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Topic 45
Domain Acquisition

- The **prerequisite** for following this (part of the) lecture is that you now know what should go into a domain model: Descriptions of its intrinsics, its business processes, its supporting technologies, its management and organisation, its rules and regulations, their scripts, and the variety of human behaviours, and, possibly, many more facets.

- The **aims** are

  ⋆ that you will now know how to gather facts about the domain, and

  ⋆ that you will then know how to organise those facts for subsequent analysis.

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- The **objective** is

  ⋆ that you will competently lead and carry out thorough acquisition of domain facts from domain stakeholders.

- The **treatment** is pragmatic and systematic.

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Introduction

Characterisation 12.185 *Domain Acquisition:* By *domain acquisition* we shall understand

- the process of obtaining facts about the domain, that is,

  ⋆ of *eliciting* (i.e., capturing) facts from domain stakeholders,

  ⋆ of *writing* down descriptions about them,

  ⋆ and of roughly *structuring* (i.e., roughly organising, roughly *classifying*) these descriptions

  .　∎

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- The term *elicitation* is thus not synonymous with *acquisition*.

- *Elicitation* stands for part of the acquisition process.

- The *structuring* (organising or *classifying*) is meant as not being based on any serious, nontrivial analysis — that comes later!

- It is just an *indexing* for purposes of making easy some process of *search* for *domain description units* having specified *properties*.

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- Acquisition involves *stakeholders*, and usually many of them.

- And acquisition involves writing something down, namely: *domain prescription units*.

- *Elicitation* is difficult. So we shall further investigate that concept.

- But first, let us examine what it is we have to elicit, to extract, to capture, namely *domain facts*.

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Domain Facts

Characterisation 12.186 By *domain facts* we shall understand

- what is conceivable of as

  ⋆ (manifest) phenomena

  ⋆ or (intellectualised) concepts

  of the domain,

- whether as properties

  ⋆ of entities, or

  ⋆ of functions, or

  ⋆ of behaviours (processes with events)

  .　∎

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2.1.2 Elicitation of Domain Facts　　Institute of Informatics and Mathematical Modelling
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Elicitation of Domain Facts

Characterisation 12.187 By *elicitation of domain facts* we mean

- a process of *studying* the domain, that is,

  ⋆ of *reading about* the domain.

  ⋆ Of *talking with*, *interviewing*, domain stakeholders.

  ⋆ Of yourself, or stakeholders, *recording* (possibly aided by *questionnaires*) your, or their conception — i.e., perspective or views — of the domain,

  ◇ that is, the properties of the entities, the functions, the behaviours, including the events of the domain.

  ◇ These are either *phenomenological*, i.e., are actually manifest,

  ◇ or are *conceptual*, i.e., are "intellectualised", in the domain

  .　∎

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Recording Domain Facts

Characterisation 12.188 By *recording domain facts* we shall understand

- a not necessarily systematic, nor coherent or complete,

- writing down of "bits and pieces" of rough-sketch descriptions

- of one or another fragment of a domain,

- such that each of these bits and pieces forms a *unit of domain description*

- which is then suitably *indexed* (i.e., *classified*, categorised, named)

.

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Characterisation 12.189 • Roughly, an *index* of a *unit of description* is a marking

★ as to one or more categories of
◇ the name of the phenomena or concept being recorded, and/or
◇ the names of the stakeholders, and/or
◇ a category name for the stakeholder group, and/or
◇ whether the unit describes a phenomenon or a concept, and/or
◇ the type of the phenomenon or concept (entity, function, behaviour), and/or
◇ the type of the attributes and/or
◇ the type of the domain facets

.   ■

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Characterisation 12.190 By *unit of domain description* we shall understand

• some informal or formal, usually rough-sketch text
★ which starts describing something,
★ or which adds to a description of something,

• with the unit description being annotated by some initial classification,

• such that the unit description forms a whole (e.g., a complete sentence)

.   ■

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• A unit of description is, deliberately, a loose notion.

• It reflects the nature of the elicitation process.
★ This process is exploratory, even experimental:
◇ The persons involved in the elicitation process,
◇ normally, at the outset of elicitation, do not know where the elicitation process will take them,
◇ that is, what will evolve!

• Eventually, a "large body" of units of domain descriptions,
★ that is, of recordings of domain facts,
will evolve.

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Example 12.153 *Units of Domain Descriptions:* We give three examples of units:

• A railway net consists of lines and stations.
★ *Initial (rough) classification:*
◇ stakeholder: *Miss AA, passenger;*
◇ phenomena/concept type: *phenomena: entity;*
◇ attribute: *static;*
◇ facet: *intrinsic;*
◇ phenomena names: *railway net, line, station.*

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• One may perform the following operations involving simple demand/deposit bank accounts: opening, deposit, withdrawal, transfer, obtaining a statement (of past operations) and closing.

★ *Initial (rough) classification:*
◇ stakeholder: *Mrs. BB, bank teller;*
◇ primary phenomena/concept types: *phenomena: entity;*
◇ secondary phenomena/concept types: *phenomena: functions;*
◇ attributes: *inert* (for primary and secondary phenomena);
◇ facet: *intrinsic* (for primary and secondary phenomena);
◇ primary phenomena name: *demand/deposit bank account;*
◇ secondary phenomena names: *demand/deposit, open, deposit, withdrawal, transfer, statement, close.*

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• An aircraft journey consists of a sequence of two or more airport visits.
★ *Initial (rough) classification:*
◇ stakeholder: *Mr. CC, pilot (captain);*
◇ phenomenon/concept type: *concept: behaviour;*
◇ attribute: *dynamic;*
◇ facet: *intrinsic;*
◇ phenomena names: *aircraft journey, airport visit, ...*

■

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• We observe, from the above examples,
★ that often the unit text is (far) shorter than the classification.
★ And that the classifications need to be refined into
◇ primary and
◇ secondary
phenomena and concept
◇ types,
◇ attributes and
◇ facets.

• We refrain from detailing possible forms of units and their classifications.

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Indexing Domain Description Sketches

Characterisation 12.191 By an *index* we shall understand a "naming" of

• phenomena and/or concept names;

• a stakeholder group and one or more persons of that group;

• whether the primary (i.e., the defining) and secondary (i.e., the using) ideas are phenomena or concepts;

• the kind of primary and secondary phenomena or concepts: whether entities, functions, events or behaviours;

• relevant domain attributes;

• relevant domain facets: intrinsics, support technology, etc

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- Indexing is basically an informal endeavour.

- Indexing is carried out in order to facilitate the search for some properties:

  ⋆ as to the name of entity, function, event or behaviour; or

  ⋆ as to stakeholder group or person; or

  ⋆ as to whether a phenomenon or a concept; or

  ⋆ as to entity, function, event or behaviour; or

  ⋆ as to attribute kind; or

  ⋆ as to facet category.

- That is, we envisage that the domain engineer, in the analysis process, may wish to review several domain description units with respect to some (logical) criteria that involve one or more of the above-listed classification categories.

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Characterisation 12.192 By *indexing domain sketches* we shall understand

- a process of

  ⋆ equipping, i.e., of annotating,

  ⋆ domain description units,

  ⋆ with one or more classification indexes,

- where these distinct indexes cover

  ⋆ phenomena or concept names,

  ⋆ stakeholder kinds and person names,

  ⋆ phenomena or concept kinds and types,

  ⋆ domain attributes and

  ⋆ domain facets

. ∎

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The Acquisition Process

- The acquisition process now, typically, proceeds, in one or (usually) more rounds (i.e., cycles) of each of the "steps" as now listed:

  ⋆ *Review of stakeholder index, etc.:*

    ◇ Is such a listing of "all relevant" stakeholders established?

    ◇ If so, is it adequate?

    ◇ If not, then establish it, and review.

    ◇ Establishment of contact to, i.e., liaison with, identified stakeholder groups and persons.

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⋆ *Study of domain documents:*

  ◇ Gathering such documents from various sources: stakeholders, libraries (books, journals), research centres, the Internet, etc.;

  ◇ evaluation of relevance of such documents;

  ◇ reading of relevant documents; and

  ◇ preparation for the recording of domain description units (see below).

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⋆ *Casual talks with stakeholders:*

  ◇ Initial, "loosening up" talks, i.e., chats, in person, with stakeholders,

  ◇ for the purposes of establishing "rapport", i.e., confidence, trust,

  ◇ including preparation for the recording of domain description units (see below).

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⋆ *Systematic, questionnaire-based interviews of stakeholders:*

  ◇ Formulation and "printing" of questionnaires;

  ◇ distribution, or personal handing out of questionnaires;

  ◇ gathering of more or less completed questionnaires;

  ◇ and preparation for the recording of domain description units.

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⋆ *Recording of domain description units:*

  ◇ There is the recording done by either the stakeholders, or by the (domain engineer) interviewers;

  ◇ and there is the result of this recording: a document consisting of one or more domain description units.

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⋆ *Classification of domain description units:*

  ◇ Each domain description unit is then briefly examined, individually,

  ◇ i.e., separately from the examination of other domain description units,

  ◇ and to each is affixed as many of the domain description unit attributes as are relevant and as can be ascertained.

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2.2 The Acquisition Process

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★ *Review of domain acquisition process:* Once, what is believed to be, at some point in time, "all" domain description units — once all these have been received and indexed,

  ⬦ they are examined as to whether those that have been elicited form a necessary and sufficient collection,

  ⬦ whether they truly represent what has been said, i.e., are "vetted" for accuracy,

  ⬦ or whether some need to be rejected, and/or more may be needed.

- We will now treat several of the above "steps" in some detail.

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1 Stakeholder Liaison

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Stakeholder Liaison

- We can assume that a list of all possibly relevant domain stakeholders has been established and reviewed by all parties to a contract of development of a domain description.

- Now comes the effectuation, the liaison and interaction with what is considered appropriate, identified members of those domain stakeholder groups who are deemed relevant for a successful completion of that development.

- The contract must secure timely availability of both the domain development engineers and the identified domain stakeholders.

- Let us refer to the latter as the domain stakeholder representatives.

- A pair of managers from, respectively, the domain development engineers and the stakeholders must ensure an ongoing, free and timely use of the time resources of the domain development engineers and the identified domain stakeholders.

- It is that act of ensuring we could call the domain stakeholder liaison.

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2.2.2 Elicitation Studies

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Elicitation Studies

- Well-nigh every application domain has its literature,

  ★ one, which in one form or another
  ★ more or less explicitly hints at
  ★ descriptions of one or another segment of the domain.

- Please observe the hedges incorporated in this last sentence.

- By this we mean that it is not always that obvious to find good, written descriptions of every domain.

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2 Elicitation Studies

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- **Air Traffic:** ICAO, the International Civil Aviation Organization

  ★ publishes journals and reports,
  ★ organises Air Navigation and other conferences, manuals, etc.,
  ★ on such subjects as airport, air traffic control, air navigation, etc.

- **Railway Systems:** UIC, the International Union of Railways likewise publishes journals, reports,

  ★ thematic periodicals,
  ★ thematic bibliographies,
  ★ follows European railway system legislation,
  ★ etc.

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2.2.2 Elicitation Studies

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- **Ports and Harbours:**

  ★ The International Association of Ports and Harbors' home page lists publications of journals and proceedings from port and harbour conferences, etc.

  ★ The International Harbour Masters' Association home page provides some input to studies on ports and harbours.

  ★ The Port Technology International home page is likewise a promising source of information, and its 'Partners Page' lists partners with interests in the well-being of ports and harbours.

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2 Elicitation Studies

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- **Logistics:**

  ★ The Australian government's department of Transport and Regional Services home page provides interesting references to starting points for studies of the logistics domain.

  ★ So does the Logistics Management Institute home page.

  ★ The private, it seems, one-man firm Freightworld home page also seems to be a good reference source.

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2.2.2 Elicitation Studies

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- **Hospitals:**

  ★ The International Hospital Federation's home page is a good starting point for studying the domain of hospitals.

  ★ The Virtual Hospital home page is certainly a relevant source.

  ★ The European standards organisation CENELEC's page gives references to European Standardization of Health Informatics.

  ★ Finally, it seems that the Health Information Systems Special Interests Group page at the University of Aveiro, Portugal is worth consulting.

In other words: Internet-based search engines are primary instruments for information acquisition.

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3 Elicitation Interviews

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Elicitation Interviews

- The purpose of elicitation talks was to establish rapport and build confidence between each domain stakeholder group and the domain engineers assigned to capture domain facts from respective domain stakeholder group members.

- Instead we shall, in this part of the lecture, more closely examine the processes of interviews and their follow-up.

- To repeat,
  - ⋆ the domain engineer embarks on interviews by first preparing a customised questionnaire, one that is "fitted" to the specific domain at hand.
  - ⋆ The domain engineer meets one or more representatives of the designated stakeholder group in order to introduce them to the questionnaire.
  - ⋆ This introduction ("familiarisation") is done by "walking" through the questionnaire with these representatives, explaining terms to them, and by answering questions that might arise during this interview.
  - ⋆ Then these representatives are left to fill in their own copy of an identical questionnaire, either individually, or as a group.
  - ⋆ Members of the group are encouraged, before filling out the questionnaire, to contact their domain engineer for resolution of any "metaquestions", that is, questions about how to interpret the questions in the questionnaire.
  - ⋆ Finally, the questionnaire is believed completed and is returned to the group's domain engineer.

Elicitation Questionnaires

- But how is such a questionnaire formulated?
- And, is there only one round of questionnaire interviews?
- We can right away suggest that there should be as many rounds of questionnaire interviews as the domain engineer thinks necessary to cover the various domain stakeholder groups' perspectives in necessary and sufficient depth.
- That is, we cannot usually plan for how many rounds are needed.
- For an unfamiliar domain, one that has not been described before, domain acquisition is a research undertaking — and for such research we cannot beforehand determine the number of "rounds" needed.
- But we can give some general guidelines for how to formulate a questionnaire, and, after that, we will give an example of such a questionnaire.

General Guidelines: Questionnaire Structure and Contents

- We know, now, what a domain description should look like, what it should contain.
- Namely, at the least,
  - ⋆ it should contain an enumeration of domain stakeholders: their names and categories.
  - ⋆ It should contain descriptions within the chosen span and scope of the domain with respect to the following aspects:
    - ⋄ a set of description units that covers each applicable *facet*
      - ○ (intrinsics,
      - ○ support technologies,
      - ○ management and organisation,
      - ○ rules and regulations,
      - ○ human behaviour,
      - ○ and scripts),

- ⋄ i.e., a set of description units which emphasise the various *domain attributes*
  - ○ (temporal and spatial attributes,
  - ○ attributes of continuity, discreteness and chaos,
  - ○ static and dynamic attributes,
  - ○ tangibility attributes,
  - ○ dimensionality attributes,
  - ○ etc.).

- ⋄ Finally, it should contain a set of description units which,
- ⋄ for each facet, attribute, and "thing",
- ⋄ provide the type and some details of
  - ○ whether the "thing" is a *phenomenon* or a *concept,*
- ⋄ and specifically of what *kind* the phenomenon or concept is:
  - ○ entity,
  - ○ function,
  - ○ event or
  - ○ behaviour.
- So our questions should be such as to tempt the stakeholders to convey these *facets, attributes* and *phenomena* or *concept* kinds to the domain engineer.

Special Guidelines: Questionnaire Structure and Contents

- When outlining the questions concerning
  - ⋆ facets,
  - ⋆ attributes, and
  - ⋆ phenomena or concept kinds,

  the domain questionnaire
- must be tailored — "tuned" — with examples that are pertinent to the domain.
- In our next example we shall indicate that "tuning" with *italic font*.

Example 12.154 *An Example Questionnaire:* We show, over the next pages, a long example of a questionnaire directed at healthcare workers (nurses, porters, medical doctors, and the like) in a hospital.

- (0) Dear stakeholder, you are please asked to 'collect your thoughts', i.e., to concentrate on thinking — thoroughly, conceptually — about your work.
  - ⋆ (0.1) Not your work as you would like it to be, or to become,
  - ⋆ (0.2) but as you honestly believe it is, as it is.

  Please do not idealise it, or paint your own role pessimistically or optimistically, or in any other way express opinions about it. Please discuss it just as it is, objectively and loyally.

- (1) First we ask you (see questions (1.1 and 1.2) a little further down) to tell us about what we call the *entities* of your work, the things you can point to or the things that you can otherwise conceive.

  Typical entities of your work are such as (and now we enumerate a long list of such things) *people: patients, nurses, medical doctors, technicians, next-of-kin (of patients), etc.; materials: medicine, bandages, distilled water, etc.; tools: syringes, blood pressure meter, thermometer, etc.; documents: patient medical records, etc.; other facilities: wards (with beds, etc.), operating rooms (with their equipment), etc. And so forth.*

  - ⋆ (1.1) Please list, by naming them, the entities that you meet in your daily work, whether frequently, sometimes or seldomly.
  - ⋆ (1.2) For each entity listed please describe its characteristics, its properties and its use — not whether it is a good entity or a bad one.

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2.2.4.2 Special Guidelines: Questionnaire Structure and Contents | Technical University of Denmark
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- (2) Then we ask you (see questions (2.1 and 2.2) a little further down) to tell us about what we call the *functions* of your work, the things you do with entities.

  Typical functions of your work are such as (and now we enumerate a long list of such things) *inject, with a syringe, penicillin into a patient; create, edit or copy a patient medical record; transfer a patient from a ward bed to a movable bed, etc.*

  - ⋆ (2.1) Please list, by naming them, the functions that you perform in your daily work, whether frequently, sometimes or seldomly.
  - ⋆ (2.2) For each function listed please describe its characteristics: which things enter into doing the function, and which things result from having performed the function.

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- (3) Finally, we ask you (see questions (3.1 and 3.2) a little further down) to tell us about what we call the *behaviours* of your work, the procedural sequences of functions involving entities as well as *events* that trigger your work in different directions, etc.

  A typical behaviour of your work is, for example, *the process of interviews, analyses, diagnostics, treatment, etc., such as a patient undergoes during hospitalisation.* In more detail: *A patient hospitalisation behaviour starts with admission to the hospital — during which interviews, analyses, etc., takes place. Then it proceeds with referral to a ward, installation in the ward, etc. After, typically, a night, the patient for a surgery treatment is prepared for operation, conveyed to the operating room, made ready, the operation is performed, and the patient is put under observation in a special "wake-up" (i.e., intensive care) ward.* And so on.

  - ⋆ (3.1) Please list, by naming them, the behaviours that you observe, or participate in, in your daily work, whether frequently, sometimes or seldomly.
  - ⋆ (3.2) For each behaviour listed please describe its characteristics.

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- (4) Now we go back to item (1) and ask you to provide further details.
  - ⋆ What we want you to do is to tell us more about the entities you have listed and whose facets you have described.
  - ⋆ If during doing this you are reminded of entities that you encounter in your daily work, but which you forgot to first list, then please add them to your original list.
  - ⋆ Now for each entity please consider the following, what we call *facets:*
    - ◇ intrinsics, business process, support technologies, management and organisation, rules and regulations, human behaviour, etc.
    - ◇ Here the domain engineer explains, by using respective examples already understood from the domain, the concept of these facets.
  - ⋆ (4.1) For each entity of your list please go into detail and describe whether you consider it an intrinsic facet, a business process facet, a support technology facet, a management and organisation facet, a rules and regulations facet, a script facet, or a human behaviour facet.

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- (5) Now we go back to item (4) and ask you to provide further details.
  - ⋆ What we want you to do is to tell us even more about the entities you have listed and whose facets you have described.
  - ⋆ If during doing this you are reminded of entities that you encounter in your daily work, but which you forgot to first list, then please add them to you original list.
  - ⋆ Now for each entity please consider the following, what we call *attributes:*
    - ◇ temporal and spatial attributes, continuous, discrete and chaotic attributes, static and dynamic attributes, tangibility attributes, dimensionality attributes, etc.
    - ◇ Here the domain engineer explains, by using respective examples already understood from the domain, the concepts of these attributes.
  - ⋆ (5.1) For each entity of your list please go into detail and describe which attributes you think it enjoys: temporality and spatiality, continuity, discreteness and chaoticness, whether it is static or dynamic, and then which kind of dynamics it enjoys, its tangibility, and its dimensionality.

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- (6) Now we go back to item (3), behaviours, and ask you to provide further details.
  - ⋆ These details are concerned with such things as
    - ◇ whether the ordering of some functions being performed can be changed,
    - ◇ which events might occur and the reaction expected,
    - ◇ and what flow of people, material, information and control such events may designate.
  - ⋆ (6.1) For each behaviour that you have described,
    - ◇ please review whether actions of behaviours may occur in any order, or do occur in specific order;
    - ◇ and please name and describe what you consider important events:
    - ◇ the people, materials, information and control (stimuli) which partake in the events.

  ■

From domain to domain, and from case to case (i.e., contract to contract) the domain engineers may extend or shorten the above exemplified questionnaire.

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5 Elicitation Reports | Technical University of Denmark
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Elicitation Reports

- The domain engineer now assembles an elicitation report.
- Roughly it consists of all the reports received from solicited stakeholders,
- together with the domain engineer's "quick" assessment of these reports:
  - ⋆ their trustworthiness, as well as their
  - ⋆ indexing.
- We expect an elicitation report to be both electronically available, and available in paper form.

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2.3.1 Concept and Process Review | Technical University of Denmark
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Discussion
Concept and Process Review

- We have outlined important concepts of and steps in the domain acquisition process:
  - ⋆ the concepts of domain description units and their indices;
  - ⋆ the identification of and liaison with domain stakeholder groups and representatives;
  - ⋆ and the concept and formulation of domain acquisition questionnaires — as based on what we know of how a domain model is structured and what it must contain.

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1 Concept and Process Review | Technical University of Denmark
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  - ⋆ We also include in this list
    - ◇ the process of domain engineer studies of the domain;
    - ◇ the process of domain stakeholder interviews and domain stakeholder completion of questionnaires — cum writing domain description units;
    - ◇ the process of indexing;
    - ◇ and the process of evaluating whether a domain acquisition should be ended or continued.

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2.3.2 Process Iteration
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Process Iteration

- Domain acquisition, especially for "untrodden" domains, i.e., for new, unfamiliar domains, is an art.

- It hinges on being research-oriented.

- As already indicated it will certainly evolve in iterations,

- and hopefully these can be quickly ascertained as to whether they are converging rapidly enough, or not — or even diverging.

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3 Delineation: Acquisition and Analysis
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Delineation: Acquisition and Analysis

- We have decided here to present the domain acquisition process as separate from the domain analysis process.

- As two processes they interact:
  - ⋆ The latter may result in
  - ⋆ a call for resumption of the former.

- One might therefore, as the term "resumption" indicates, treat them as coroutines.

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2.3.3 Delineation: Acquisition and Analysis
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- To us, the essential difference is:
  - ⋆ The acquisition process is very stakeholder-intensive, and is centred around rough-sketching description units.
  - ⋆ On the other hand, the analysis process is not stakeholder-intensive, and is centred around analysing description documents, and in concept formation.

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4 Principles, Techniques and Tools
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Principles, Techniques and Tools

- We summarise:

Principles 12.74 The principle of *domain acquisition* is that of providing material which helps one

- to uncover inconsistencies and conflicts in human perceptions of the domain, and

- to discover such concepts as can be claimed to underlie the domain

. ■

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2.3.4 Principles, Techniques and Tools
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- This is truly a daunting task.

- It is, by its very nature, a task requiring training, more in science than in engineering.

- The principle, as formulated, also underlies the work of a natural science researcher when exploring nature.

- Commensurate with that, we formulate the next point.

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4 Principles, Techniques and Tools
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Techniques 52 The techniques of *domain acquisition*,

- besides all those clerical ones mentioned earlier in this lecture —
  - ⋆ review of and liaising with stakeholders;
  - ⋆ identifying, collecting and reading up on domain literature;
  - ⋆ casual, explorative talks with stakeholders;
  - ⋆ formulation of questionnaires and questionnaire-based interviews with stakeholders;
  - ⋆ recording the results of these interviews; and
  - ⋆ collecting and indexing domain description units —

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2.3.4 Principles, Techniques and Tools
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are also the

- review of these indexed domain description units, i.e., the "vetting" of their contents, so to speak.

- That is, ensuring
  - ⋆ that the set of indexed domain description units is necessary and sufficient, and
  - ⋆ that the set is accurate, and properly reflects bona fide stakeholder perspectives

. ■

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4 Principles, Techniques and Tools
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Tools 12.16 *Domain Acquisition:* Since the domain acquisition process is necessarily an informal one, the tools are:

- human reading and interviews,

- processing the recording of domain description units

- in a way that facilitates storage and retrieval,

- and which allows for specialised programs (queries) to be (later) expressed and performed with the aim of facilitating domain analysis

. ■