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Software Systems Engineering
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E-01: Requirements Engineering Fundamentals

Sample Solution

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Note: In particular, when creating diagrams based on textual descriptions, there are many other acceptable solutions – in addition to the solutions presented here.

Task 1: Activities in Requirements Engineering Processes

Task 1A: Identify the manifestations of the five RE activities in the exemplary process description. (Sample Solution)

Excerpts from an exemplary Requirements Engineering Process – Sample Solution included

Peter heads a team of requirements engineers (Peter, Vanessa, Martin, Hans, Jennifer und Andrea) responsible for specifying the requirements of the envisioned system to support and improve university teaching and administration. [*Management*: As a first start after the official start of the project, Peter plans the requirements engineering activities in detail. The responsibilities for the different steps to be performed in the course of the RE phase of the project are discussed in a team meeting.]

Vanessa is assigned the task of [*Elicitation*: conducting a workshop aiming at the identification of important system goals that students have in mind about the new system. The workshop involves nine representative students from different degree programmes, who were asked to participate by the university's administration. Vanessa starts the workshop with a brainstorming session to uncover and collect an initial set of goals. The students are very creative so that the brainstorming results in a multitude of goals.] [*Documentation*: Vanessa sketches the goals by short names, documents each goal on a separate sheet of paper, and pins them to a white board. Next, the goals are structured and organized by clustering related ones on the board, together with the students. However, they are not yet specified according to documentation rules.] [*Negotiation*: Each goal is further discussed with the students. It turns out that three of the participating students actually do not consider the goal "Internship market", which was mentioned by another student before, as important. It is agreed that the majority of students will probably not benefit from such an internship market. Hence, Vanessa suggests removing this goal, and eventually there are no objections.] [*Documentation*: Once the workshop is over and the students are released, Vanessa creates a goal model using the modelling editor "Goal+", which supports the company-wide established standard of documenting goals, in order to specify the goals and their relationships formally and in more detail.] [*Management*: She stores the goal model in the Requirements Management System eventually.]

[*Elicitation*: The next day, Martin interviews an experienced lecturer as representative of this user group. The lecturer mentions a similar university information system called "TeachSupport 2", which he got to know at the nearby partner university he recently visited.] Though this very old system is no longer maintained by the authorities, and has some severe limitations regarding the support of teaching activities, it is still in use today. [*Management*: Martin informs Peter about this legacy system that he found worthwhile to take into account when developing the new system. Peter agrees, and consults a contact person at the partner university to learn more about TeachSupport 2. Eventually, he

receives an invitation to get some insights into the workflows and processes of this university.] [*Elicitation*: In particular, the university kindly offers to demonstrate how lecturers and students actually use TeachSupport 2 in their daily activities. […] On site, Martin observes a lecturer uploading and providing course material for the students, as well as a student who then browses and accesses this material. Additionally, an administrative process that involves an employee of the examination office entering exam results into the TeachSupport 2 system, and sending out notifications to the students is demonstrated.] [*Management*: The examination officer hands him a copy of the TeachSupport 2 user manual, which also includes detailed descriptions of the interaction sequences that he has been presented.

Back in office, Martin hands Jennifer the user manual.] [*Elicitation*: Peter asked Jennifer to analyze this guidebook in order to identify the main user functions, as well as corresponding data elements. Jennifer takes her time to do so, and comes up with in total 18 high-level system functions that can be used by the students, lecturers, and the administration offices. Furthermore, she identifies the required input and produced output data of each function.] [*Documentation*: She documents all the relevant information about the identified functions in a table.] [*Validation*: Since she is not so familiar with this textual documentation format, she asks Hans to take a look at the table. Hans spots a few minor issues, but the overall quality of the functional descriptions is very good.]

[*Management*: Peter receives a mail saying that the university president has a pretty clear vision about the tasks and goals of the new university education system, which need to be taken into account. Furthermore, the president as administrative head of the university and additional stakeholder is the contact person to define and agree on budget and delivery constraints that will affect the whole project. Thus, new agreements have to be made.] [*Elicitation*: A first phone call reveals that the president's major concerns are about privacy and usability. Moreover, the new system shall better support the administrative processes; however, its introduction should preferably not require any severe organizational changes. To this end, the president's secretariat sends Peter the organizational structure chart and some flow diagrams illustrating the administrative processes of the examination and the registrar's office.] [*Management:* The secretariat also stresses the point that compliance with the country's data privacy acts and laws need to be assured in any circumstances. The university's data protection officer should be contacted in due time to clarify further details about additional privacy policies of the university.]

[…]

At the end of the first week of the project, [*Validation*: Peter analyses the course of requirements engineering activities that have been performed so far. His aim is to check the outcome of each of these activities against the expected quality, and identify weaknesses and drawbacks of the process. Doing so, Peter notices that two of the

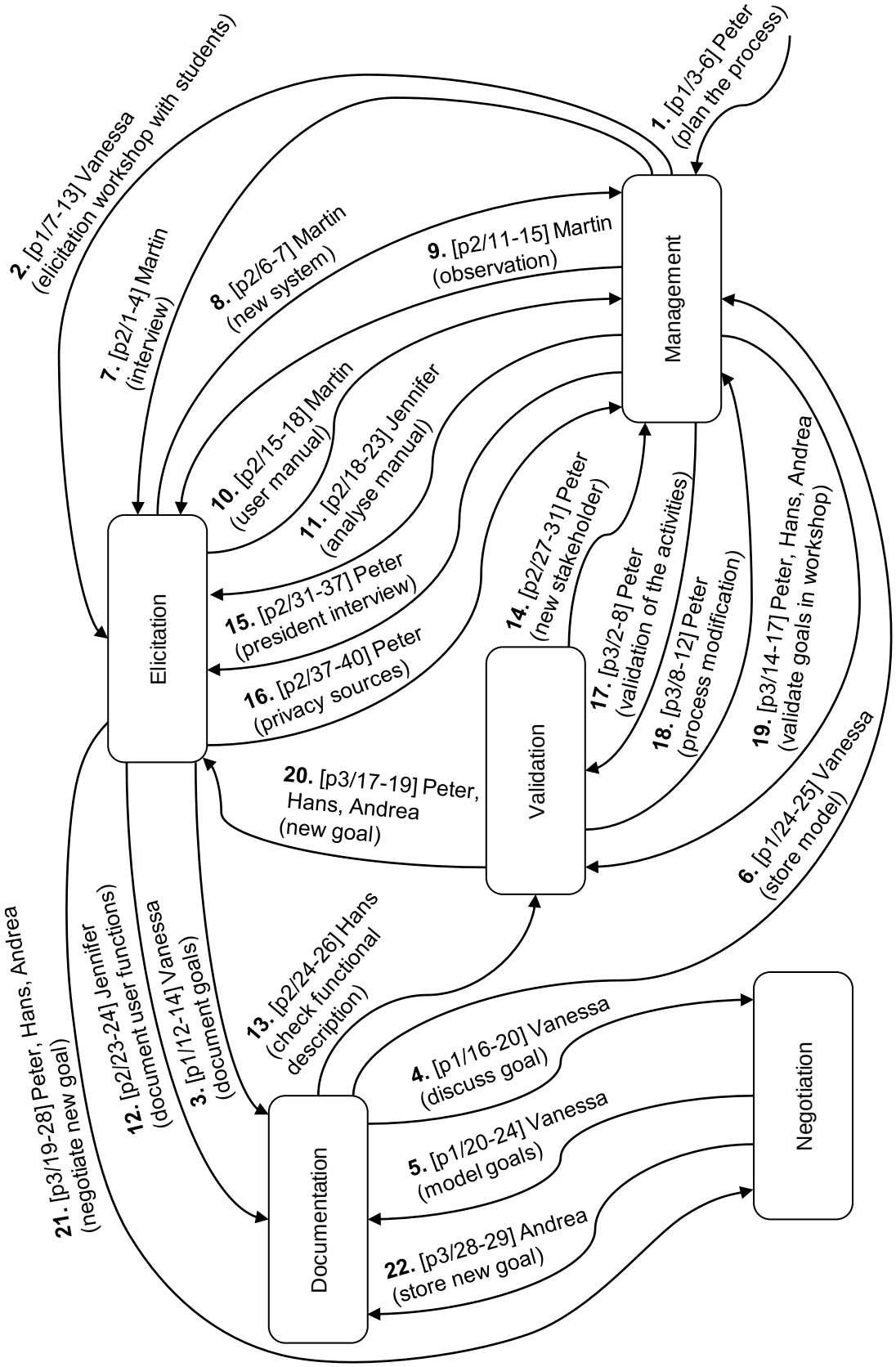
interviews conducted by his team did not lead to concrete results. In particular, many responses of the interviewees were not precise enough to derive concrete goals or requirements due to inaccurately specified interview questions.] [*Management*: As a consequence, Peter adapts the interview preparation process so that at least one other team member shall review a questionnaire before a certain interview is conducted with stakeholders. This requires more work, but will significantly enhance the quality of the interview activities. The company-internal process guideline for requirements is modified accordingly.]

[…]

[*Validation*: A few weeks later, Peter, Hans and Andrea present the goals elicited from the previously performed interviews to a group of examination officers. This workshop aims at checking if the corresponding scenarios of using the system are complete, and correctly reflect the stakeholder intentions.] [*Elicitation*: During the workshop, Mr. Smith, one of the invited examination officers, states an additional goal that has not been considered so far and writes it down on the board by using natural language. This goal indicates that he would like the system to generate exam certificates automatically.] [*Negotiation*: Hans asks the other workshop participants if they support this goal, or if they have any objections against adding it to the goal model. It turns out that indeed one colleague of Mr. Smith states he does not have this goal for himself, since he is used to the way this task is carried out in their current workflow. Hans asks Mr. Smith to explain why he considers this goal important for the new system. The explanation, which is actively discussed with the other participants, is convincing so that the other examination officer who was skeptical about the goal, finally agrees and understands the benefit of having a higher degree of automation in the examination processes.] [*Documentation*: Back in office, Andrea updates the goal model by including the additional goal according to the documentation rules.]

[…]

Task 1B: Go through the process description again, and illustrate the sequence of the performed process steps in a diagram. (Sample Solution)



Task 2: Requirements Sources

Task 2A: Identify the requirements sources that are mentioned in the process description. Classify each source into one of the three types of requirements sources. (Sample Solution)

No.	Requirements source	Requirements source type	Line reference (not comprehensive)
1	Each University of the country	Stakeholder (organization)	page 1
2	Students	Stakeholder (person)	page 1, lines 7-10
3	Lecturers	Stakeholder (person)	page 2, lines 1-4
4	University president	Stakeholder (person)	page 2, lines 27-29
5	Examination officers	Stakeholder (person)	page 2, lines 13-15, page 3, lines 14-15
6	Mr. Smith (Examination officer)	Stakeholder (person)	page 3, lines 17-19
7	Teach Support 2	Existing system	page 2, lines 2-4
8	Teach Support 2 user manual	Existing Documentation	page 2, lines 15-17
9	University Data Protection Officer	Stakeholder (person)	page 2, lines 38-40
10	Registrar office	Stakeholder (organization)	page 2, lines 35-37
11	Data Privacy acts and laws	Existing Documentation	page 2, lines 37-38
12	University privacy policies	Existing Documentation	page 2, lines 38-40

Task 3: The three Dimensions of RE

Task 3A: Consider the following paragraphs of the requirements engineering process description, and identify the progress evolution in the three dimensions. (Sample Solution)

Page 1, lines 7-25
Increase in the progress along the content dimension (page 1, lines 8-12): The elicitation workshop results in a set of additional requirements. This constitutes one step towards a complete set of requirements.
Decrease in the progress along the documentation dimension (page 1, lines 12-15): At this stage, the new goals are only documented in an ad-hoc manner, and not according to the documentation rules and formats.
Decrease in the progress along the agreement dimension (page 1, lines 16-18): Discussing the goals reveals that there are two opposite opinions regarding the benefit of the goal "Internship market". Hence the initial elicitation also results in a decrease in agreement, since there is no consolidated view on the new goals yet.
Increase in the progress along the agreement dimension (page 1, lines 18-20): Based on the discussion results, Vanessa solves the problem by removing the goal from the board.
Increase in the progress along the documentation dimension (page 1, lines 20-24): By using the model editor "Goal+", Vanessa documents the elicited and agreed goals in compliance with the companies policies related to goal modeling.
Page 2, lines 27-40
Decrease in the progress along the agreement dimension (page 2, lines 27-31): The university president is identified as an additional stakeholder, whose goals have not been considered yet. Thus, there are intentions and requirements that have not been captured by the requirements engineers yet.
Increase in the progress along the content dimension (page 2, lines 31-37): The university president is asked about his goals, resulting in a set of new requirements. Furthermore, the secretariat provides additional background information that helps understanding the elicited requirements.
Increase in the progress along the content dimension (page 2, lines 37-40): Again, an additional requirements source is identified, i.e., the privacy laws as well as the responsible person are mentioned by the university president's secretariat.
Page 3, lines 14-29
Increase in the progress along the content dimension (page 3, lines 17-19): During the validation workshop, a stakeholder states an additional goal. Uncovering this missing requirement contributes to a more complete set of requirements.
Decrease in the progress along the documentation dimension (page 3, lines 17-19): Since the new goal is not yet documented, its elicitation causes a step back along the documentation dimension.
Decrease in the progress along the agreement dimension (page 3, lines 22-24): Obviously, another stakeholder has a conflicting view on the new goal.

Increase in the progress along the agreement dimension (page 3, lines 24-28): The new goal is discussed by the stakeholders. Eventually, an agreement among all the participants is achieved.
Increase in the progress along the documentation dimension (lines 28-29): Finally, the new goal is added to the goal model. Thereby, the documentation is increased, since all the agreed goals are now again specified according to the documentation rules.

Task 4: Problems Originating from Insufficient RE

Task 4A: Analyze the situation descriptions w.r.t. to risks that may occur. (Sample Solution)

- Situation 1: *Lack of executive support*. Given that Mr. Miller's supervisor is against the introduction of the new system, it seems likely that Mr. Miller is not supported in participating in any corresponding activities. For instance, he might not be released from his regular tasks and responsibilities to have sufficient capabilities and resources to support Peter. This situation endangers the project success since subsequent activities will start with a delay.
- Situation 2: *Lack of involvement*. As the students' participation in the requirements activities are cut short, important requirements may not be elicited and thus remain unconsidered. This situation also threatens the success of the new system because it may not satisfy the unconsidered expectations. Hence, students might refuse to adopt the new system once it is in operation.
- Situation 3: *Requirements Changes – Volatile Requirements*. The new university administration has a different view However, it is to note that this situation may have been foreseen and avoided by thoroughly observing changes in the system context, since such a substantial change in the university's organization is usually planned in the long run. Obviously, there is the danger that other development artifacts that have been developed based on the requirements, are outdated as well.
- Situation 4: *Lack of involvement*. Similar to Situation 2, important stakeholders have not been involved in the requirements engineering activities. Here, they even have not been considered at all from the start. Again, this situation indicates insufficient context consideration during RE.
- Situation 5: *Incomplete Requirements*. Important requirements that were gathered in interviews got lost and were not implemented. As a consequence, the system fails in satisfying the needs of its users, and the success of the project is threatened. This situation exemplifies that all the subsequent development phases and activities depend on complete (and correct) requirements specification. For instance, testing, which is usually performed to validate a system against its documented requirements, did not detect this deficiency w.r.t. incomplete requirements.

Task 5: System Vision and Focus

Task 5A: Please think of and formulate two proposals of a system visions for "UniversityTeach plus". (Sample Solution)

"Introducing 'UniversityTeach plus' shall significantly improve the current examination, teaching and learning workflows."
"Lecturers, students, and examination officers shall be supported by partly automating their daily activities."

Task 5B: Analyze the following three system visions proposed by a colleague of yours. (Sample Solution)

- **Vision 1**: This vision is quite abstract in the sense that it covers a wide range of users and corresponding usage scenarios. For instance, lecturers, students, and the administrative personnel will need to be considered as stakeholders. The phrase "shall be supported in their daily activities" is also very vague since it might also cover activities that do not relate to the stakeholder's roles as student, lecturer, examination officers, or registrar's office employees, respectively.
- **Vision 2**: This vision sets the focus on supporting the employees of examination and registrar's offices. Furthermore, it mentions the process of processing student examination information, i.e., concrete data that is relevant for the system. Though the verb "to process" still leaves room for a variety of potential interpretations, it is easy to understand it in the given context of the specific offices, and the data that are in focus. Hence, it is very precise, and significantly restricts the solution space.
- **Vision 3**: Here, the level of granularity is similar to Vision 2. However, the focus is very different since this vision is focused exclusively on lecturers. Specific details of their support are omitted, but the focus is on teaching, which narrows the focus. A requirements engineering process based on this vision may involve eliciting requirements from students as well. However, since the vision focuses on lecturers, students' intentions will probably not be prioritized as high as the requirements elicited from lecturers.

Task 5C: Please name five real-world objects that are relevant for "UniversityTeach plus" for each of the three dimensions presented above. (Sample Solution)

- Vision 1:
  - Lecturers
  - Students
  - Examination officers
  - Exams
  - Courses
  - Lectures
  - […]
- Vision 2:
  - Examination officers
  - Registrar's office employees
  - Students
  - Exams
  - Exam results
  - Exam certificates
  - Grading system
  - Degrees
  - Study programs
  - Courses
  - […]
- Vision 3:
  - Lecturers
  - Lectures
  - Courses
  - Teaching material
  - Students
  - Lecture rooms
  - Exams
  -
  - […]

Task 6: Types of Requirements (Sample Solution)

Req. no.	Type	Quality requirement type	Explanation
Req-1	Constraint		This requirement refers to established policies that regulate the storage of data, and apply for the whole university.
Req-2	Functional requirement		The iteration describes a concrete function of the system. It is measureable and testable so that its execution can be checked with the implemented system. Furthermore, the requirement defines clear conditions in which the function is executed.
Req-3	Quality requirement	Integrity	This statement does not refer to a certain function, but rather affects the data elements it manages, i.e., the examination results.
Req-4	Constraint		This requirement refers to a non-negotiable policy of the university, which must be considered. This has a constraining influence on the functionality that is to be implemented.
Req-5	Quality requirement	Availability	This requirement specifies the required level of service in terms of the quality “availability”, which is specified in concrete numbers. The requirement impacts all the functionality the system provides.
Req-6	Functional requirement		Here, it is stated that the system shall provide the function of generating examination certificates. The requirement also describes to which external stimuli the system shall react by executing this function. Hence, it describes a testable system function.
Req-7	Quality requirement	Usability	This requirement describes a quality property of the functionality the system provides to register for exams. Though it defines a time constraint, it refers to usability, because efficient system usage is enabled, e.g., by an intuitive user interface.
Req-8	Constraint		This constraint defines a delivery deadline that is imposed by the management. Such management decisions typically affect the development process.
Req-9	Functional requirement		The nature of this requirement is functional since it refers to a concrete function that the system performs. Though not explicating in which situations the grade point average is actually calculated, the round function is a part of it.
Req-10	Quality requirement	Interoperability	This requirement describes a property of the system, which relates to its quality of interoperability. It affects the data management of the system, but cannot be associated with a specific functionality.

Req. no.	Type	Quality requirement type	Explanation
Req-11	Functional requirement		The requirement defines a specific functionality that the system shall provide. i.e., sending a notification to students. It also specifies the condition in which this function has to be performed (i.e., upon upload of new course material).
Req-12	Functional requirement		The requirement specifies a concrete function of the system, i.e., providing and submitting evaluation forms. The function can be executed upon request of a student, and the system can be tested in order to check the realization of this function. The anonymity has a qualitative notion, but the way it is phrased here emphasizes the focus on the functionality.