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Chapter 2

Requirements Engineering processes

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Objectives

- To introduce the notion of processes and process models for requirements engineering.
- To explain the critical role of people in requirements engineering processes.
- To explain why process improvements is important and to suggest a process improvement model for requirements engineering.

Processes

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- A process is an organized set of activities which transforms inputs to outputs.
- Process descriptions encapsulate(capture)knowledge and allow it to be reused.
- Examples of process descriptions:
  - An Instruction manual for a kitchen dishwasher describes the process of using that machine to clean dishes. The input to this process is a pile of dirty dishes and a dishwasher; the output is a dishwasher full of clean dishes.

Processes…..

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- A cookery book describes a set of processes to prepare and cook various different types of meal. The inputs to these processes are ingredients; the outputs are cooked meals.
- A quality manual for software development describes the processes which should be used to assure the quality of the software. It may include descriptions of standards which are the basis for the quality checking. The inputs here are documents and programs to be checked and the quality standards which must be followed; the outputs are reports of the quality assurance activities.

Design processes

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- Design processes are processes which involve creativity, interactions between a wide range of different people, engineering judgement and background knowledge and experience.
- Generally, the **inputs** to these processes are not exactly defined.
- There are many possible **outputs** which may result to satisfy these inputs.

Examples of design processes:

- The process of Writing a book: the **inputs** are background knowledge and experience plus other books and papers, and the **output** is the book that you are reading.

Examples of design processes:…

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- The process of organizing a conference: the **inputs** are background experience plus details of the type of conference, the expected size, details of local hotels etc. and the **outputs** are a conferences program, hotel reservations for delegates and so on.

- The process of designing a processor chip: the **inputs** are background knowledge and experience, details of current processors(compatibility is essential), details of fabrication technology, and the **outputs** are a processor design specification, a system simulator, etc.

Requirements Engineering process - inputs and outputs

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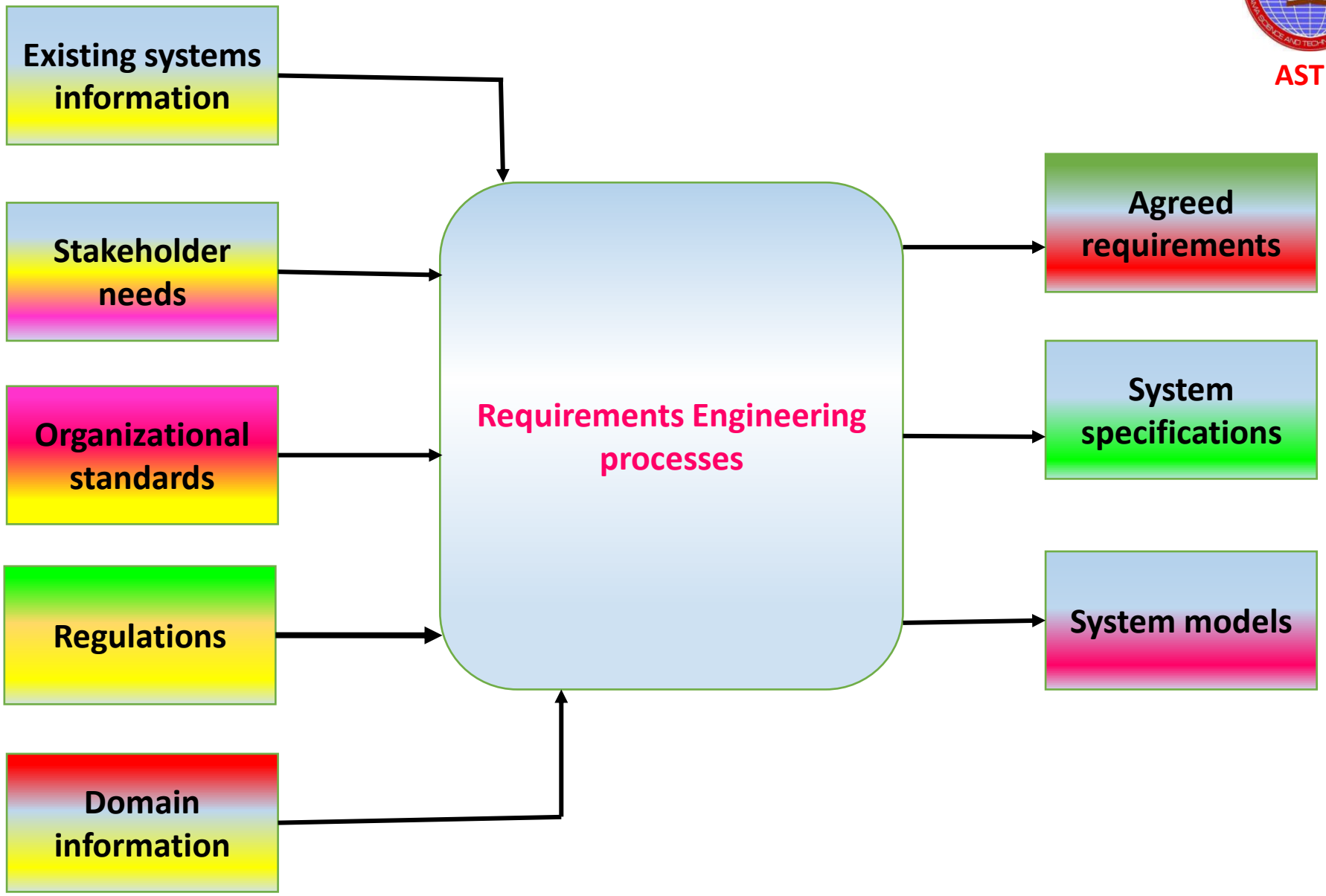

Input/output description

Input or output	Type	Description
Existing system information	Input	Information about the functionality of systems to be replaced or other systems which interact with the system being specified
Stakeholder needs	Input	Descriptions of what system stakeholders need from the system to support their work
Organizational standards	Input	Standards used in an organization regarding system development practice, quality management, etc.
Regulations	Input	External regulations such as health and safety regulations which apply to the system.
Domain information	Input	General information about the application domain of the system
Agreed requirements	Output	A description of the system requirements which is understandable by stakeholders and which has been agreed by them
System specification	Output	This is a more detailed specification of the system functionality which may be produced in some cases
System models	Output	A set of models such as a data-flow model. an object model, a process model, etc. which describes the system from different perspectives

Requirements Engineering process variability

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- In practice, RE processes are very variable.

Number of Factors contributing to this variability include:

Technical maturity:

- The technologies and methods used for requirements engineering vary from one organization to another.

Disciplinary involvement:

- The types of engineering and management disciplines involved in requirements engineering vary from one organization to another.

Requirements Engineering process variability…

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Organizational culture:

- The culture of an organization has an important effect on all business processes and, as the culture varies, so too does the requirements engineering process.

Application domain:

- Different types of application system need different types of requirements engineering process.

- *There is therefore no 'ideal' requirements engineering process.*

Process models

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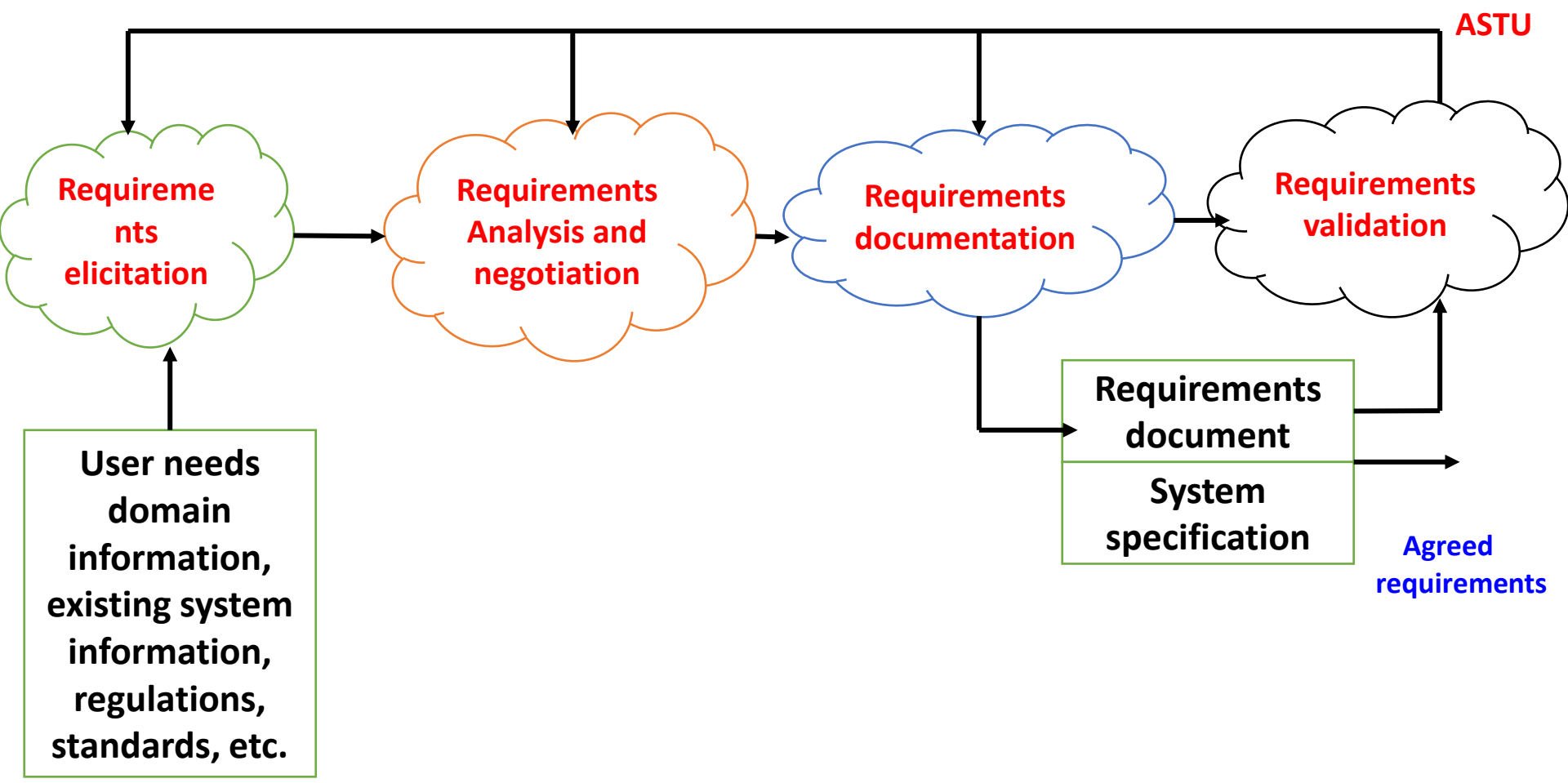
- A process model is a simplified description of a process presented from a particular view.
- Types of process model include:
  - Coarse-grain activity models.
  - Fine-grain activity models.
  - Role-action models.
  - Entity-relation models.

Coarse-grain activity model of RE



- RE activities using cloud icons. These have been chosen to indicate that there are no separate boundaries between these activities.

RE process activities

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Requirements elicitation:

- Requirements discovered through consultation with stakeholders, from system documents, domain knowledge and market studies. Other names for this process are requirements acquisition or requirements discovery.

Requirements analysis and negotiation:

- The requirements are analyzed in detail and different stakeholders negotiate to decide on which requirements are to be accepted.
    - This process is necessary because there are unsurprisingly conflicts between the requirements from different sources, information may be incomplete or the requirements expressed may be incompatible with the budget available to develop the system.

RE process activities….

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Requirements documentation:

- A requirements document is produced.

Requirements validation:

- The requirements document is checked for reliability and completeness.
- This process is future to detect problems in the requirements document before it is used as a basis for the system development.

Actors in the Requirements Engineering process

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- Actors in a process are the people involved in the execution of that process.
- Actors are normally identified by their roles(e.g. project manager, purchasing director, system engineer) rather than individuals.
- Requirements engineering involves actors who are mainly interested in the system as a way to help them solve particular problems or support particular activities (end-users, etc.) as well as actors interested in the solution (system designers, etc.).
- Role-action diagrams document which actors are involved in different activities.

Role-action diagram for software prototyping

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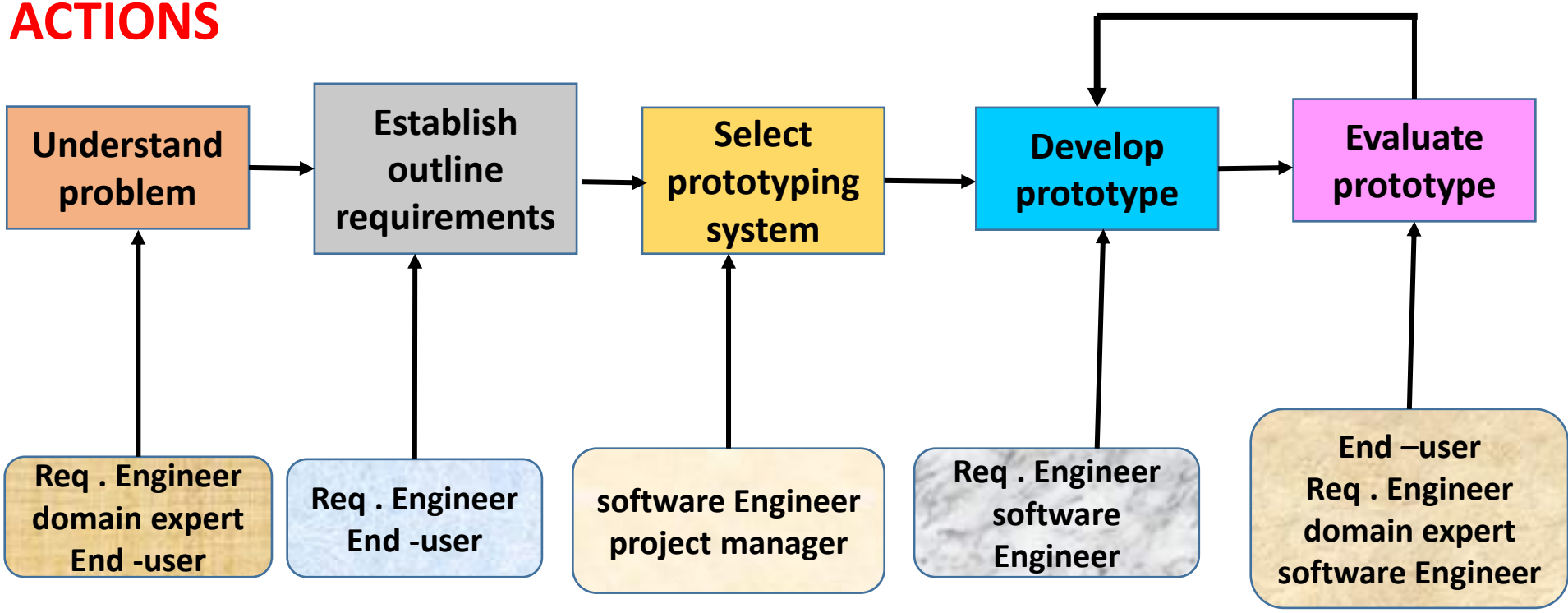

Roles in the prototyping process

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Role	Description
Domain expert	Responsible for providing information about the application domain and the specific problem in that domain which is to be solved.
System end-user	Responsible for using the system after delivery.
Requirements engineer	Responsible for eliciting and specifying the system requirements.
Software engineer	Responsible for developing the prototype software system
Project manager	Responsible for planning and estimating the prototyping project.

Human, social and organizational factors

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- Requirements engineering processes are dominated by human, social and organizational factors because they always involve a range of stakeholders from different backgrounds and with different individual and organizational goals.

- System stakeholders may come from a range of technical and non-technical background and from different disciplines.

Different stakeholder types

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- Examples: different stakeholder types are:
  - Software engineers responsible for system development.
  - System end-users who will use the system after it has been delivered.
  - Managers of system end-users who are responsible for their work.
  - External regulators who check that the system meets its legal requirements.
  - Domain experts who give essential background information about the system application domain.

Factors influencing requirements

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- Personality and status of stakeholders.
- The personal goals of individuals within an organization.
- The degree of political influence of stakeholders within an organization.

Example:

- In a university, there is a constant tension between administration and academic departments. If a budget information system is planned, the administration is likely to propose requirements which give them more power. However, the academic departments are likely to oppose this and suggest system requirements which mean that they increase their own financial management.

Process Support

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- CASE(Computer-Aided Software Engineering) tools provide automated support for software engineering processes(software design, configuration management and testing).

- The most mature CASE tools support well understood activities such as programming and testing and the use of structured methods(orders of magnitude improvement in software productivity).

- Support for requirements engineering is still limited because of the informality and the variability of the process.

CASE tools for Requirements Engineering process

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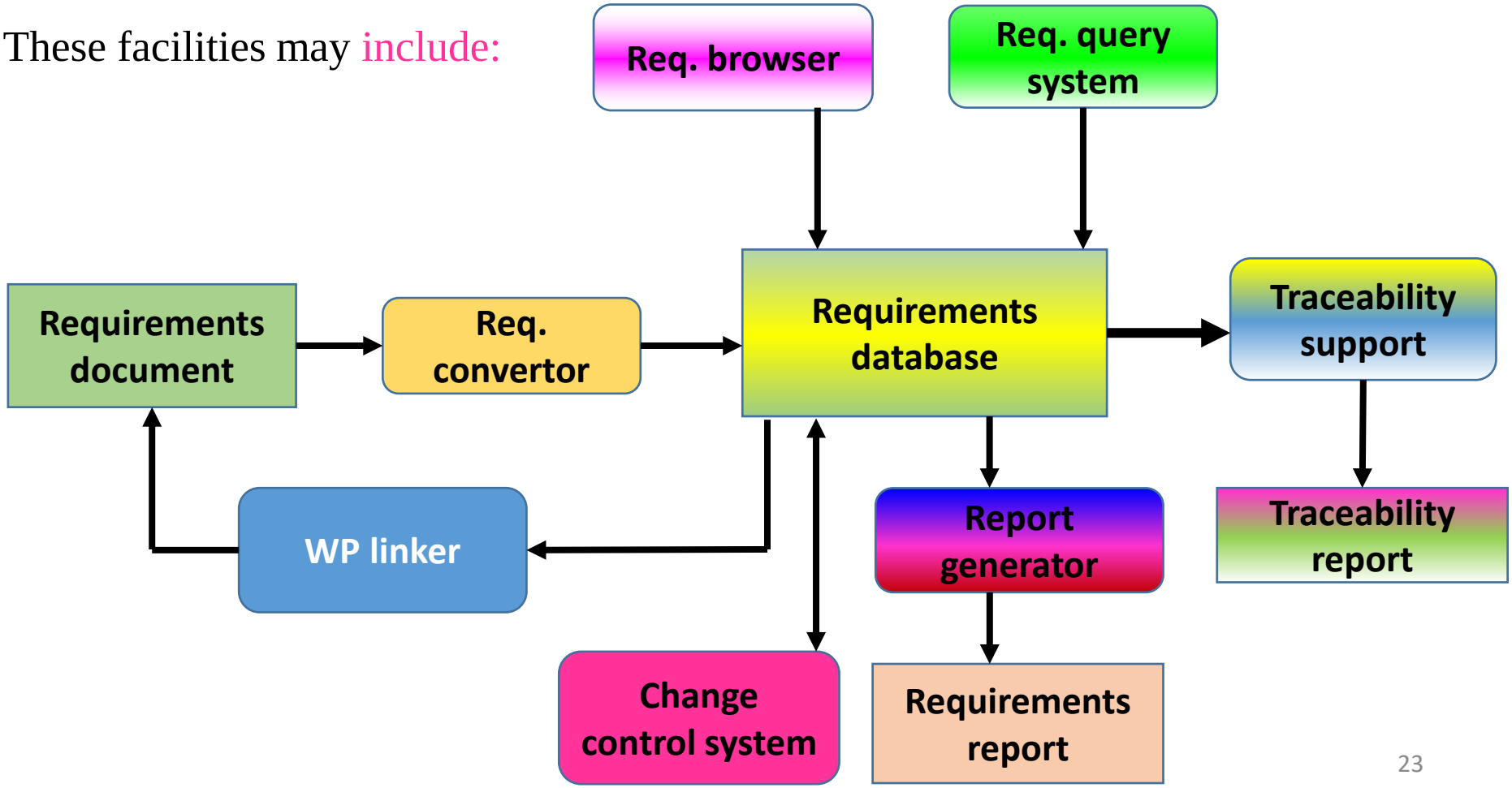
- Two types of tools which are available to support the requirements engineering process:

1. **Modeling and validation tools**
   - support the development of system models which can be used to specify the system and the checking of these models for completeness and uniformity.
2. **Management tools**
   - Helps to manage a database requirements and support the management of changes to these requirements.

A requirements management system

- Requirements management tools collect the system requirements in a database or repository and provide a range of facilities to access the information about the requirements.

These facilities may include:



Requirements management tools

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- **A Requirements browser** so that readers of the requirements can browse the database.
- **The Requirements query system** so that tool users can retrieve specific requirements or requirements which are related in some way.
- **A Traceability support system** which can be used to generate traceability information.
- **A more general Report generator** which can generate various different types of reports about the requirements such as requirements from specific stakeholders, etc.

Requirements management tools…

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- **A Requirements converter and word processor linker** which can covert requirements in a word processor document in to the requirements database format and which can maintain links between the database and the natural language representation of the requirements.
- **A Change control system** which can maintain information about requested requirements changes and links to the requirements affected by the changes.

Process improvement

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- Process improvement is concerned with modifying processes in order to meet some improvement objectives.

***Process Improvement objectives may include*:**

- **Quality improvement:** The outputs produced by the process are of higher quality. In the case of requirements, this means that they may contain less errors, may be more complete or may better reflect the real needs of the system stakeholders.
- **Schedule reduction:** The outputs from the process are produced more quickly. In the case of requirements, this means that less time is needed to produce the final version of the requirements document.
- **Resource reduction**: less resources such as staff time are needed to enact the process. Therefore, a smaller team of requirements engineers can produce the final requirements document.

Planning process improvements

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There are **four questions** which should be answered when Planning process improvements:

1.What are the problems with current processes?

- Example: late delivery of products, budget over-runs, poor quality, etc., meeting-dominated process, and key problems might be problems of process understanding-no-one actually known what process are followed.

2.What are the improvement goals?

- Example : this is related to identified problems(ISO 9000).

Planning process improvements….

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3.How can process improvement be introduced to achieve these goals?

-identifying changes to these which will contribute to the improvement goals.

4. How should process improvements be controlled and managed?

- procedures to collect feedback on improvements, which may be either quantitative measurements of the process or informal comments on the improvements, must be put in place.
- You should also ensure that action is taken in response to this feedback to correct any identified problems.

Process maturity

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- Process maturity can be thought of as the extent that an organization has defined its processes, actively controls these processes and provides systematic human and computer-based support for them.
- The SEI's Capability Maturity Model(CMM) is a framework for assessing software process maturity in development organizations.

Capability maturity model

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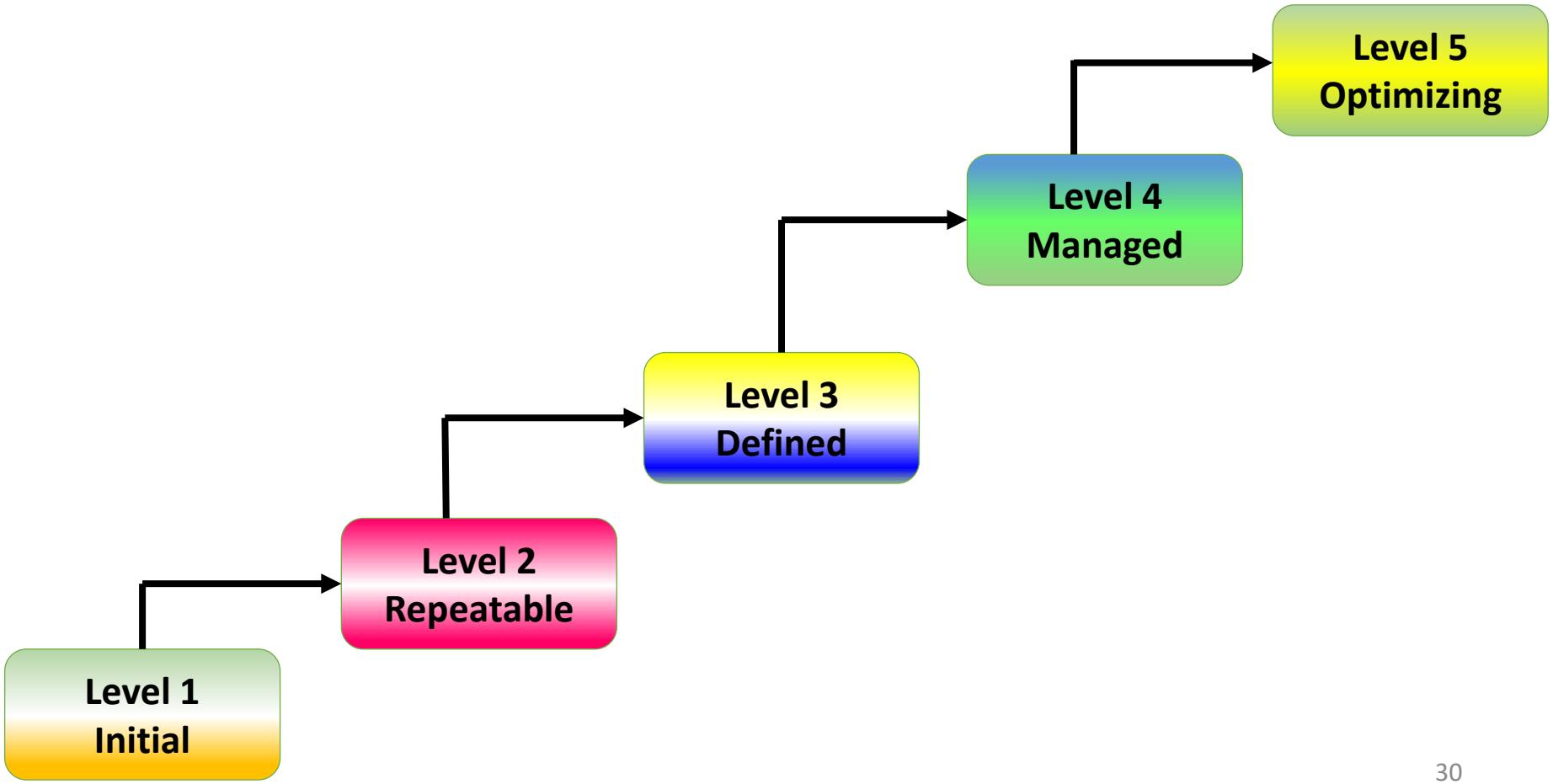
- The five levels in the SEI's capability maturity model are as follows:



Maturity levels

- **Initial level:** Organizations have an undisciplined process and it is left to individuals how to manage the process and which development techniques to use.
- **Repeatable level:** Organizations have basic cost and schedule management procedures in place. They are likely to be able to make consistent budget and schedule predictions for projects in the same application area.
- **Defined level:** The software process for both management and engineering activities is documented, standardized and integrated into a standard software process for the organization.
- **Managed level:** Detailed measurements of both process and product quality are collected and used to control the process.
- **Optimizing level:** The organization has a continuous process improvement strategy, based on objective measurements, in place.

A Requirements Engineering process maturity model

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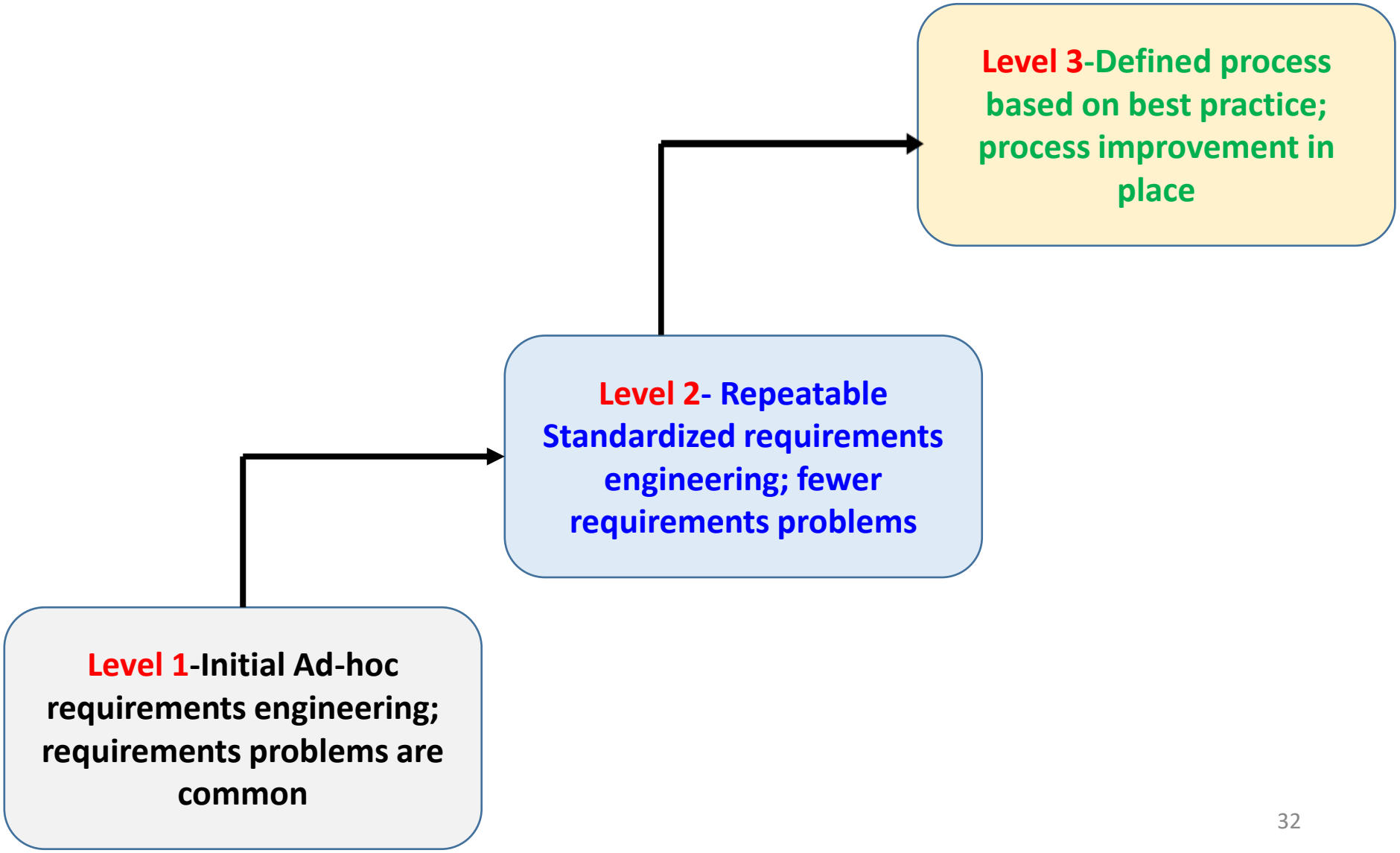

A RE process maturity model

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Initial level:

- No defined RE process. Suffer from requirements problems such as requirements volatility, unsatisfied stakeholders and high rework costs.
- Dependent on individual skills and experience.

Repeatable level:

- Defined standards for requirements documents and policies and procedures for requirements management.

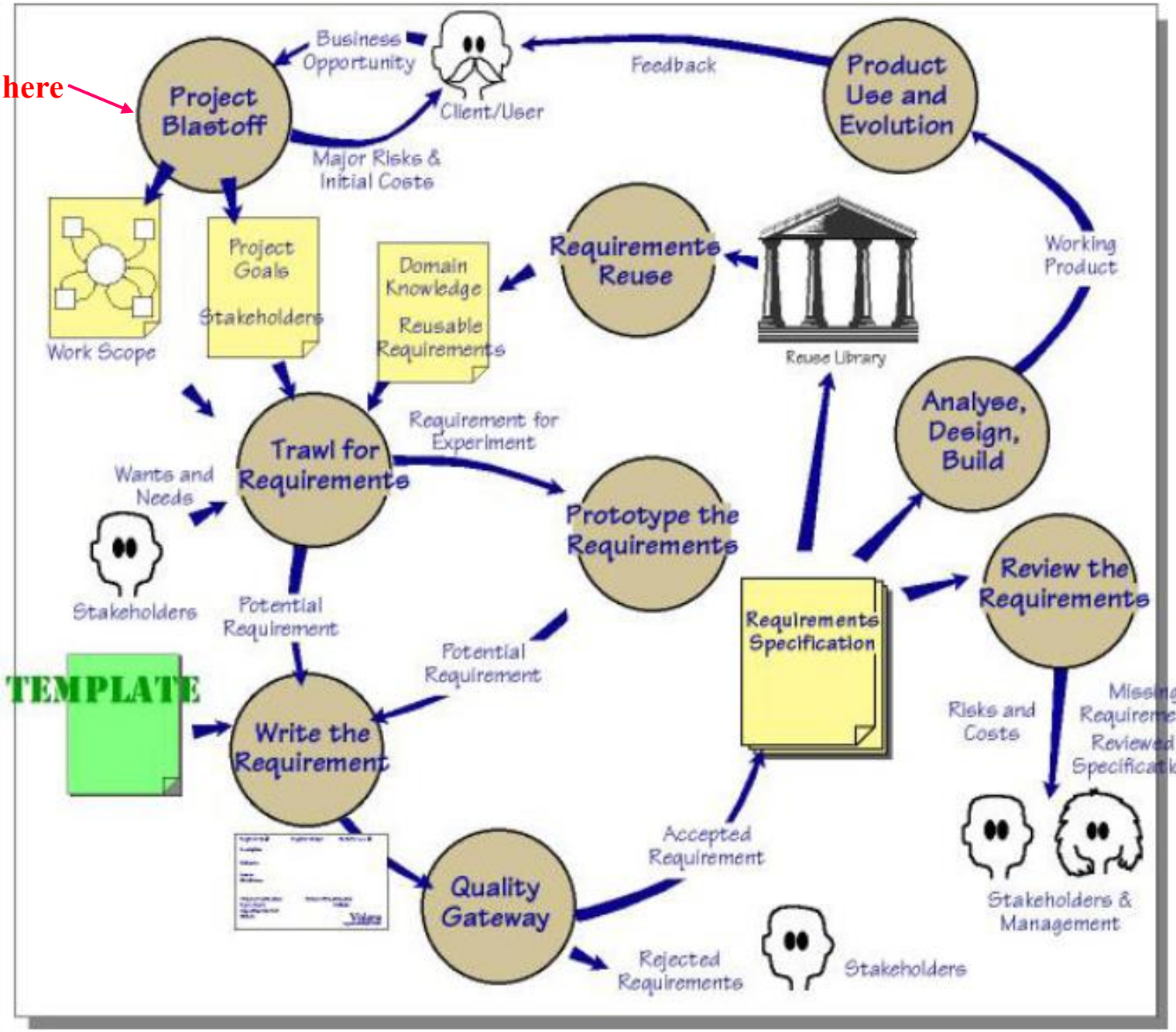
Defined level:

- Defined RE process based on good practices and techniques. Active process improvement process in place.

Good practice for RE process improvement

- RE processes can be improved by the systematic introduction of good requirements engineering practice.
- Each improvement cycle identifies good practice guidelines and works to introduce them in an organization.
- Examples of good practice guidelines:
  - Define a standard document structure.
  - Uniquely identify each requirement.
  - Define policies for requirements management.
  - Use checklists for requirements analysis.
  - Use scenarios to elicit requirements.
  - Specify requirements quantitatively.
  - Use prototyping to live requirements.
  - Reuse requirements.

Volere Requirements Process Design *(www.volere.co.uk)*



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Suzanne & James Roberts on, Atlantic Systems Guild

Data flow diagram for a requirements management process- [Gane et al. 1997] & [Yourdon 1988]