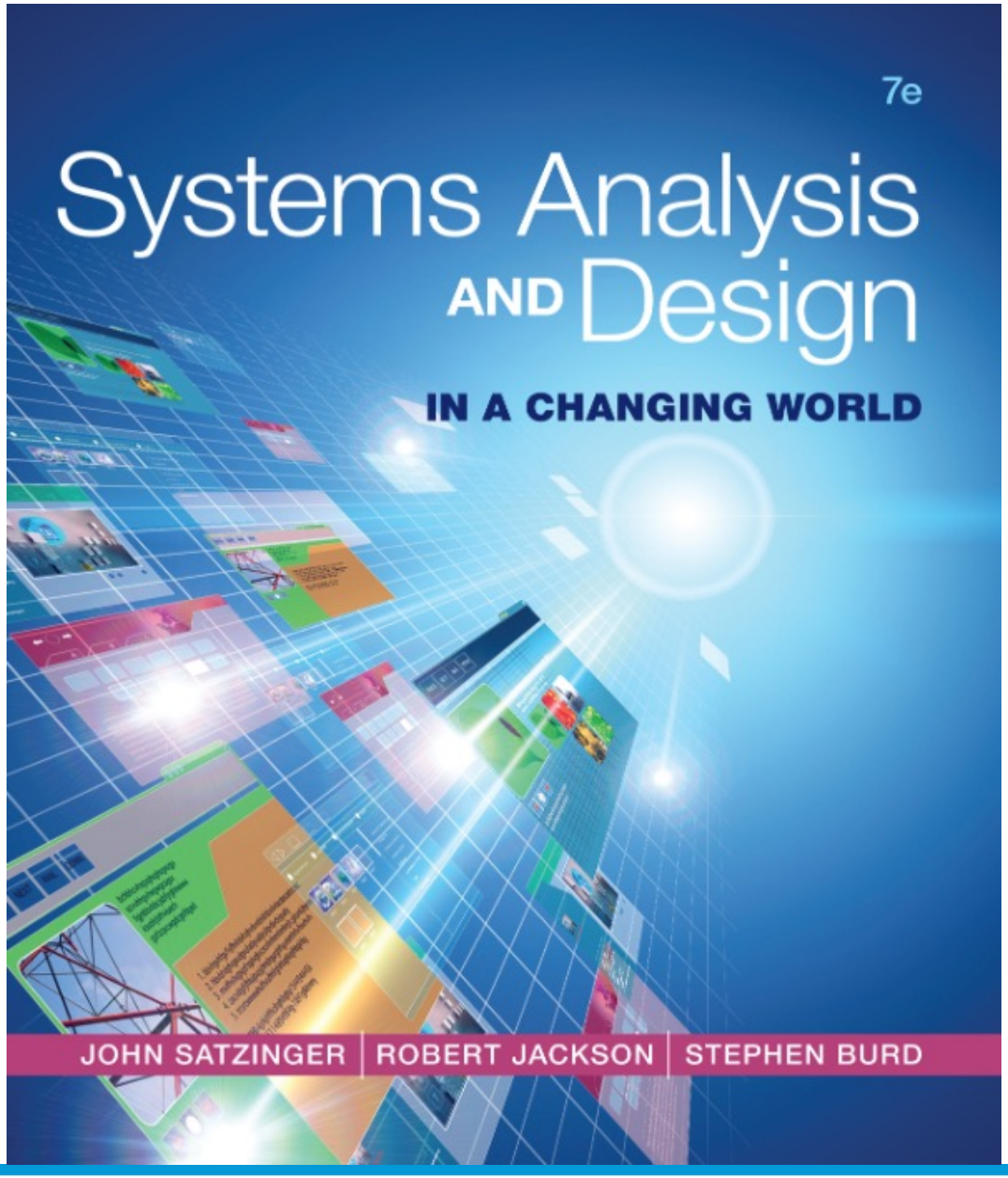
Systems Design Theory Lesson 1

Ch. 6 pp. 158-168

Pitso Tsibolane (Senior Lecturer)
pitso.tsibolane@uct.ac.za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Systems Analysis
AND Design
IN A CHANGING WORLD
JOHN SATZINGER | ROBERT JACKSON | STEPHEN BURD

Course Objective

A. Understand the theory and body of knowledge underpinning the systems design and development process.

Lesson Objectives

1. Describe the purpose of systems analysis and design when developing information systems.
2. Describe systems design and contrast it with systems analysis.
3. List the documents and models used as inputs to or output from systems design.
4. Understand how models developed in the analysis phase of the project can be enhanced and refined to arrive at the detailed design.

What I ordered vs. What I got ☺

Software development lifecycles (SDLC)

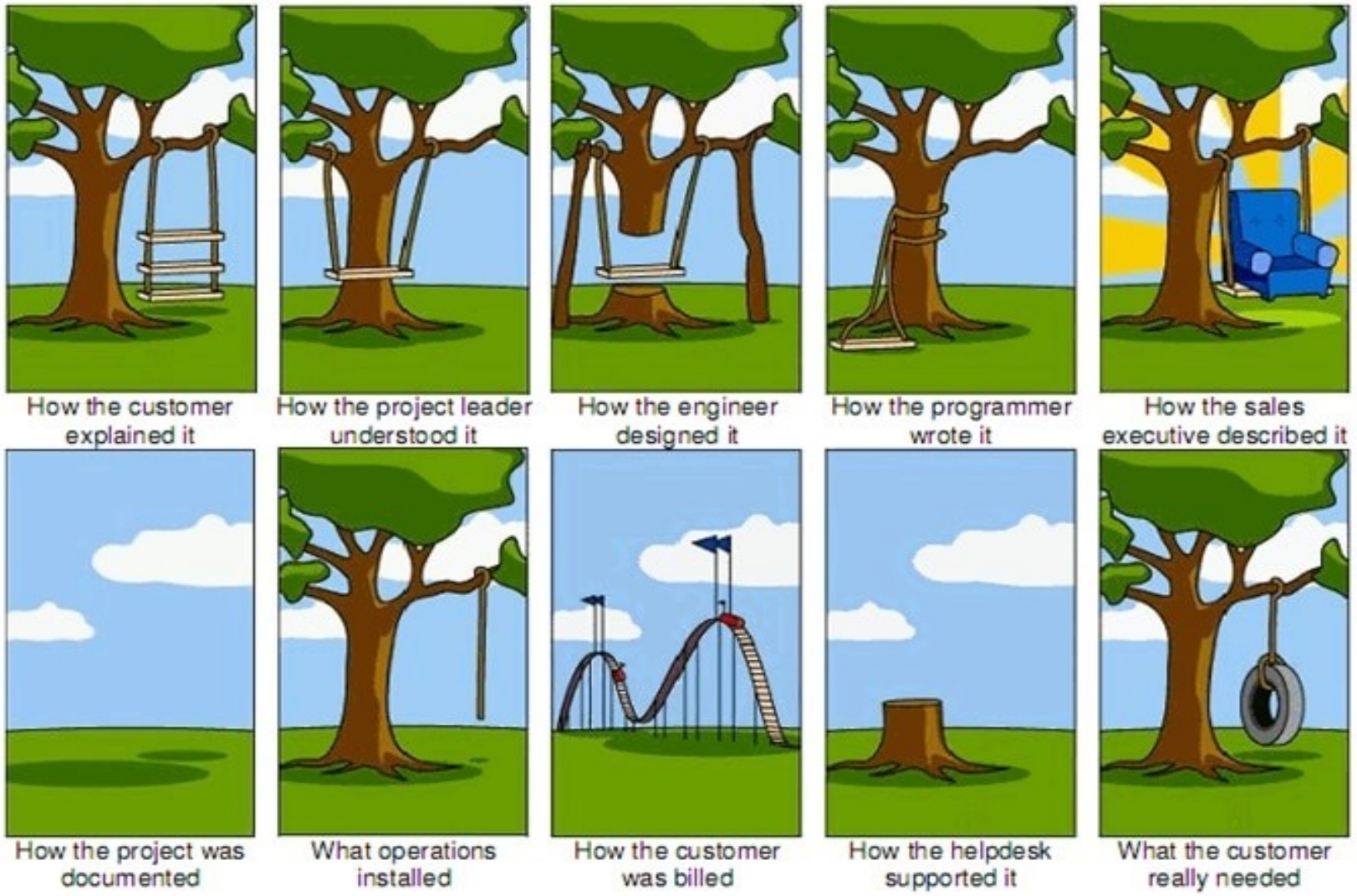
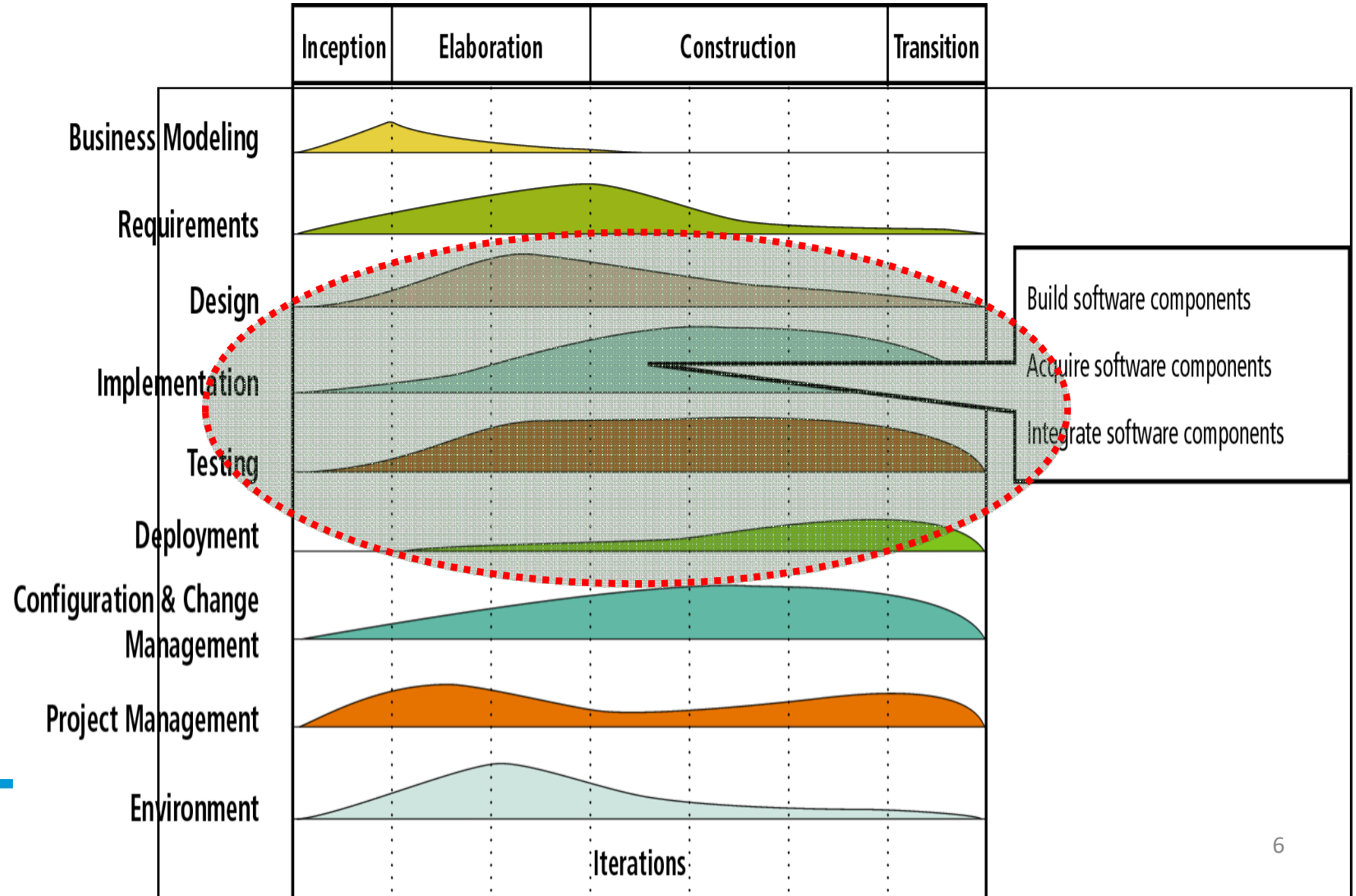


Image credit: https://pmac-agpc.ca/project-management-tree-swing-story

Scope for INF2011S



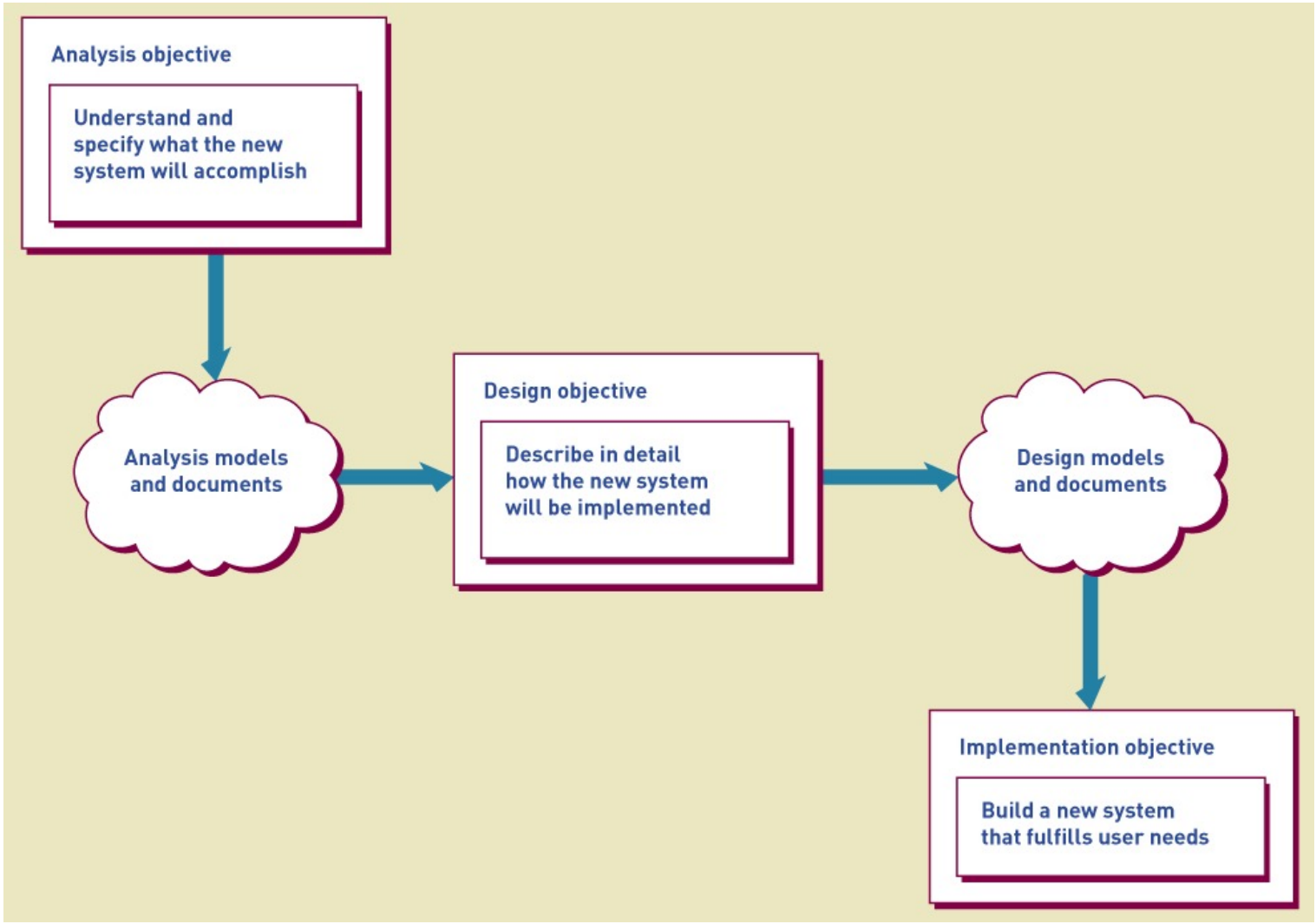
Systems Analysis and Design

- **Systems analysis** – those activities that enable a person to understand and specify what an information system should accomplish…i.e. ***what*** the system must do to solve the business need (INF2009F)
- **Systems design** – those activities that enable a person to define and describe in detail the system that solves the need…i.e. ***how*** the system will work. (INF2011S)
- **System development** – Build, test, and integrate system components—lots of programming and component integration – according to your chosen architecture and methodology
- **System Implementation** – Installing, testing and securing and backing-up the system.

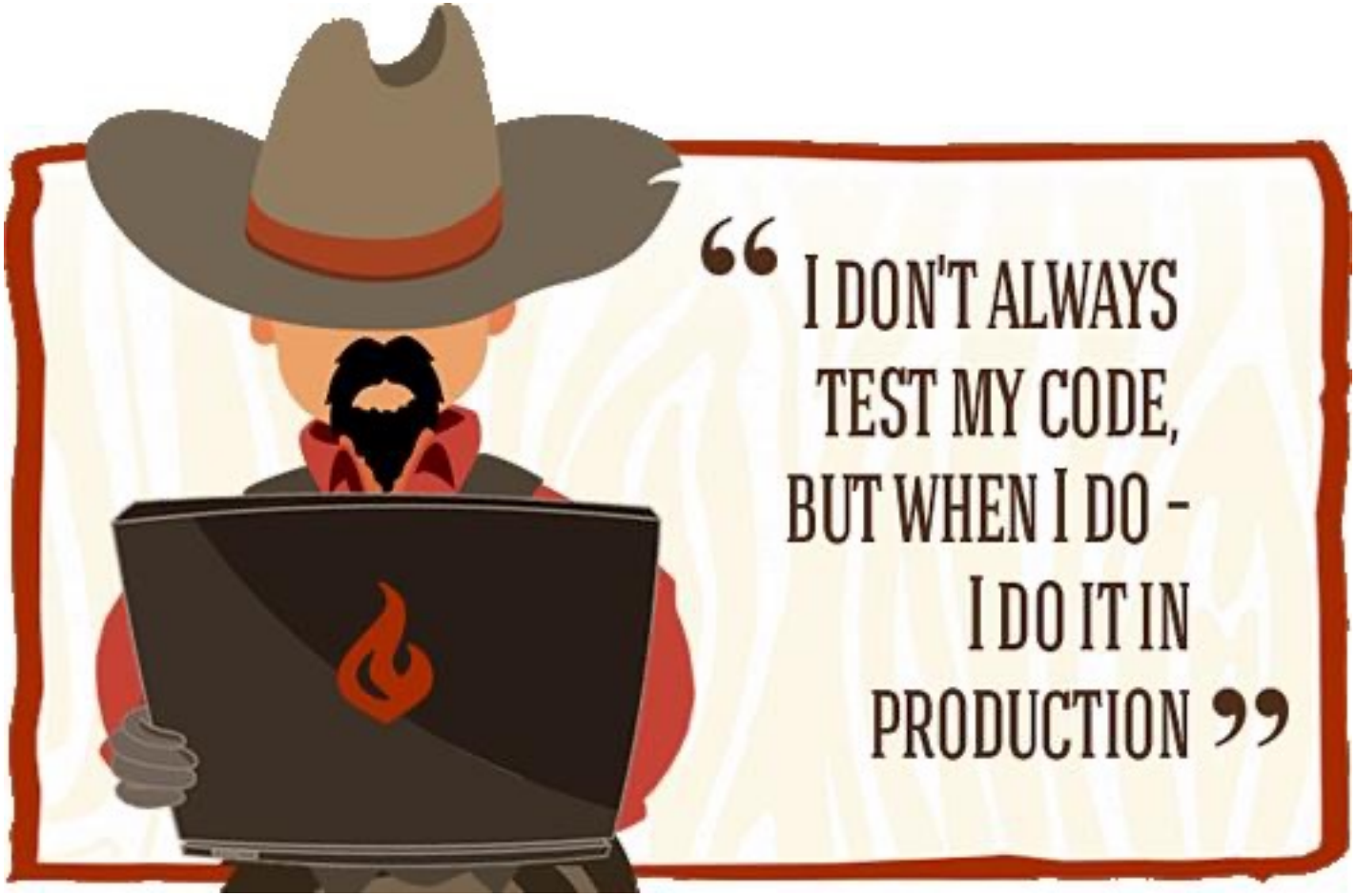
What is Systems Design

- The objective of design is to define, organize, and structure the components of the final solution to serve as a blueprint for development.
- Systems design provides the starting point for systems development.
- Systems analysis provides the starting point for systems design

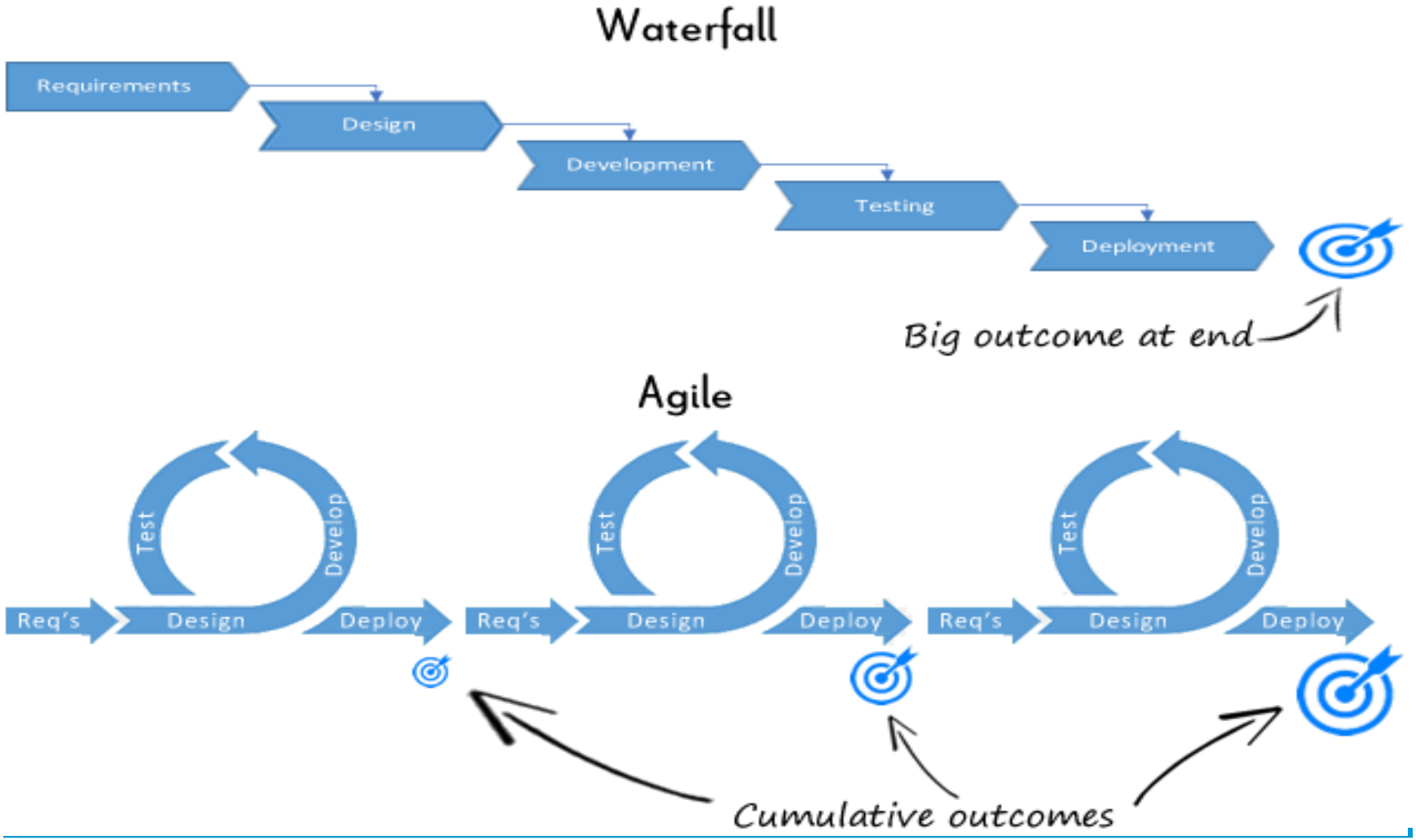
From Analysis to Design to Implementation



Key Concept: Cowboy Coding Avoidance

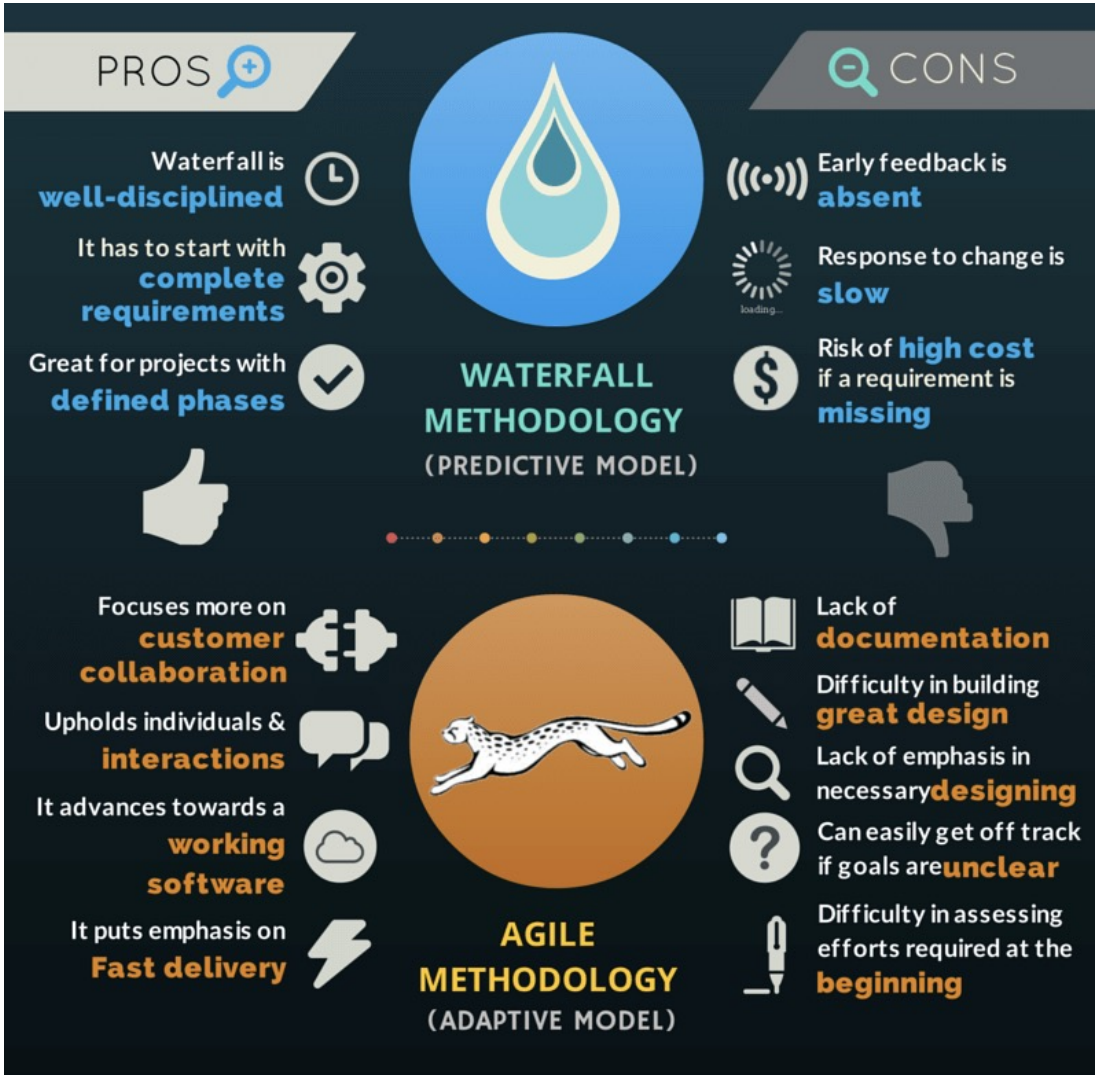


Waterfall vs Agile



Where does analysis stop and design start?

- In a waterfall life cycle there is a clear transition between the two activities (Analysis & Design)
- In an iterative life cycle the analysis of a particular part of the system will precede its design, but analysis and design may be happening in parallel
- It is important to distinguish the two activities and the associated mind-set



How is analysis (What?) different from design (How?)

- Throughout design, the project team carefully considers the new system in respect to current environment and systems that exist within the organisation as a whole
  - Environmental Factors (e.g. integrating with an existing system)
  - Converting data from legacy systems
  - Leveraging skills that exist in-house
  - Getting UX (user experience) & UI (user interfaces) right

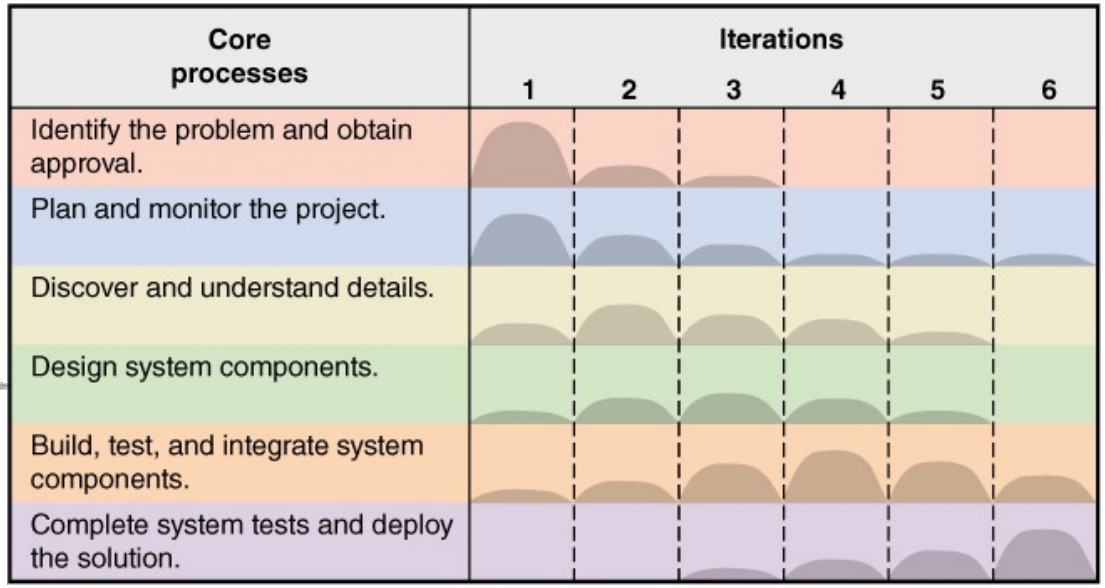
- Key activities undertaken during the design stage:
  - Examine several design strategies and decide which will be used to build the system
  - Detailed design of the individual classes and methods
  - Designing user interface, systems inputs, and systems output
  - Making physical architecture decisions regarding the hardware and software that will be purchased to support the new system

Two Levels of design

- Design takes place at **more than one level** :
  - **System Design** deals with the high-level architecture of the system - structural aspects and standards that affect the overall system
    - Hardware, network, and system software infrastructure
    - Communication between sub-systems
    - Standards for screens, reports, help etc
- **Detailed design** adds detail to the analysis to provide a detailed system specification
    - Class Design (types of attributes, method specs)
      - Includes implementation classes to handle user interface, business logic etc
    - Sequence Design (informs the methods of the software)
    - User Interface and Report Design
    - Database design
    - Security and Controls Design

Key Design Activities and Iterations

Design activities
Describe the environment. Design the application components. Design user interface. Design the database. Design the software classes and methods.



Key Design Questions for each Activity

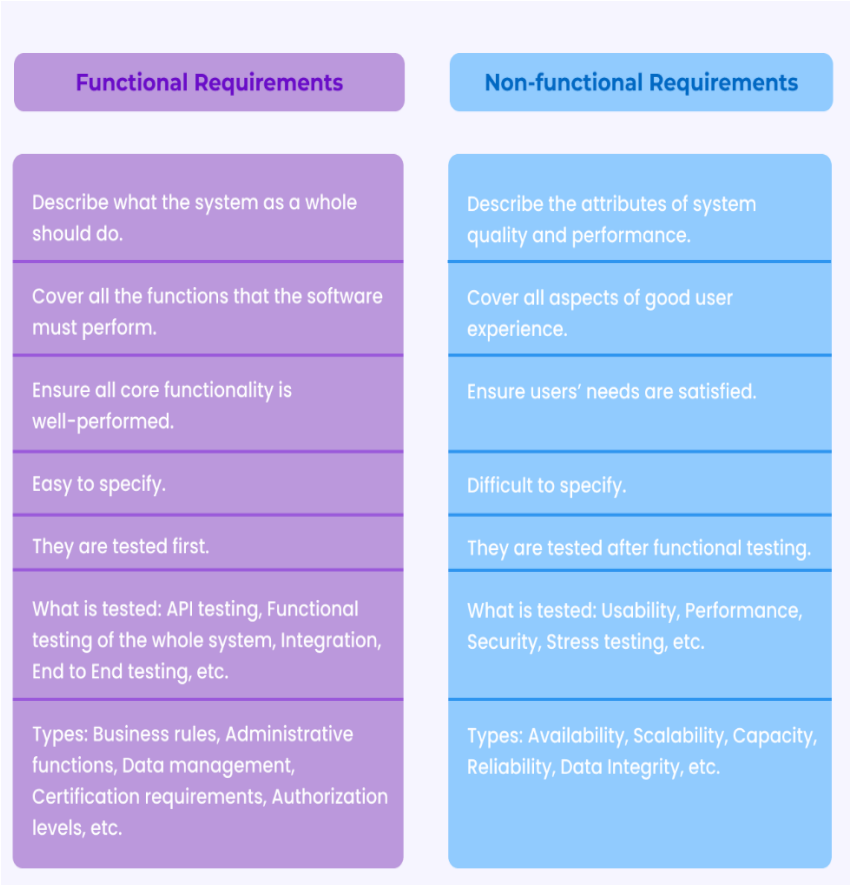
Design activity	Key question
Describe the environment	How will this system interact with other systems and with the organization's existing technologies?
Design the application components	What are the key parts of the information system and how will they interact when the system is deployed?
Design the user interface	How will users interact with the information system?
Design the database	How will data be captured, structured, and stored for later use by the information system?
Design the software classes and methods	What internal structure for each application component will ensure efficient construction, rapid deployment, and reliable operation?

Design Models

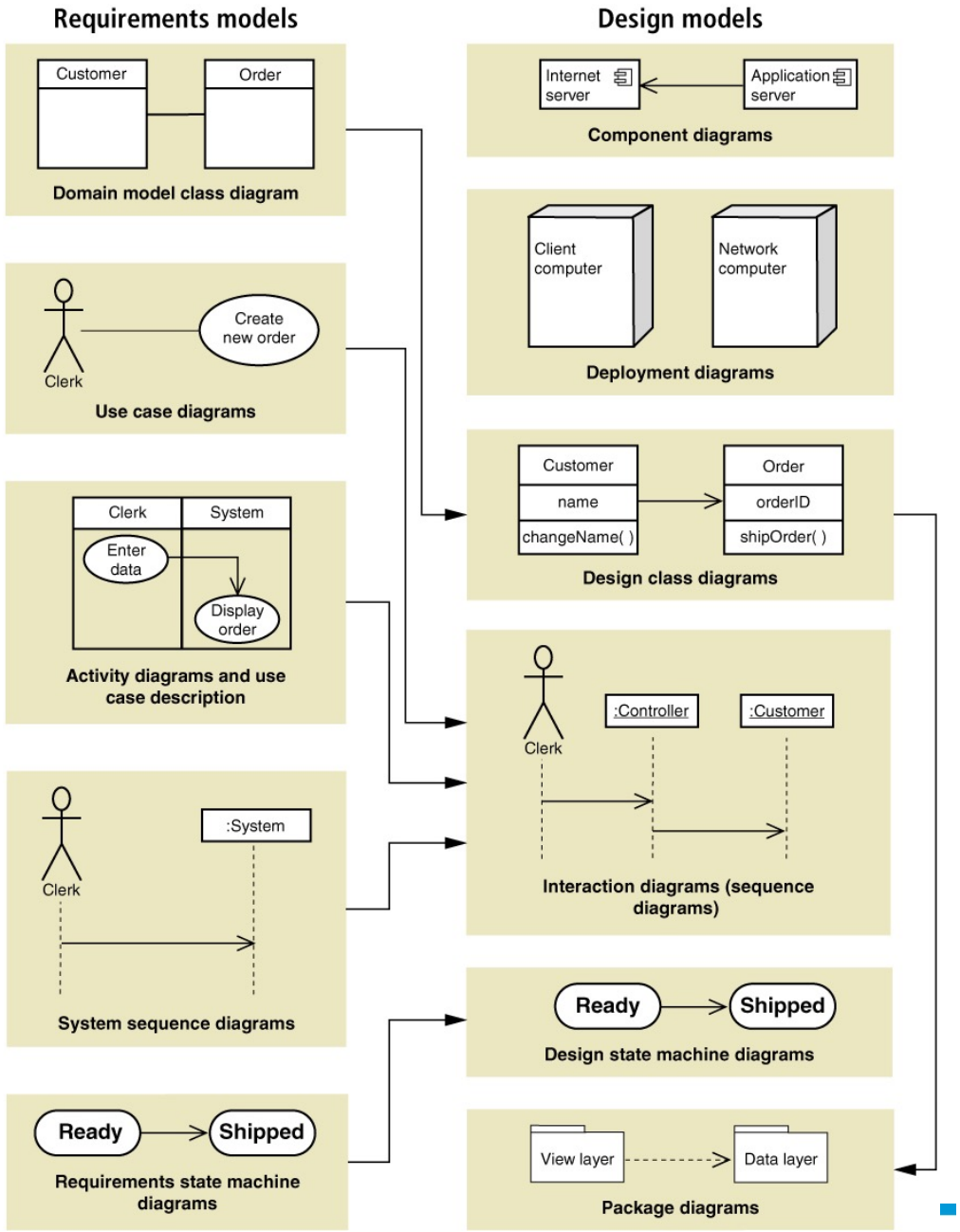
- Design is a model-building activity
  - The formality of the project will dictate the type, complexity, and depth of models.
  - Agile/iteration projects typically build fewer models, but models are still created
  - Jumping to programming without design often causes less than optimum solutions and may require rework

Evolving the Analysis Models into Design Models

- The primary purpose of the **design** models is to increase the likelihood of **successfully delivering** a system that implements the functional requirements in a manner that is **affordable**, **usable** and easily **maintainable**.
- Therefore, in system **design**, we address both the **functional** and the **non-functional** requirements
- Non-Functional Requirements:
  - Operational Requirements
  - Performance Requirements
  - User Experience (UX) and User Interface (UI)
  - System Controls and Security Requirements
  - Cultural and Political Requirements



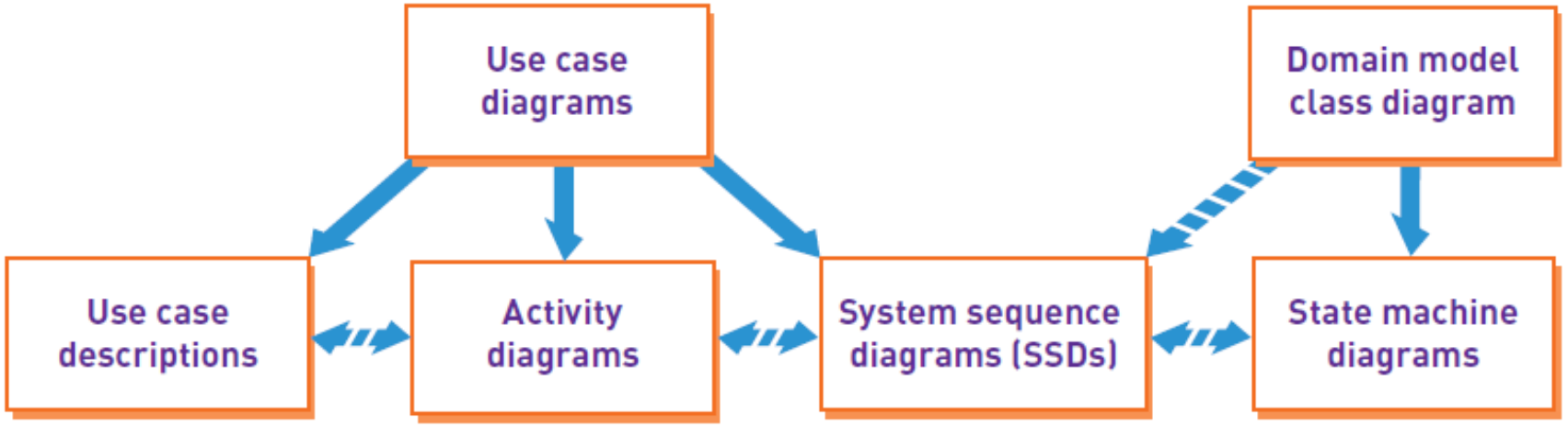
From Analysis Models to Design Models



Key Design Models

Design Activity	Definition/Purpose	Diagrams/Models	Lesson
User Requirements	Identifying the problem and documenting the objective of the solution system	Use Case Diagrams Sequence Diagrams	INF2009F Lesson 1
Systems Architecture	The set of computing and network hardware and topology, and system software required by the system	Component Diagrams Deployment Diagrams Package Diagrams	Lesson 2
Data Design	Define data needed to support the business processes within the scope of corresponding information system	Design Class Diagrams	Lesson 3
Software Design	Software resource requirements and prerequisites for optimal functioning of an application	Design Sequence Diagrams	Lesson 4
UI/UX Design	The look and feel, the presentation and interactivity of a product as well as the user experience.	Storyboards UI Design Report Design	Lesson 5
Security Design	Key authentication, security protocols and backups design	Identity, Authentication and Security Diagrams	Lesson 6
Implementation Design	Key procedures and processes for implementing the system	Project Plan System Configuration Test Cases	Lesson 7

Integrating Design Models



Measurable Objectives in Design

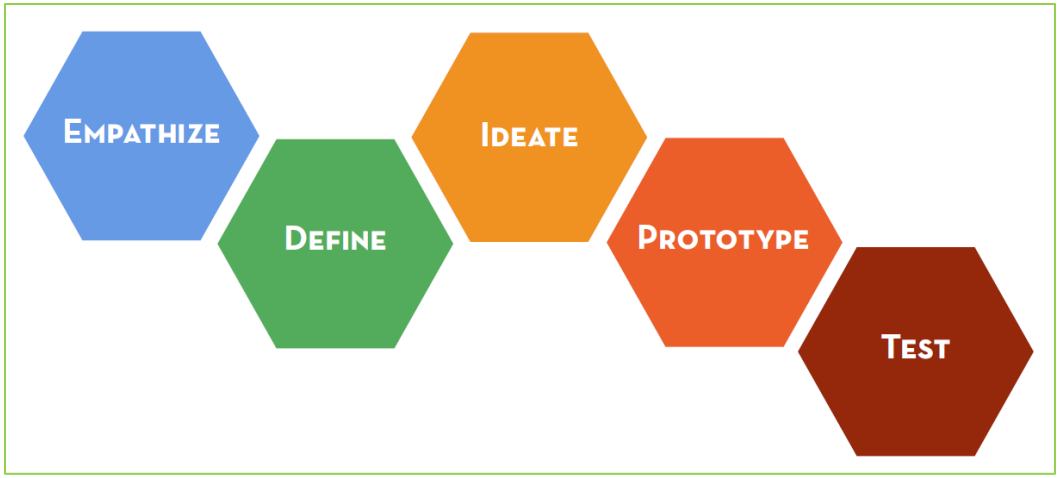
- How can we tell whether the design requirements have been achieved?
  - Measurable objectives set clear targets for designers
  - Objectives should be quantified so that they can be tested
  - SMART objectives are Specific, Measurable, Actionable, Realistic and Time-based

SMART Design Objectives

- **Specific** - "We want more visitors" could mean too many things:
  - The client would be satisfied with 2,000 visitors/month
  - The client is expecting more than 30,000 visitors
  - The client would be happy with an increase of 20%
- **Measurable** - "We want to improve user morale" is beautiful and noble objective
  - But happiness is a subjective value that is difficult to measure.
  - "We want to decrease user sick leave by 20%" is measurable
- **Actionable** - "We want users to read our articles completely" is not very actionable at least from a UX design perspective.
  - "We want to increase the user's engagement on articles" is more actionable.
  - We can design solutions to meet that objective: buttons for upvoting the article or the author, forms for leaving feedback, a new commenting section, etc.
- **Realistic** - "We want every single visitor on our site to sign up" is a very ambitious goal.
  - One must be mindful of the numbers and metrics that clients expect.
- **Time-Based** - "We want to increase site traffic by 10%" is not time-bound.
  - We need to know how much time we have to achieve that goal.
  - "We want to acquire 1,000 users on a monthly basis for the next six months" is very specific, measurable, actionable, realistic, and timely.

Qualities of Design

- Measured by how well we identify and resolve the systems non-functional requirements in the context of the functional requirements
  - In **analysis** the focus was on ***doing the right thing***
  - In **design** the focus is on ***doing things right***



12 Qualities and Objectives of Design (1-3)

1. Functional

- System should perform **completely and correctly** those functions that it claimed to perform
- Documented **requirements** should be **met fully** and according to specification

2. Efficient

- System should perform the required functionality ***efficiently both in terms of time and resources****, etc. (e.g.* disk storage, processor time, and network capacity) – Design is about producing striving towards an optimal solution

3. Economical

- Applies not only to the **fixed costs** of the hardware and software required to run it, but also to the **running costs of the system (TCO)**

12 Qualities and Objectives of Design (4-6)

4. Reliable

- It should not be prone to hardware or software failure
- It should reliably maintain the **integrity of the data** in the system
- Reliability depends to some extent on the ability of the system to be **tested thoroughly**

5. Secure

- System should be designed to be **secure against malicious attacks** by outsiders and against unauthorised use by insiders
- How: E.g. Passwords, firewalls

6. Flexible

- Ability of system to **adapt to changing requirements** as time passes
- Ability to configure the system to handle different circumstances based on control values that are not compiled into the system but are available for the user to set at run-time

12 Qualities and Objectives of Design (7-9)

7. Buildable

- From the perspective of the programmer who has to write the program code to build the system, it is important that the design is clear and not unnecessarily complex
- The physical design should relate closely to the features that are available in the development language

8. Manageable

- A good design should allow the project manager to estimate the amount of work involved in implementing the various subsystems
- Should provide for subsystems that are relatively self-contained and can be marked off as completed and passed for testing without fear that changes to other parts of the system that are still in development will have unforeseen consequences on them

9. Maintainable

- System should be easy to maintain as easy maintenance implies less costs.

12 Qualities and Objectives of Design (10-12)

10. Usable

- System should be both satisfying and productive
- Many of the features that contribute to user satisfaction are characteristics of good Human-Computer Interactions (**HCI**)

11. Reusable

- Reuse affects the designer in three ways. The designer should:
  1) consider how economies can be made by designing reuse into the system through the use of inheritance
  2) look for opportunities to implement **design patterns**, which provide templates for the design of reusable elements
  3) seek to reuse existing classes or components

12. Elegant-Beautiful

- A delight, users must **want to use** system, must love using it

Qualities of a good designer…

	QUALITY	competency	attitude
1.	**Communicate, negotiate and persuade**	Skills in oral presentation, report writing, formulating persuasive arguments, effective communications	Embracing the importance of informing, updating, listening to and persuading colleagues.
2.	**Work effectively in a team**	Skills in team organization, setting meeting agendas, meeting facilitation, taking on leadership role	Real buy-in to team efforts (as opposed to individual "star" mind-set). Concern for team spirit, and mentoring and nourishing others. Willingness to take on leadership role and develop vision.
3.	**Engage in self-evaluation and reflection**	e.g., skills in journaling, matching local problem to big picture	Valuing taking time for reflecting on progress, learning from both mistakes and successes.
4.	**Utilize graphical and visual representations and thinking**	Skills in the appropriate use of sketching, geometric and physical modeling and CAD at various stages of design process	Sensitivity to the various uses of sketching (both as a thinking and communications tool). Awareness and support of how others use visual representations in their work. Drawing also provides a focal point for idea generation. Graphical representations are a central piece of vocabulary for engineering.
5.	**Exercise creative and intuitive instincts**	Skills in both right-brain and left-brain thinking.	It is o.k. to take risks and go with intuitive feelings. Design is a creative enterprise that involves imagination. Value willingness in self and others to act in the absence of complete knowledge and certainty.
6.	**Find information and use a variety of resources (i.e., resourcefulness)**	e.g., skills in database searches, interviewing potential customers	Learn from the past and from all of the information available, borrowing ideas is o.k., be curious and delight in learning.
7.	**Identify critical technology and approaches, stay abreast of change in professional practice**	Skills in project definition and planning, knowing "hot" publications in a given field, awareness of Professional Society activities	Planning is a valuable activity, along with reviewing the continued validity of the plan and revising as necessary. Learning does not end at graduation; joy for continued learning.
8.	**Use of analysis in support of synthesis**	Skill in identifying when analysis will provide insight into the quantification of a design or into strengths/weaknesses of a design. What type of analysis is appropriate?	Analysis is a valuable tool in the engineer's "toolbox." Analysis should support design decisions but not necessary drive them.

http://www-adl.stanford.edu/images/frdestbl.pdf

Qualities of a good designer…(cont)

	QUALITY	competency	attitude
9.	**Appropriately model the physical world with mathematics**	Idealization of complex geometries/loads into simple components that can be analyzed, but realization that the map is not the territory (per Prof. Rolf Faste, Stanford University)	The output from a mathematical model is only as good as the input. Mathematical models can provide valuable insight into product performance.
10.	**Consider economic, social, and environmental aspects of a problem**	Understanding of basic issues in these domains	Sensitivity to and concern for the inter-dependence of domains. Valuing non-technical issues.
11.	**Think with a systems orientation, considering the integration and needs of various facets of the problem**	Understanding issues of importance to product success, including other engineering fields, psychology, aesthetics, etc.	Sensitivity to quality and how encompassing it is. Very few products are single-faceted, and everyone involved in a product needs to be concerned about effective integration of subsystems.
12.	**Define and formulate an open-ended and/or under-defined problem, including specifications**	Gantt charts, QFD, needfinding, etc.	Valuing the contribution of up-front time spent in defining the real problem. Sensitivity to human needs and service to humankind.
13.	**Generate and evaluate alternative solutions**	e.g., brainstorming, mind-mapping, visual thinking, kinesthetic thinking	A very good design is likely to "happen" the more ideas that are generated up front. Don't become married to your ideas. Gleefully defer judgment!
14.	**Use a systematic, modern, step-by-step problem solving approach. Recognize the need for and implement iteration.**	Skills in project definition and planning, mind-mapping. Ability to use or formulate an appropriate problem solving procedure.	Planning is a valuable activity, along with reviewing the continued validity of the plan and revising as necessary. Design is not a random process (but neither is it an exact science), but recognition that intuitive leaps do happen. Value and reward flexibility in thinking. Willingness to abandon or modify and approach if it is not working
15.	**Build up real hardware to prototype ideas**	Basic machining and laboratory skills, understanding of time and cost issues related to prototyping, and knowledge of rapid prototyping skills.	A physical prototype can provide insight into a design that a two-dimensional geometric presentation can not. There is not 1-to-1 correspondence between a prototype and the final product. Willingness to do a rapid prototype and to iterate
16.	**Trouble-shoot and test hardware**	e.g., design of experiments, data analysis, diagnostic skills.	A well designed experiment can lend insight into design decisions. Characteristics such as doggedness, attention to detail, "can do" attitude.

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Conclusion

INTERVIEWS (Usability)

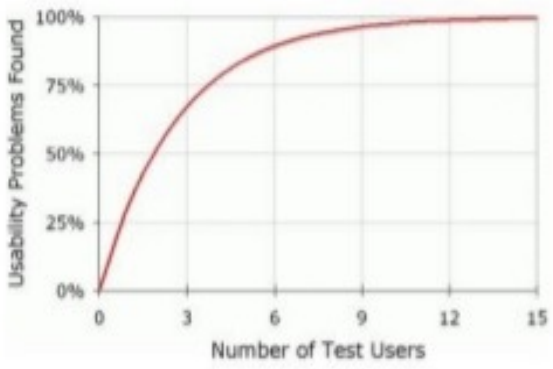
YOU ONLY NEED TO TEST

5

USERS

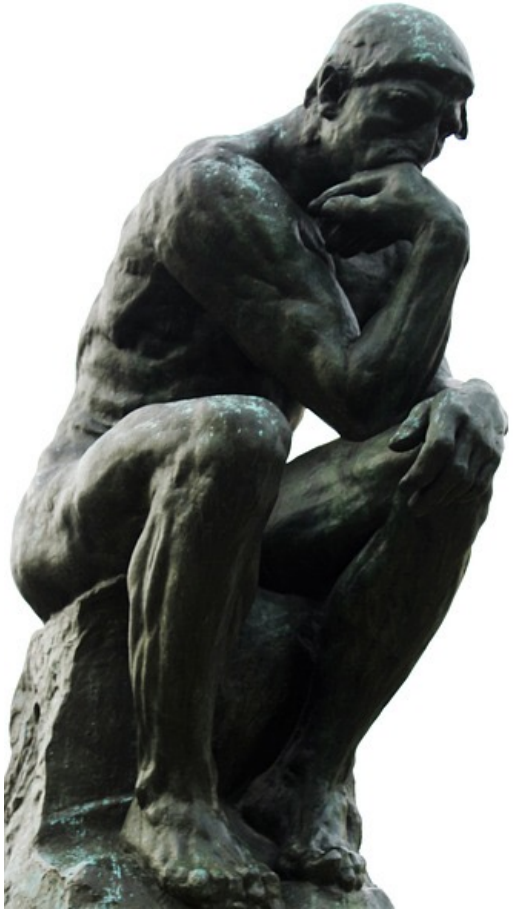
"Some people think that usability is very costly and complex and that user tests should be reserved for the rare web design project with a huge budget and a lavish time schedule. Not true. Elaborate usability tests are a waste of resources. The best results come from testing no more than 5 users and running as many small tests as you can afford."

- Jacob Nielsen



Q&A Forum Discussions

- Please post any questions that you may have regarding this lesson on the online class forum.



Revision Questions

1. How does the objective of systems analysis differ from the objective of systems design?
2. What are the inputs to systems design? What are the outputs?
3. List and briefly describe each design activity.
4. What models are developed during each design activity?
5. How can we tell whether the design requirements have been achieved?

References

- J.W. Satzinger, R.B. Jackson, & S.D. Burd, 2016. "Systems Analysis and Design in a Changing World", 7th edition, Cengage.
  See https://www.cengagebrain.co.uk/shop/ProductDisplay?urlRequestType=Base&catalogId=10051&categoryId=&productId=708634&errorViewName=ProductDisplayErrorView&urlLangId=-1&langId=-1&top_category=&parent_category_rn=&storeId=10654
- Further Reading: Read this classic document: Design Thinking by Tim Brown – Harvard Business Review, June 2008