the head, or equally, the head is sourced in, or justified by, the tail
The element in the head is one of many similar elements belonging to a set in the tail
The element in the tail is placed into a set of other similar elements
Delineates a phase of SSM, characterized by a particular focus
C Customers
Who will benefit and who will lose from this transformation?
A Actors
Who will do this transformation, or make it happen physically?
T Transformation
W Weltanschauung
What reason or perspective justifies doing this transformation?
O Owners
Who can stop or change this transformation?
E Environment
What restrictions are there in the immediate surroundings of this transformation?
For each transformation (T), identify:
who is involved and how they are involved (C, A, O);
why this transformation should be done (W); and,
the immediate restrictions/constraints surrounding this transformation (E).
The CATWOE indicates that the realization of a transformation (T) cannot be planned unless one understands who is involved and how they are involved (C, A, and O), why this transformation should be done (W), and the immediate restrictions which should be taken into account when thinking about, and planning for, this transformation (E).
Root Definition
Collate the CATWOE elements into a statement that states what is required of the T as set within a particular context (constituted by C, A, O and E) and as driven by some intention (W)
3. Design and debate models for operationalizing the transformations
Human Activity System (HAS)
For each CATWOE and accompanying root definition, identify tasks that will operationalize the respective transformation;
Consider the interrelationships between the tasks in order to identify the precedent and successor activities;
Design a network diagram of the activities;
Enclose the network diagram by drawing a boundary around it, thus creating a HAS;
Identify the control criteria against which progress will be measured for ensuring that the activities achieve their desired outcome;
Place the control criteria as a monitoring sub-system linked to the HAS.
The five control criteria of SSM (the 5Es)
Criteria | Questions | Focus
Efficacy | How will we know if the means are working? | Processes and their output
Efficiency | How will we measure minimal resource usage? | Resource usage
Effectiveness | How will we know if the transformation contributes to the attainment of the Owners' (O) goals and expectations? | Strategy
Ethicality | How will we defend the transformation as being a moral thing to do? | Social, moral and ecological responsibility
Elegance | How will we know if the transformation is being undertaken in an aesthetically attuned manner? | Socio-cultural sensibility
Set of Human Activity Systems
Once respective HASs have been designed and agreed upon for all transformations, they are linked together to form the overall systemic plan that is to be followed in order to resolve the situation
2. Identify the required changes to enable problem resolution
Use the four transformation rules to identify transformations
The Four Transformation Rules of SSM
Rule 1 | Consider only one input and one output
Rule 2 | The input must be present in the output, though most probably in a changed state
Rule 3 | An abstract/intangible input must yield an abstract/intangible output
Rule 4 | A concrete/tangible input must yield a concrete/tangible output
Set of Transformations

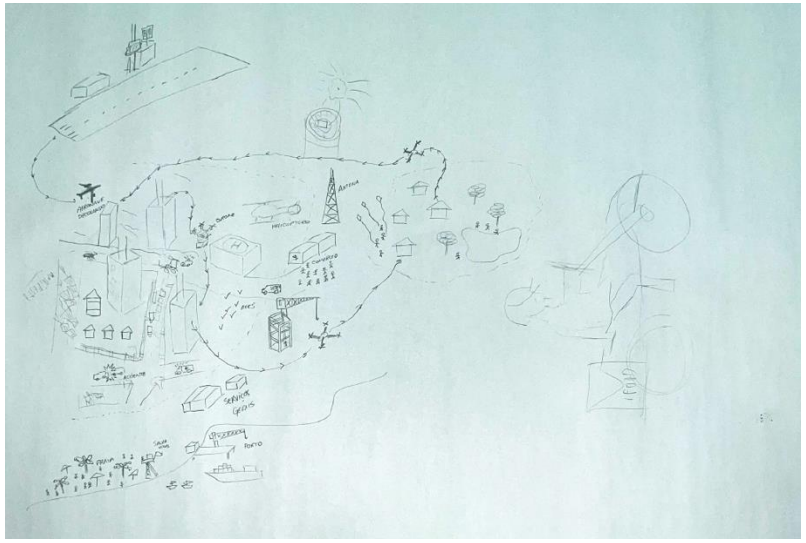
1.1 Rich Picture

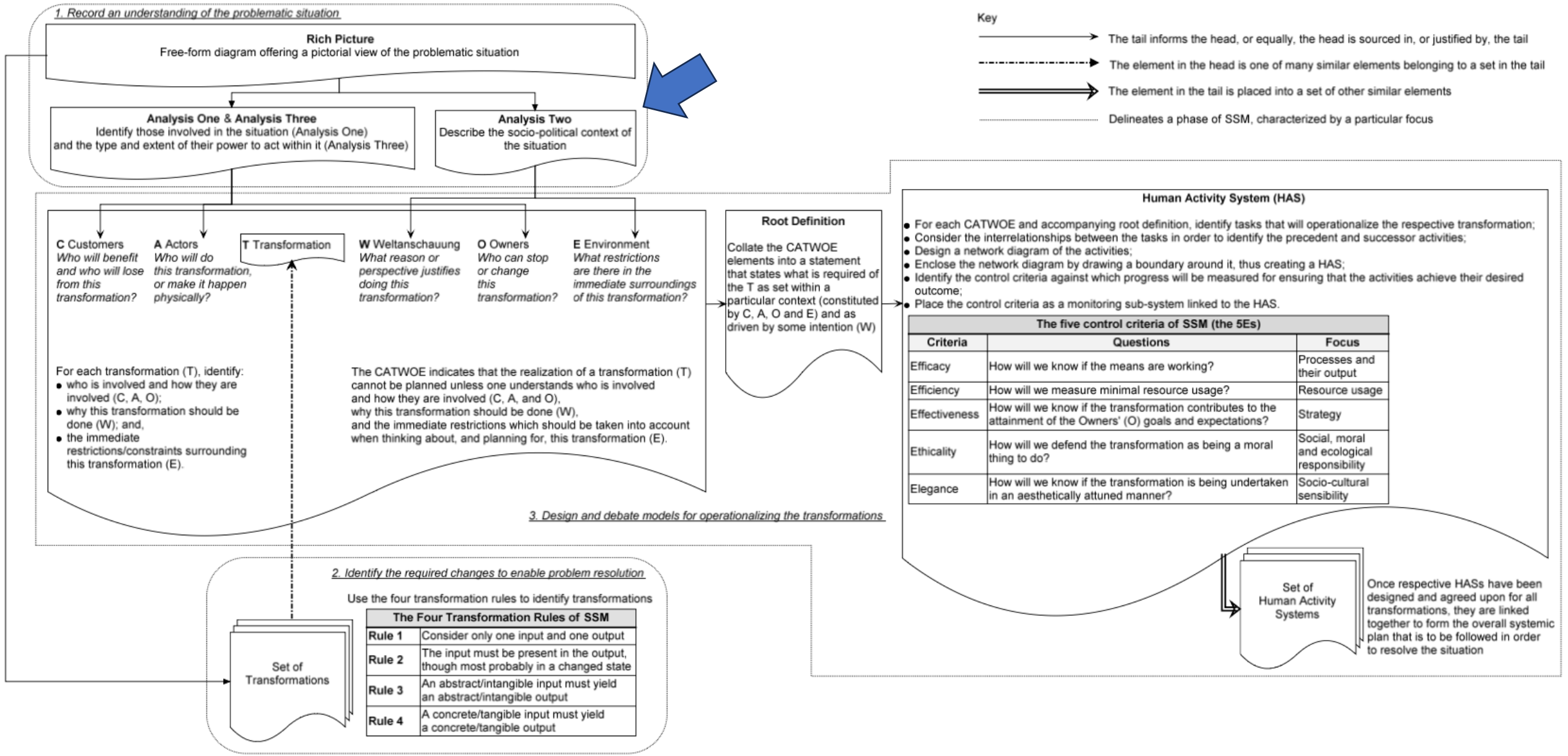
- SSM begins with the recording of contextual knowledge about the problematic situation. The quality, relevance, and effectiveness of any subsequent resolution are a function of the content and use of this knowledge.
- A free-form drawing, its utility ranges from being an ideal icebreaker to a cathartic exercise. It offers those involved in the problem the opportunity to describe their situation without necessarily resorting to written words, resulting in an initial visualization.



Checkland, P. and Poulter, J. (2006)
Learning for Action: A Short Definitive Account of Soft Systems Methodology and its use for Practitioners,






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1.2 Analysis

- The task for ***analysis one*** is relatively simple: **to list what may be termed the physical or abstract 'agents' involved in**, or who impact upon, the situation; for example, people and organizations.
- ***Analysis three*** requires a **description of the power enjoyed by each agent listed** in analysis one. Descriptions of power range from the possession of particular abilities, or competences, to the aura of charisma that exudes from a particular agent, and which gives them their power to influence.
- ***Analysis two*** is more related to the **contextual considerations**. It would ask: What is it like to be in this situation? How are things done here? What sort of culture, organizational or otherwise, permeates this situation and, to a great extent, governs it?

Example

Analysis 1 – Agents

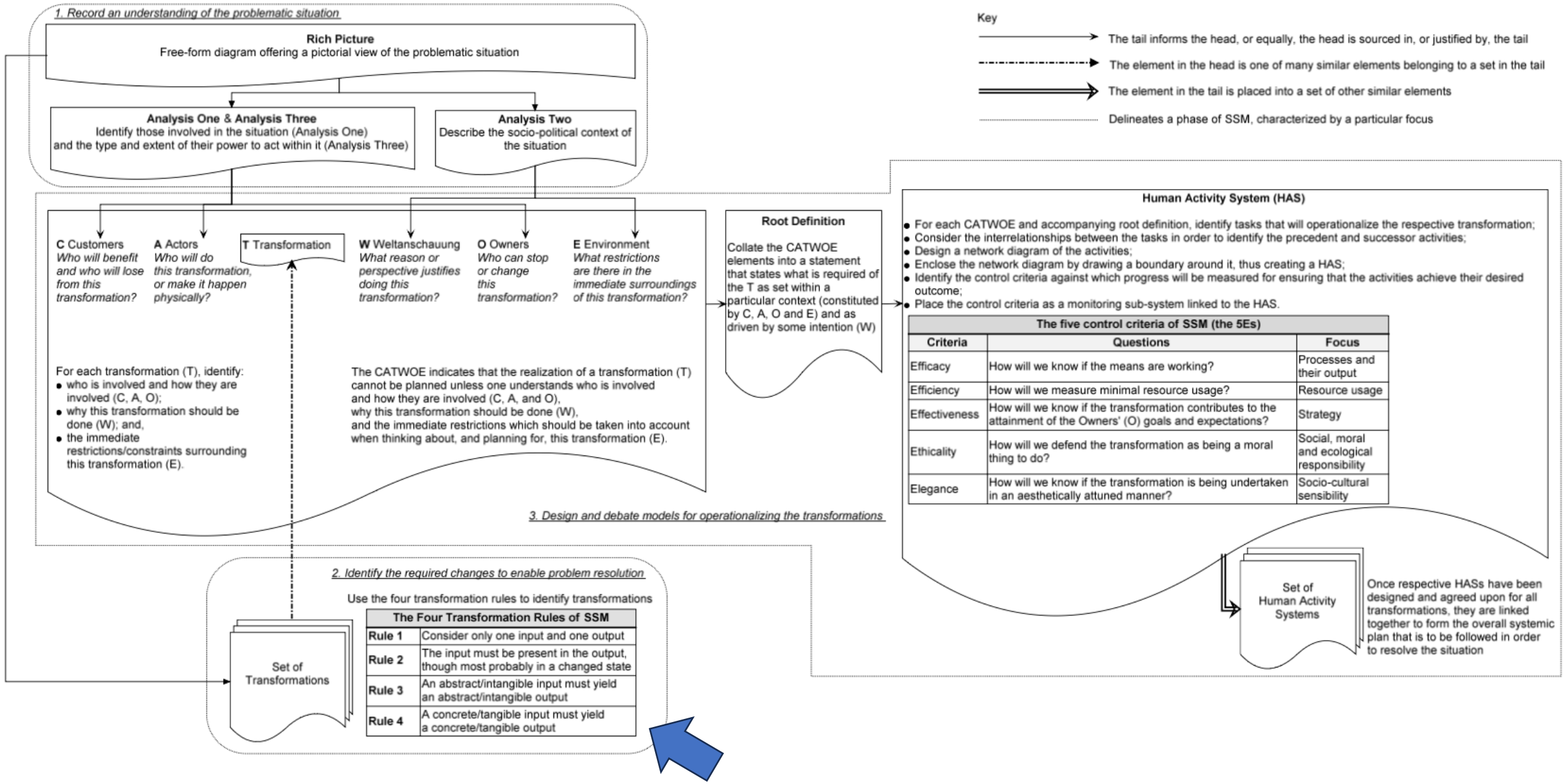
- **Customers**: Businesses relying on urgent service.
- **Staff/Team**: Service operators handling urgent demand.
- **Organization**: Service provider setting policies.
- **External specialists**: Partners or subcontractors.
- **Demand itself**: Urgent service requests.

Analysis 3 – Power

- **Customers** → exert influence by leaving or complaining; they define expectations.
- **Staff/Team** → operational control: they directly manage response times.
- **Organization** → policy and resource allocation; can set or change acceptable time lag.
- **External specialists** → can delay or enable service delivery depending on cooperation.
- **Demand** → has power by sheer urgency; it forces prioritization.

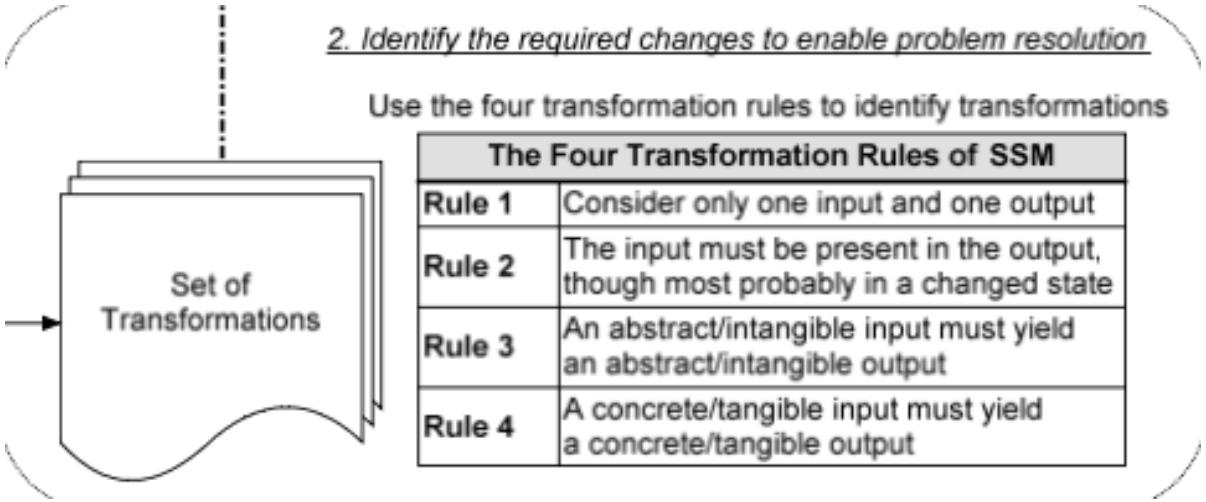
Analysis 2 – Cultural/Contextual (PREACHEES)

- **Political**: Pressure from regulators to ensure fairness in urgent responses.
- **Religious**: Not directly relevant here (but could matter if service is in faith-based context).
- **Economic**: Service delays cause customer business losses.
- **Aesthetic**: Customers expect smooth, professional service experience.
- **Cultural**: Organizational culture of firefighting rather than planning.
- **Historical**: History of poor coordination among providers.
- **Ethical**: Need to treat urgent customers fairly without neglecting non-urgent ones.
- **Ecological**: If services involve physical transport, environmental delays (e.g., weather) matter.
- **Social**: Reputation effects, word of mouth if service fails.


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2.1 Identify Transformations

- Identifying what the essential problem(s) might be in the situation – where 'essential' is the key word. SSM notes that a problematic situation implies an undesirable state which needs to be *transformed* into a desirable state.



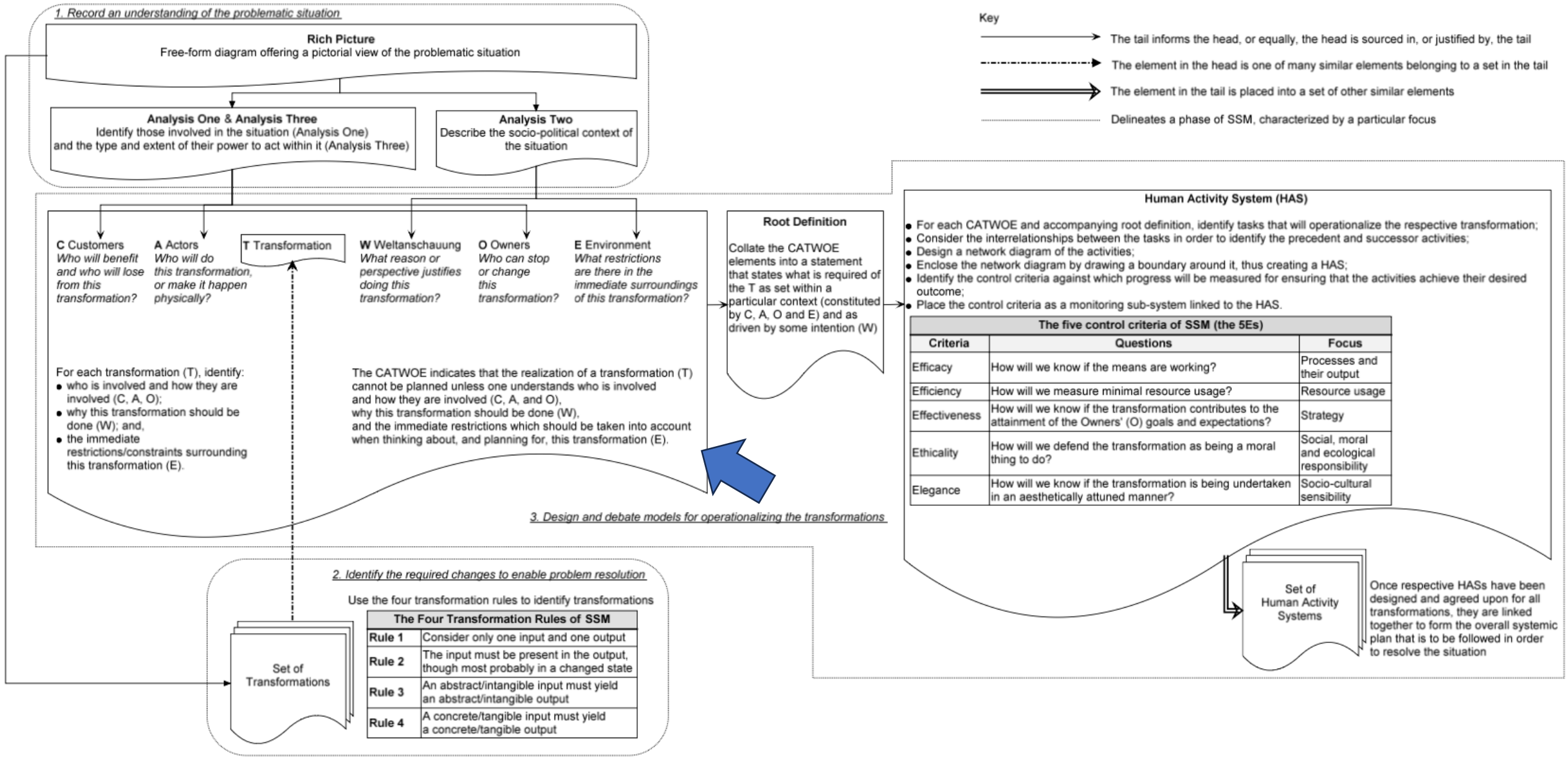
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Table 1 A set of transformations

	Input		*Output*
T_1	Unacceptable time lag in dealing with urgent demand	→	Acceptable time lag in dealing with urgent demand
T_2	Uncoordinated approach to service provision	→	Coordinated approach to service provision
T_3	Poor quality of service	→	Quality level of service which does not detrimentally affect customers' businesses
T_4	Consequent detrimental effects to our customers' businesses	→	Detrimental effects to our customers' businesses are minimised
T_5	Unclear expectations of our organisation	→	Organisational expectations clarified
T_6	Unclear expectations of our clients	→	Client expectations clarified
T_7	Unaddressed issues about the roles of staff within the team	→	Issues about the roles of staff within the team are addressed
T_8	Unaddressed issues about who we will provide a service for	→	Issues about who we will provide a service for are addressed
T_9	Negotiation required with various external specialist organisations we work with	→	Negotiation with external specialist organisations realised

Note: The numbering does not indicate priority, but merely facilitates quick referencing.

Source: Adapted from a case study by Georgiou (2008)


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3.1. Contextualization of transformations (CATWOE)

- **C – Customers** – an agent who will benefit/lose from the transformation (stakeholders)
- **A – Actors** - agent who will actually do the transformation (the “force” that will help creating the transformation // who are going to operate the system to it perform its transformations // operational stakeholders)
- **T – Transformation** – the actual transformation expected.
- **W – Weltanschauung** – difficult concept but would be something like world-view // viewpoint // culturally-organizational-moment related
- **O – Owner** – the agent who has the power to decide upon the transformation process
- **E – Environment** – situational restrictions around the transformation.

Example of transformation // Weltanschauung

Table 2 An example of how the choice of Weltanschauung influences the operationalisation of a transformation

Transformation	
card-index research database → computerised research database	
Weltanschauung 1	*Weltanschauung 2*
A computerised database speeds up research work, and in general renders it more efficient	A computerised database makes it easier to take on trips to conferences because it can be saved and used in a laptop computer
Operational influence of Weltanschauung 1	*Operational influence of Weltanschauung 2*
The transformation designed according to this Weltanschauung will consider criteria of speed and efficiency of use.	The transformation designed according to this Weltanschauung will focus upon portability, and does not imply the inclusion of speed and efficiency in the computerised output.

Example of a full CATWOE

Box 1 An example of a completed CATWOE

CATWOE for T_1

Customers: urgent demand, customers' businesses; possible lack of focus on other types of demand

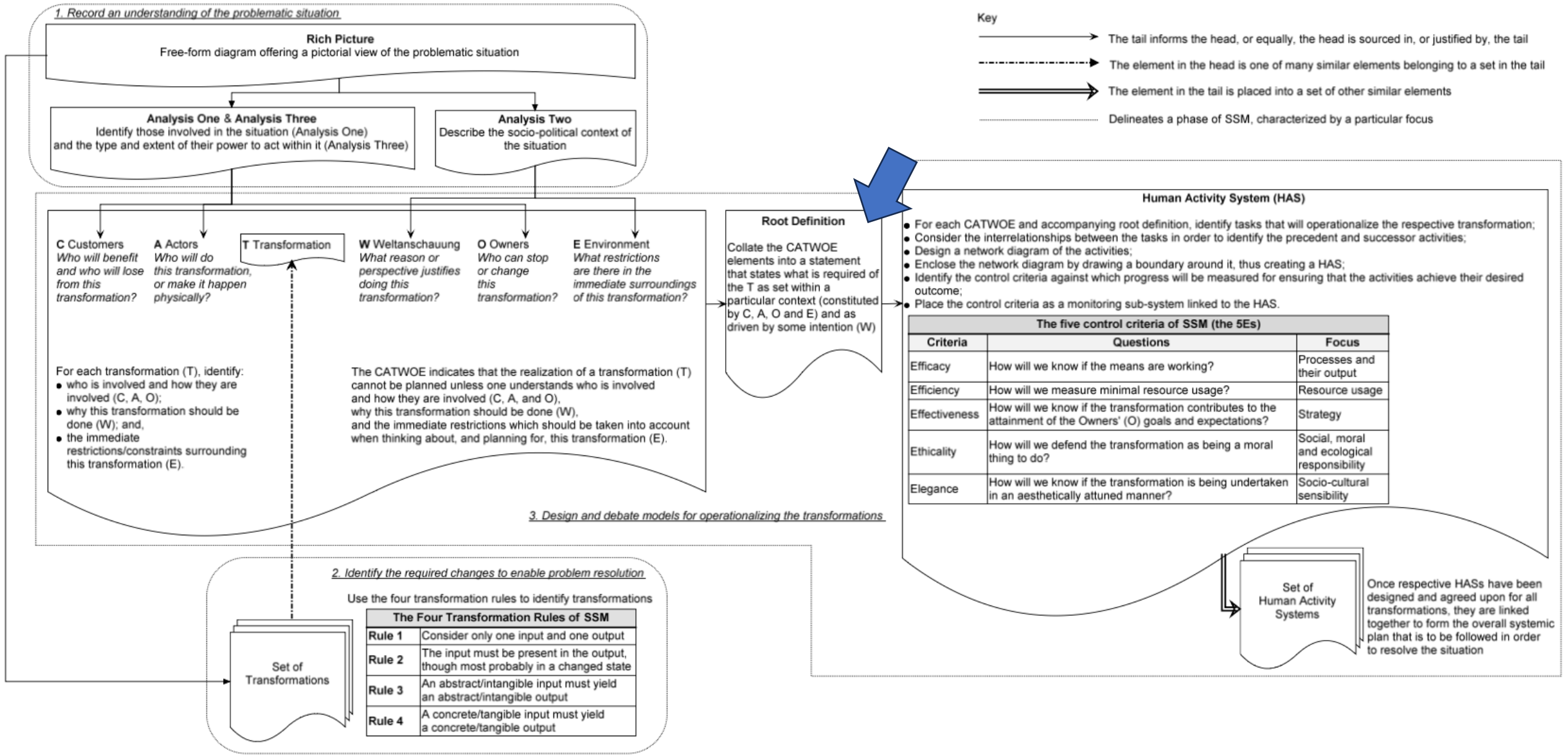
Actors: staff/team

Transformation: unacceptable time lag in dealing with urgent demand → acceptable time lag

Weltanschauung: An acceptable time lag should increase quality of the service so that detrimental effects to customers' businesses are reduced, and organisational and client expectations are met

Owners: organisation, clients

Environment: Staff roles and market issues (we must decide 'who we will provide a service for'); uncoordinated approach to service provision; capacity; operational strategy


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3.3 Root Definition

- The root definition statement allows to draft from the CATWOE an statement "template" with what is planned/asked/required/captured in order to be able to do the transformation → almost the needs
  - The root definition states what is required of the T as set within a particular context (constituted by C, A, O and E) and as driven by some intention (W).

Box 2 An example of a root definition (planning statement)

Root definition for T_1

A staff-operated *system that* defines and maintains an acceptable time lag for dealing with urgent demand, in accordance with organisational and client expectations and staff roles, in order to ensure a quality of service which does not detrimentally affect customer businesses, in an environment where there is an uncoordinated approach to service provision, and where capacity and operational strategy play a relevant role.

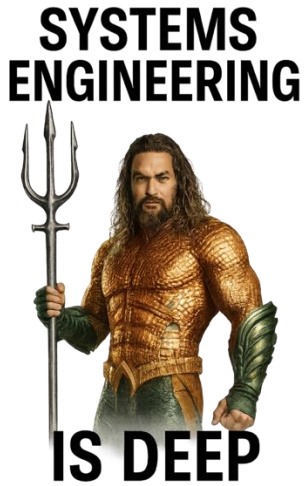
Source: adapted from Georgiou (2008)

INCOSE's need

- A **need statement** is the result of a formal transformation of one or more sources or lifecycle concepts into an agreed-to-expectation for an entity to perform some function or possess some quality within specified constraints with acceptable risk.

  - *The <stakeholders> need the<project> to …*
  - *The <stakeholders> need the<xxxxteam> to …*
  - *The <stakeholders> need the <supplier/contractor> to …*

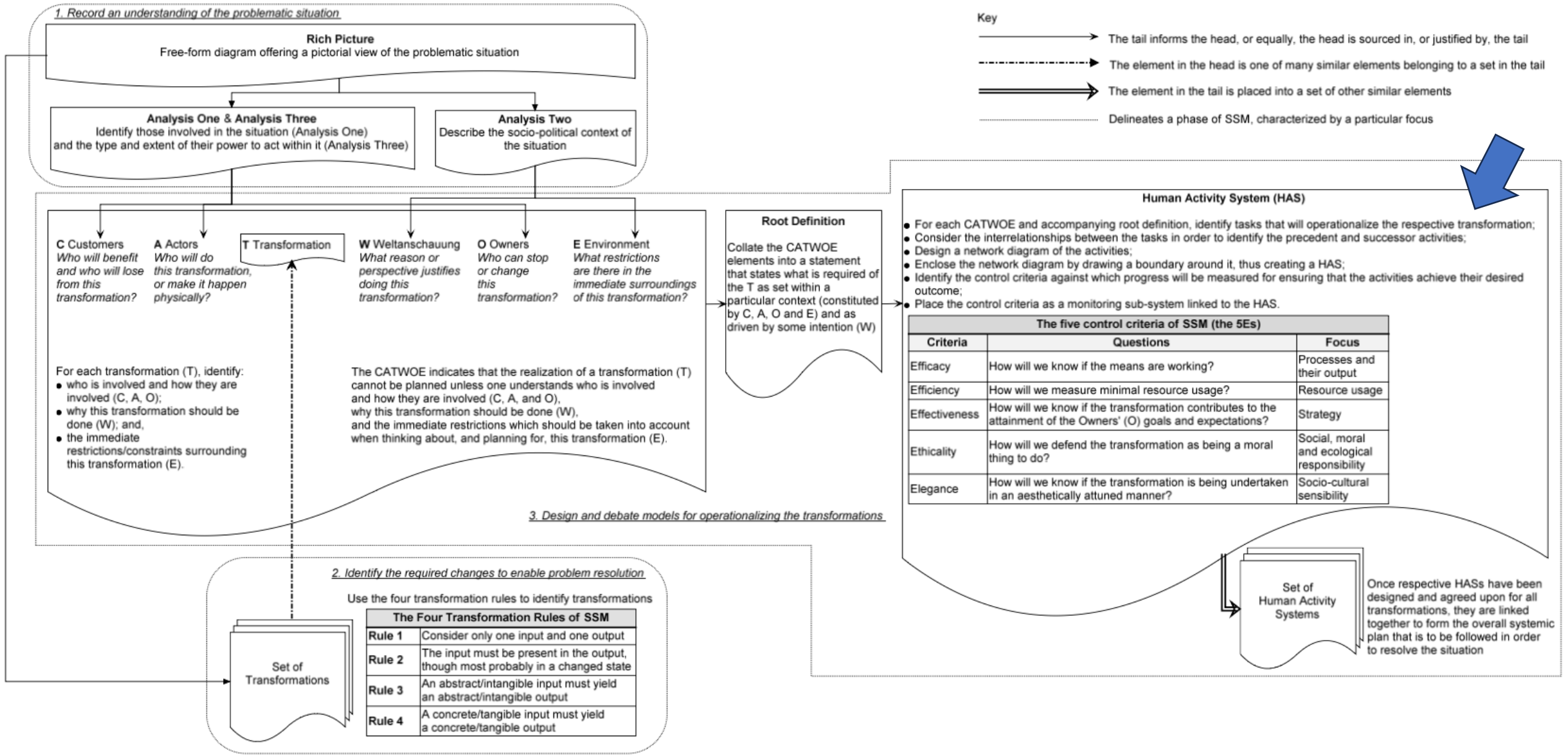
May require a **slight adaptation** to transform a root definition into a need



A staff-operated system that defines and maintains an acceptable time lag for dealing with urgent demand, in accordance with ***organizational and client expectations and staff roles****, to ensure a quality of service which does not detrimentally affect customer businesses, in an environment where there is an uncoordinated approach to service provision, and where capacity and operational strategy play a relevant role.*

User Needs (INCOSE Format)

1. **The organization** needs the staff-operated system to define and maintain acceptable time lags for responding to urgent demands.
2. **The clients** need the staff-operated system to ensure quality of service services that do not negatively affect their business operations.
3. **The operations** need the staff-operated system to remain effective in environments with uncoordinated service provision.


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[3.4 HAS – Human Activity Systems] (just to be complete – it is the decomposition of the root – we are not going to use it)

The more technical guidelines for such a design are as follows:

1. For each CATWOE and accompanying root definition, identify tasks that will operationalize the respective transformation.
2. Consider the interrelationships between the tasks in order to identify the precedent and successor activities.
3. Design a network diagram of the activities, with the final activity being the right-hand side of the transformation in question (its output).
4. Enclose the network diagram by drawing a boundary around it, thus creating a HAS.
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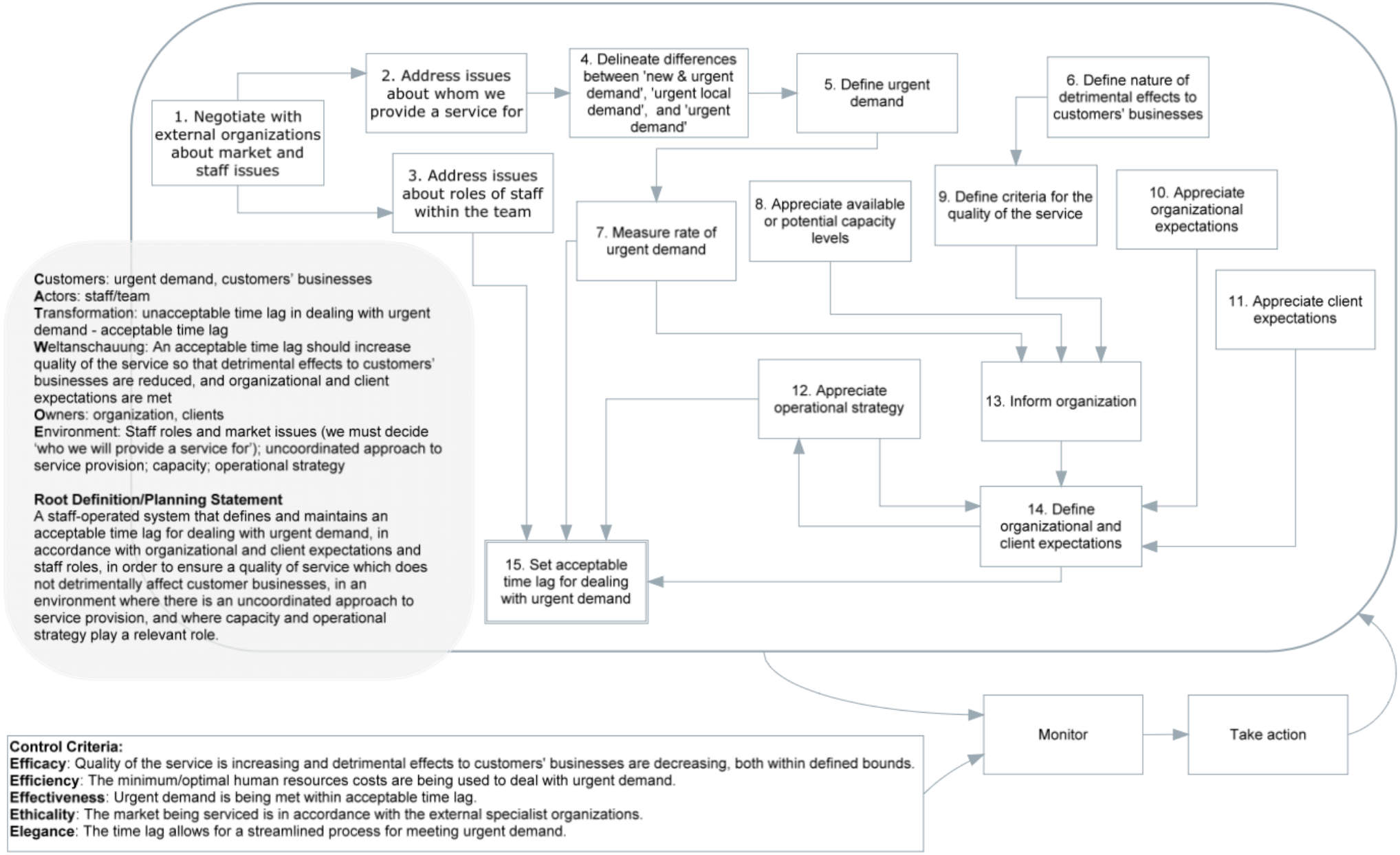
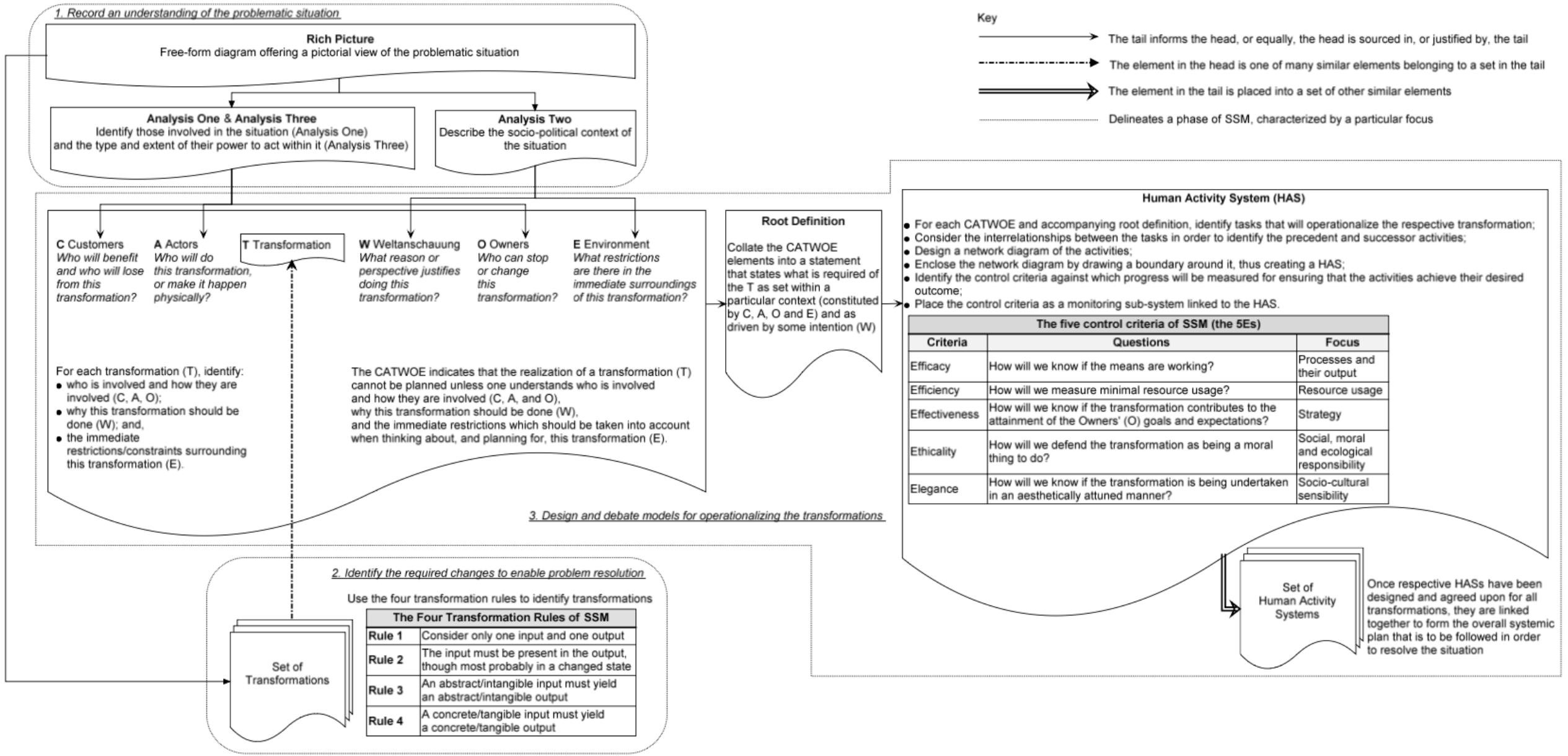


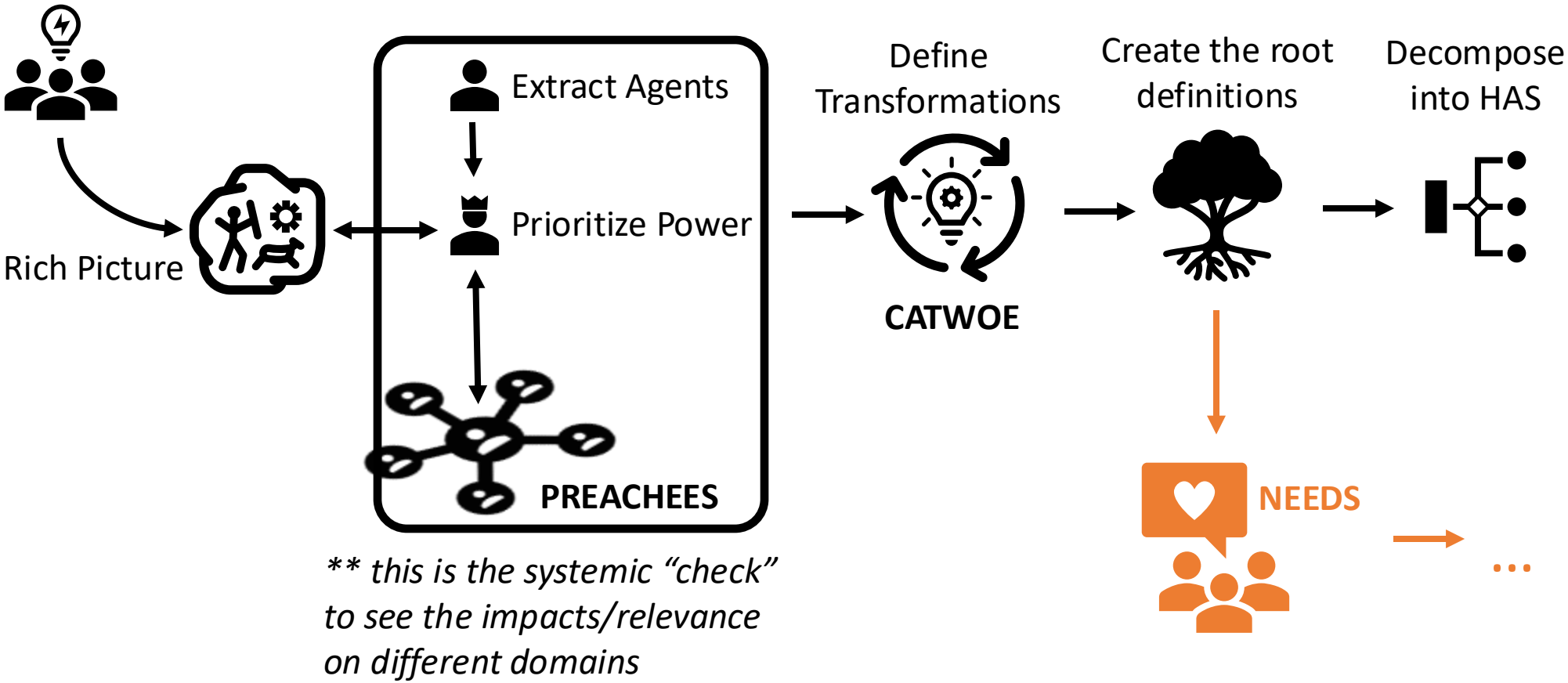
Figure 2 Individual systemic plan (human activity system) for the transformation T_1, unacceptable time lag in dealing with urgent demand → acceptable time lag

Note: The numbers of the activities are only for ease of reference and do not indicate priorities or sequences.

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Chris's view of the process



*** this is the systemic "check" to see the impacts/relevance on different domains*

Use case

MODELING FUNCTIONALITY WITH USE CASES

Use case diagram introduction

- Use cases describe the **functionality of a system in terms of how it is used to achieve the goals** of its various users. The users of a system are described by **actors (stakeholders)**, which may represent external systems or humans who interact with the system.
- Use cases can also be **classified using generalization**, but in addition, one use case may **include or extend** other use cases. Actors are related to the use cases in which they participate.
- Use cases have been viewed as a mechanism to capture system requirements in terms of the uses of the system.

Example of the use case diagram

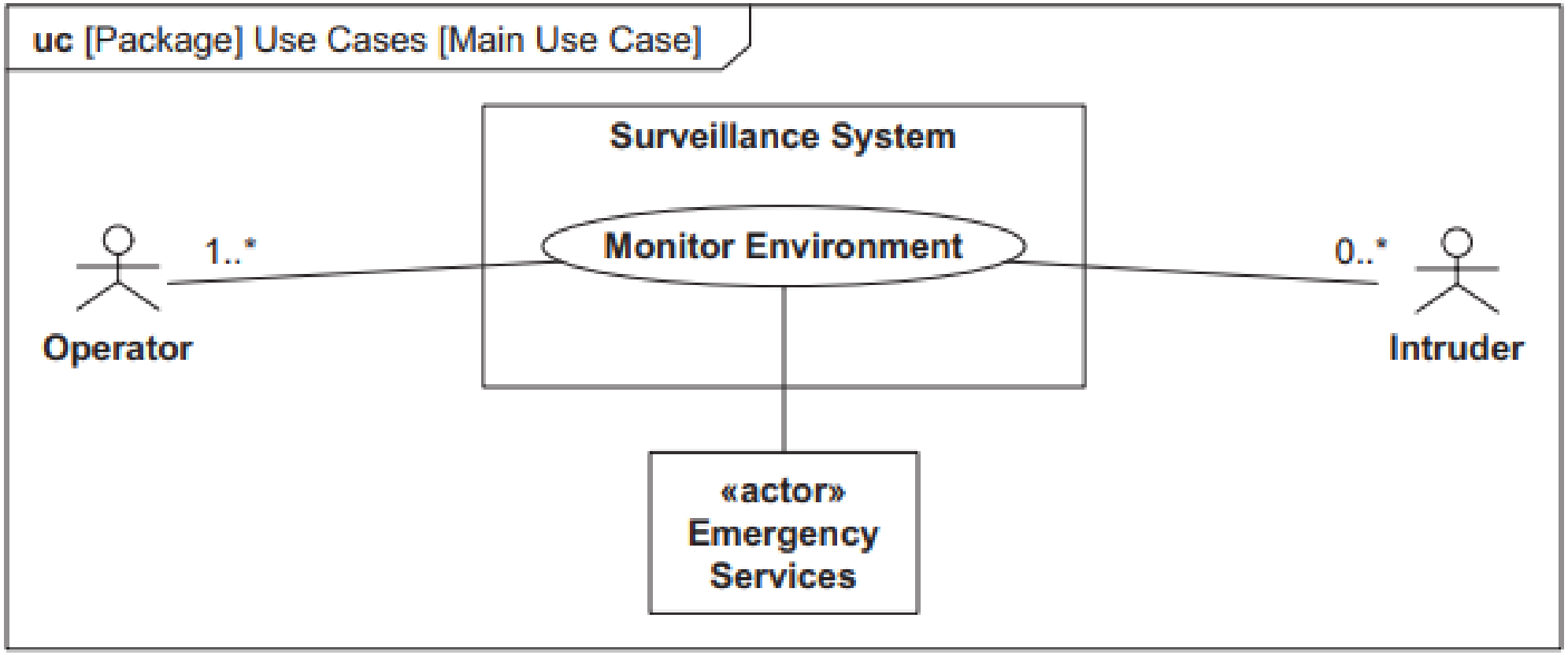


FIGURE 12.1

Example use case diagram.

Actors

- An actor is used to represent the **role of a human**, **an organization, or any external system** that participates in the use of some system.
  - Actors may interact directly with the system or indirectly through other actors.
  - Actors can be classified using the standard **generalization** relationship.
- **Actor classification** has a similar meaning to the classification of other classifiable model elements.
- For example, a specialized actor participates in all the use cases that the more general actor participates in.

Representing actors and their interrelationships on a use case diagram.

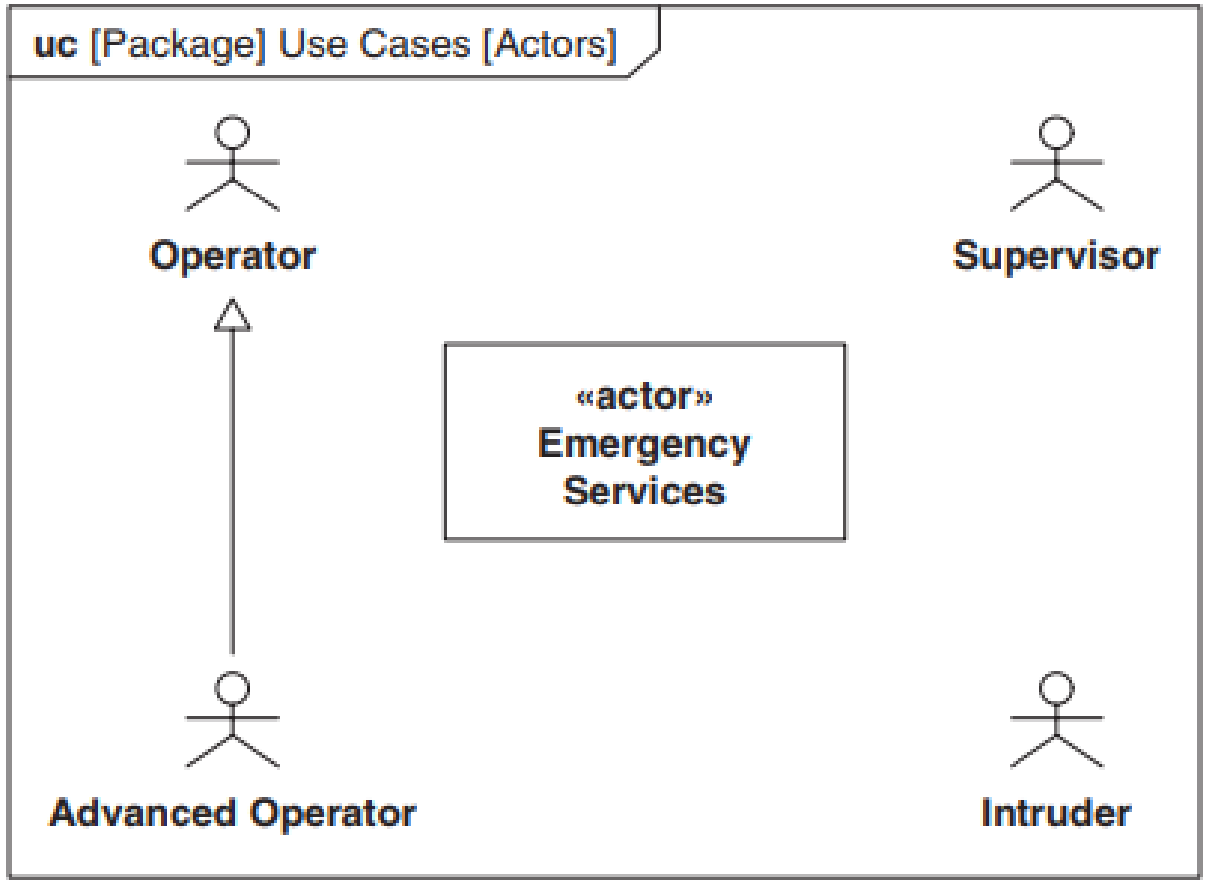


FIGURE 12.2

Representing actors and their interrelationships on a use case diagram.

Use cases

- A use case **describes the goals of a system** from the perspective of the users of the system.
- The goals are described **in terms of functionality that the system must support**. Typically, the use case description identifies the goal(s) of the use case, a **main pattern** of use, and a number of **variant** uses.
- A **use case may cover one or more scenarios** that correspond to how the system interacts with its actors under different circumstances.
- Actors are related to use cases by communication paths, which are represented as associations, with some restrictions.

Use case relationships (inclusion / extension/classification)

- The **inclusion** relationship allows one use case, referred to as the base use case, to include the functionality of another use case, called the included use case. **The included use case is always performed when the base use case is performed.**
- A use case can also **extend** a base use case using the extension relationship. The extending use case is a fragment of functionality that **is not considered part of the base use case functionality**. It often describes some exceptional behavior in the interaction, such as error handling between subject and actors that does not contribute directly to the goal of the base use case
- The meaning of **classification** is similar to that for other classifiable model elements. One implication, for example, is that the scenarios for the general use case are also scenarios of the specialized use case. It also means that the actors associated with a specialized use case can also participate in scenarios described by a general use case.

A set of use cases for the Surveillance System

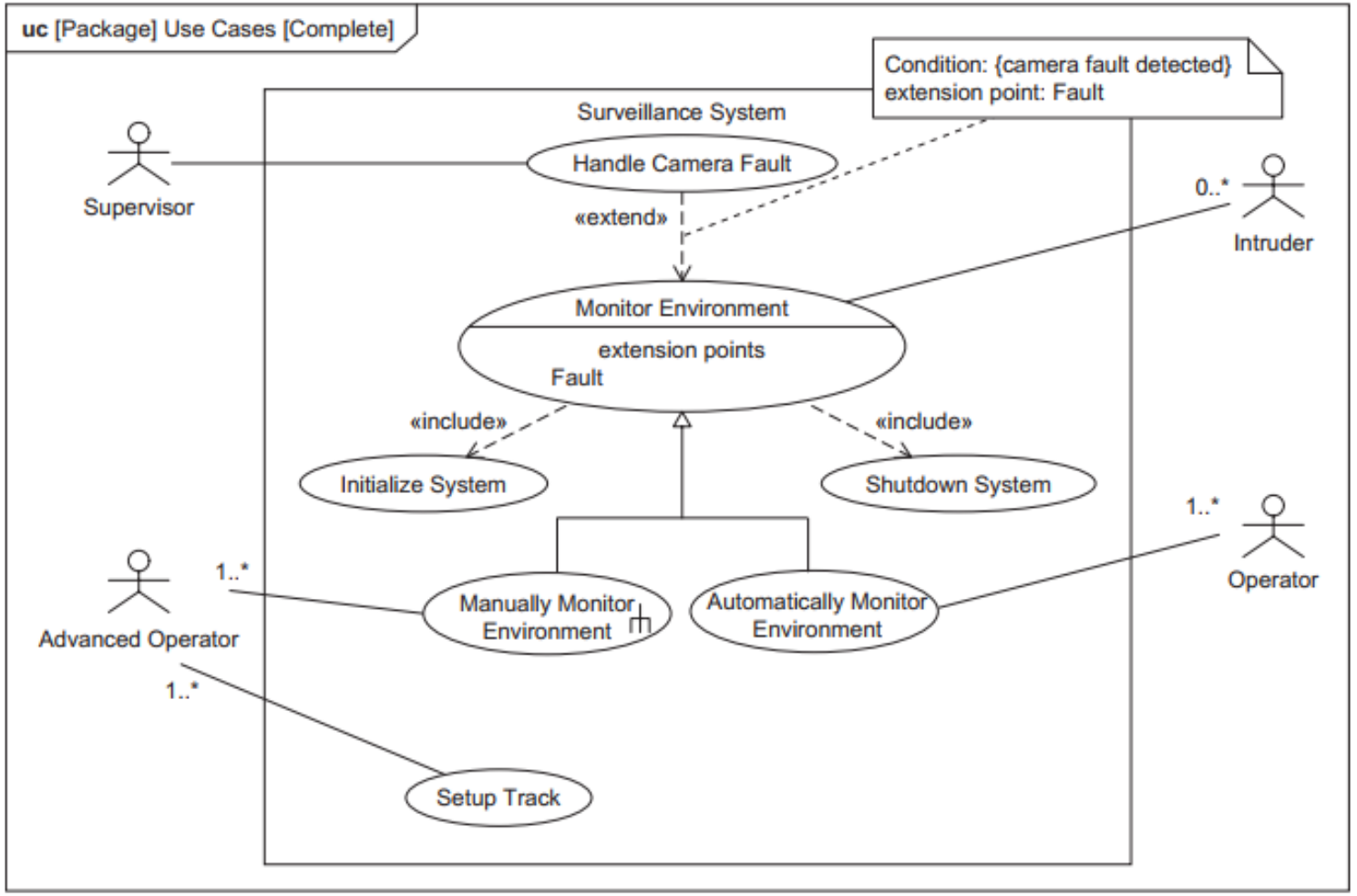


FIGURE 12.4

A set of use cases for the *Surveillance System*.

A typical use case description might include the following fields

- *Pre-conditions* - The conditions for the use case to begin.
- *Post-conditions* - the conditions after the completion of the use case.
- *Primary flow* - The most frequent scenario or scenarios of the use case.
- *Alternate and/or exception flows* - the least frequent or non-nominal scenarios. Exception flows can reference extension points and often represent flows that don't directly support the goals of the primary flow.

Here is an extract from the use case description for *Monitor Environment*:

Pre-condition

The *Surveillance System* is powered down.

Primary Flow

The *Operator* or *Operators* will use the *Surveillance System* to monitor the environment of the facility under surveillance. An *Operator* will initialize the system (see *Initialize System*) before operation and shut the system down (see *Shutdown System*). During normal operation, the system's cameras will automatically follow preset routes that have been set to optimize the likelihood of detection.

If an *Intruder* is detected, an alarm will be raised both internally and with a central monitoring station, whose responsibility it is to summon any required assistance. If available, an intelligent intruder tracking system—which will override the standard camera search paths—will be engaged at this point to track the suspected intruder. If an intelligent intruder tracking system is not available, the *Operators* are expected to maintain visual track of the suspected intruder and pass this knowledge on to the *Emergency Services* if and when they arrive.

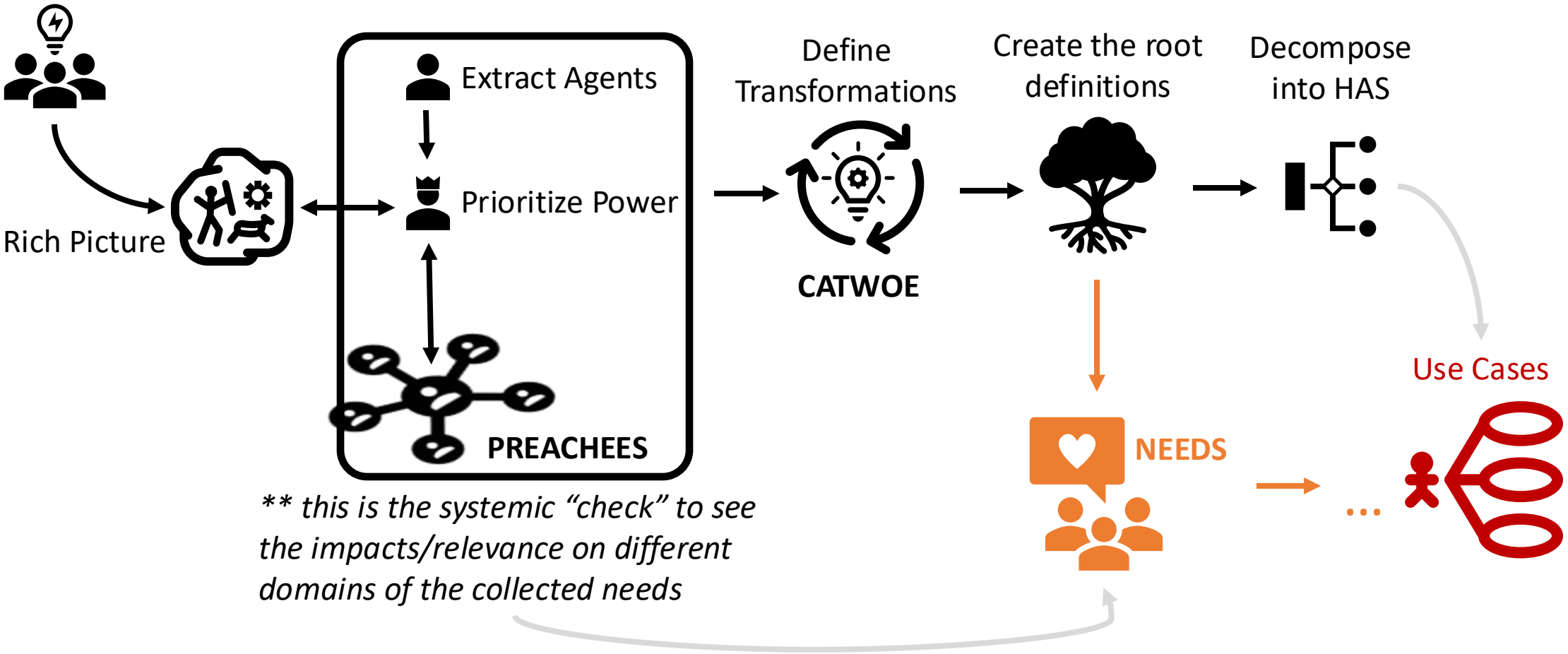
Alternate Flow

Immediately after system initialization but before normal operation begins, it is possible that a fault will arise, in which case it can be handled (c.f. *Fault* extension point), but faults will not be handled thereafter.

Post-condition

The *Surveillance System* is powered down.

Chris's view of the process



Transform the needs to the use cases

- Step 01 – Identify actors
- Step 02 – Identify the system
- Step 03 – Extract the use cases
- Step 04 – Interlink use cases and actors

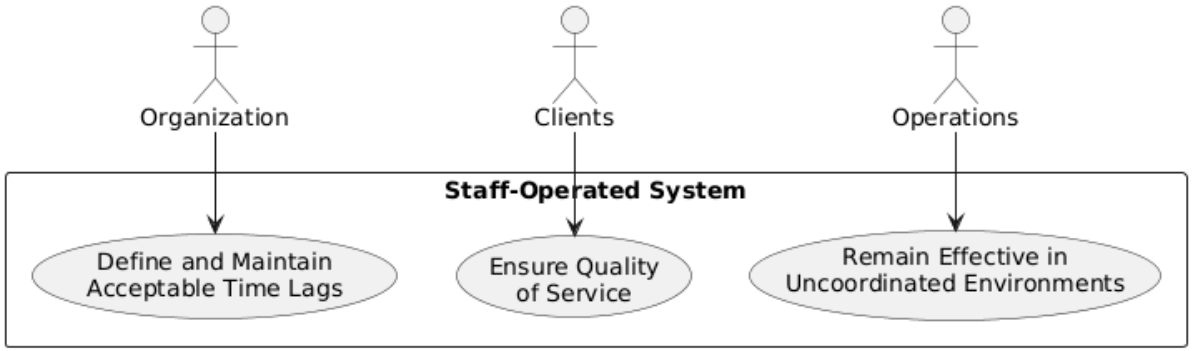
User Needs (INCOSE Format)

1. **The organization** needs the staff-operated system to define and maintain acceptable time lags for responding to urgent demands.
2. **The clients** need the staff-operated system to ensure quality of service services that do not negatively affect their business operations.
3. **The operations** need the staff-operated system to remain effective in environments with uncoordinated service provision.

```
@startuml
        actor Organization
        actor Clients
        actor Operations

        rectangle "Staff-Operated System" {
                usecase "Define and Maintain\nAcceptable Time Lags" as UC1
                usecase "Ensure Quality\nof Service" as UC2
                usecase "Remain Effective in\nUncoordinated Environments" as U
        }

        Organization --> UC1
        Clients --> UC2
        Operations --> UC3
@enduml
```



https://www.plantuml.com/plantuml/uml/SyfFKj2rKt3CoKnELR1Io4ZDoSa70000

Use Case 1: Define and Maintain Acceptable Time Lags

Pre-condition

The Staff-Operated System is powered down.

Primary Flow

The Organization initializes the system and configures service thresholds. The system records the organizational definition of acceptable time lags. Staff-operated mechanisms monitor incoming urgent demands. If urgent demand is detected, the system measures response time against the threshold. If the response is within acceptable limits, the event is logged as successful. If the response time exceeds limits, an alert is issued to management for corrective action.

Alternate Flow

If the system detects conflicting thresholds from multiple organizational policies, it will prompt the Organization to reconcile them before continuing.

Post-condition

The Staff-Operated System has stored acceptable time lag thresholds and monitoring results.

Elicitation Practice

Theme: **Smart City Traffic Light Coordination -** Use inputs from sensors, manual override, pedestrian crossing requests.

- The mission of the Smart City Traffic Light Coordination System is to enhance the safety, efficiency, and sustainability of urban mobility. The system shall manage multiple intersections by integrating real-time data from road sensors, operator commands, and pedestrian crossing requests. It shall dynamically adjust traffic signal patterns to reduce congestion, minimize travel delays, and provide safe crossing opportunities. The system shall accommodate manual overrides for emergency and special events, giving city operators the ability to impose priorities when necessary. It shall also ensure rapid clearance routes for emergency vehicles, while balancing the needs of everyday commuters and pedestrians. Operating within the constraints of city regulations, legacy infrastructure, budget limitations, and environmental concerns, the system shall aim to reduce vehicle emissions and improve the overall quality of life for urban residents.

Rich picture



Group / Case:

X / **Smart City Traffic Light Coordination**

Analize 01 (3 actors):

City Traffic Operators (control center staff)
Pedestrians (safety + crossing requests)
Drivers (road users affected by congestion)

Analize 02 (3 dimensions):

Political: City council demands congestion reduction and improved safety.
Economic: Traffic delays cost fuel, time, and productivity.
Social: Public pressure for fair pedestrian treatment and smoother traffic flow.

Analize 03:

City Traffic Operators → can configure, activate overrides, and set emergency priorities.
Pedestrians → can request crossings, influence political for safeness.
Drivers → create demand, cause congestion, and exert pressure for efficiency

C **Customers (C):** Drivers and pedestrians benefit from smoother flow and safer crossings.

A **Actors (A):** City traffic operators configure and monitor the system.

T **Transformation (T):** From uncoordinated traffic lights to coordinated signals across intersections.

W **Weltanschauung (W):** Coordinated signals reduce congestion and delays, creating safer, more efficient mobility.

O **Owners (O):** City government / transport authority decides whether the system is implemented.

E **Environment (E):** Legacy infrastructure, limited budget, city regulations.

C **Customers (C):** Pedestrians (shorter, safer waits); drivers (less risky jaywalking).

A **Actors (A):** City traffic operators and automated timing algorithms.

T **Transformation (T):** From excessive pedestrian waiting at crossings to balanced waiting times that ensure safety and mobility.

W **Weltanschauung (W):** Balancing pedestrian needs with vehicle flow improves safety, fairness, and public trust in the system.

O **Owners (O):** City government / transport authority.

E **Environment (E):** Minimum legal crossing times, high vehicle demand at rush hour, weather conditions.

Root Definition:

A city-operated system that coordinates traffic light signals across intersections using operator inputs, in order to reduce congestion and delays for drivers and provide safer crossings for pedestrians, within the constraints of city regulations, legacy infrastructure, and budget limitations.

Needs:

Need 1 - **The city government** needs the traffic light coordination system to reduce congestion and delays for drivers across multiple intersections.

Need02 - **The pedestrians** need the traffic light coordination system to provide safer and more predictable crossing opportunities.

Root Definition:

A city-operated system that balances pedestrian wait times at crossings through operator actions and automated timing algorithms, in order to improve safety and fairness for pedestrians while supporting vehicle mobility, within the constraints of legal crossing requirements, traffic demand, and environmental conditions.

Needs:

*Need03 - **The pedestrians** need the traffic light coordination system to balance waiting times so that crossing opportunities occur within acceptable limits.*

*Need04 - **The drivers** need the traffic light coordination system to maintain smooth vehicle flow while accommodating pedestrian safety and fairness.*

Use Case Diagram

