LECTURE 2

Software Engineering Concepts

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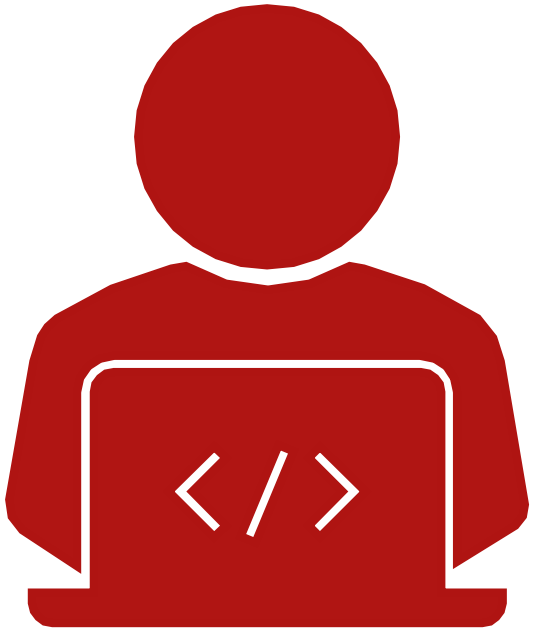
Software Evolution

- **Belady and Lehman's Laws:**
  - Software will continually change.
  - Software will become increasingly unstructured as it is changed.

- **Leveson's Law:**
  - Introducing computers will not reduce personnel numbers or costs.



Evolution?

- Is software improving at a slower rate than hardware?
- "Software expands to fill the available memory" (Parkinson)
- "Software is getting slower more rapidly than hardware becomes faster" (Reiser)
- Expectations are changing…

Is software engineering more difficult than hardware engineering?

WHY OR WHY NOT?

Why is software engineering hard?

- Curse of flexibility
- Organized complexity
- Intangibility
- Lack of historical usage information
- Large discrete state spaces

The Curse of Flexibility

No physical constraints

To enforce discipline on design, construction and modification

To control complexity

So flexible that you start working with it before fully understanding what needs to be done.

The untrained can get partial success.

"Scaling up is hard to do"

Complexity

A "simple" system has a small number of unknowns in its interactions within the system and with its environment.

A system becomes intellectually unmanageable when the level of interactions reaches the point where they cannot be thoroughly

- Planned
- Understood
- Anticipated
- Guarded against

Large discrete state spaces

Lacks repetitive structure found in computer circuitry

Cannot test exhaustively

Continuous vs. discrete math

Intangibility

Invisible interfaces

Hard to diagnose problems

Transient hardware faults vs. software errors

Hard to experiment with and manage

No historical usage information

To allow measurement, evaluation, and improvement of standard designs over time.

Always specially constructed.

Usually doing new things.

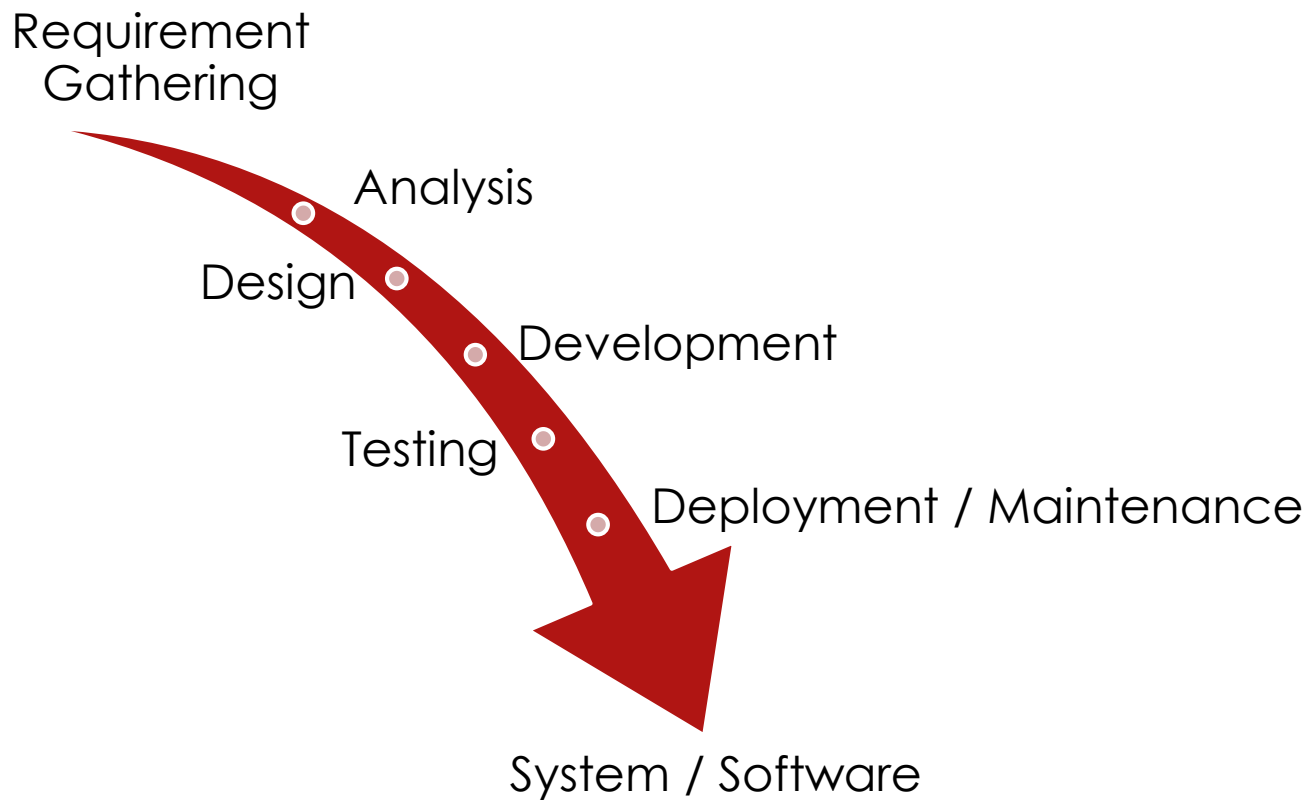
Think-out-loud…

- It is important that students bring a certain ragamuffin barefoot irreverence to their studies. They are here not to worship what is known, but to question it.

  Jacob Bronowski, The Ascent of Man

Back to it then…

Remember me???


Requirement Gathering
Analysis
Design
Development
Testing
Deployment / Maintenance
System / Software

Requirements Analysis and Definition

The system's services, constraints and goals are established by consultation with system users.

They are then defined in a manner that is understandable by both users and development staff.

This phase can be divided into:

Feasibility study (often carried out separately)	Requirements analysis	Requirements definition	Requirements specification

System and Software Design

System design: Partition the requirements to hardware or software systems. Establishes an overall system architecture

Software design: Represent the software system functions in a form that can be transformed into one or more executable programs

Programming and Unit Testing

The software design is realized as a set of programs or program units.

(Written specifically, acquired from elsewhere, or modified.)

Individual components are tested against specifications.

Integration and System Testing

THE INDIVIDUAL PROGRAM UNITS ARE:

INTEGRATED AND TESTED AS A COMPLETE SYSTEM

TESTED AGAINST THE REQUIREMENTS AS SPECIFIED

DELIVERED TO THE CLIENT

Deployment and Maintenance

Deployment: The system is put into practical use.

Maintenance: Errors and problems are identified and fixed.

Evolution: The system evolves over time as requirements change, to add new functions or adapt the technical environment.

Phase out: The system is withdrawn from service.

Jumping in the Deep End…

Feasibility Study

Before beginning a project, a short, low-cost study to identify

- Client
- Scope
- Potential benefits
- Resources needed:
  - staff, time, equipment, etc.
- Potential obstacles

Where are the risks?

- How can they be minimized?

Feasibility Study

01

A feasibility study leads to a decision:

- Go ahead
- Do not go ahead
- Think again

02

In production projects, the feasibility study often leads to a budget request.

03

In research, a feasibility study is often in the form of a proposal.

Scope

What are the boundaries of the project?

Examples:

- Used by the general public
- Varying data formats
- Support for Windows, Mac, Unix

Potential Benefits

Why are you doing this project?

Examples

- Create a marketable product
- Improve the efficiency of an organization
- Control a system that is too complex to control manually
- New or improved service
- Safety or security

Resources

Staff

- How many hours per week?
- What skills do people have?

Time

- Well, time itself…

Equipment and software

- What special needs are there?

Client

- Will the client be sufficiently available and helpful?

Obstacles

Start-up time.

Creating a team, scheduling meetings, acquiring software, learning new systems, ...

Business considerations.

Licenses, trade-secrets, ...

Too ambitious.

Nothing to show at the end.

Changing circumstances.

Client leaves...

What else?

Risk

A factor, thing, element, or course involving uncertain danger; a hazard.

The possibility of suffering harm or loss; danger.

What can go wrong in a software project?

How can the risk be reduced?

How to Minimize Risk?

Several target levels of functionality:

- required, desirable, optional

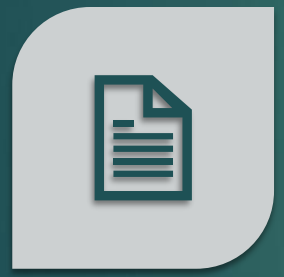
Visible software process:

- Intermediate deliverables.

Good communication:

- Within team.
- And with Clients.

Feasibility Report



A WRITTEN DOCUMENT

FOR A GENERAL AUDIENCE: CLIENT, FINANCIAL MANAGEMENT, TECHNICAL MANAGEMENT, ETC.

SHORT ENOUGH THAT EVERYBODY READS IT

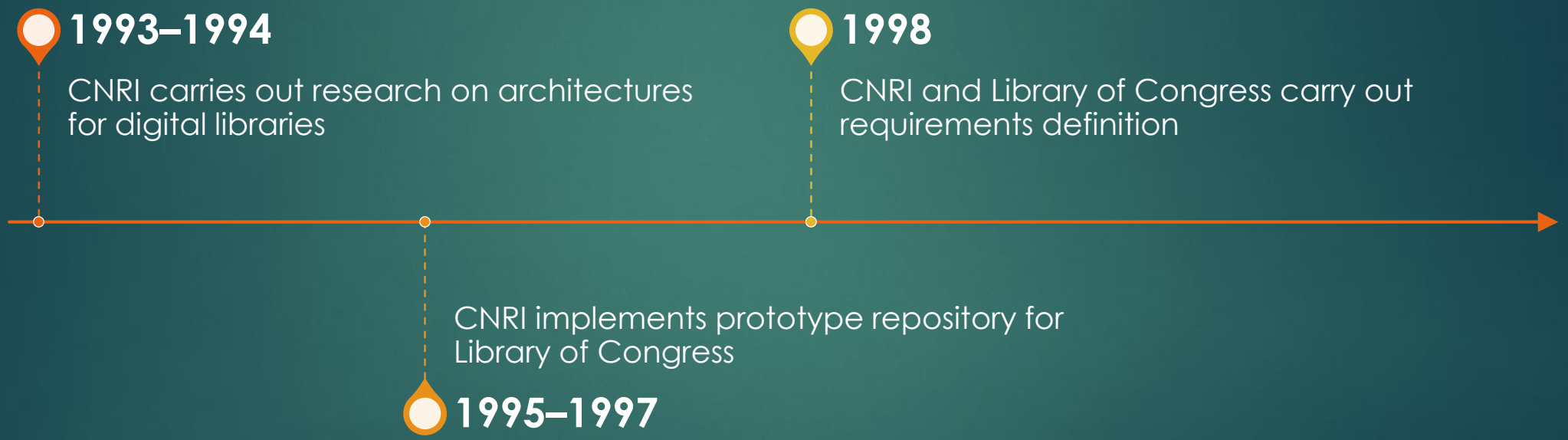
LONG ENOUGH THAT NO IMPORTANT TOPICS ARE SKIPPED

An Example…

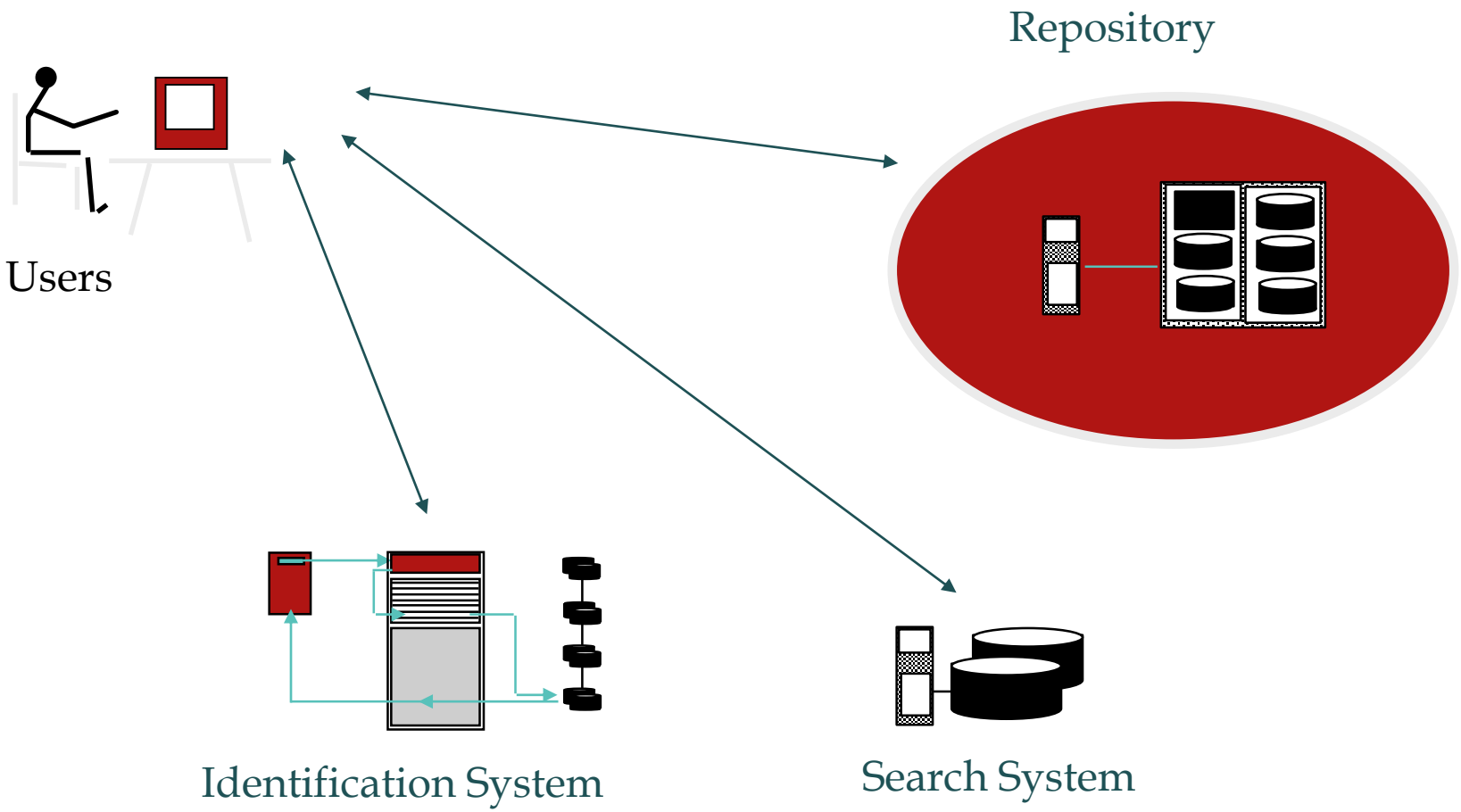
Library of Congress

- The Library of Congress requires a repository system to store and make accessible very large amounts of highly varied material over long periods of time.

Chronology


1993–1994
CNRI carries out research on architectures for digital libraries
1995–1997
CNRI implements prototype repository for Library of Congress
1998
CNRI and Library of Congress carry out requirements definition

The Repository



Representation of Complex Objects

Data:

- Several representations:
  - thumbnail image
  - reference image
  - archival image

Metadata:

- What is Metadata?
- Each representation may have its own metadata

Questions???