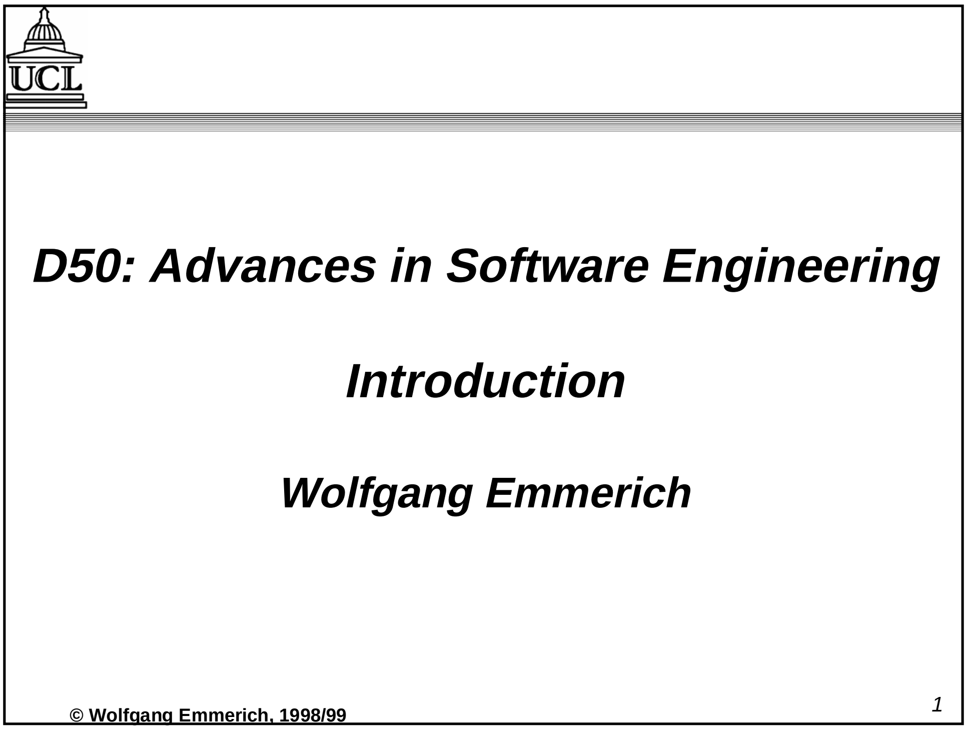

D50: Advances in Software Engineering

Introduction

Wolfgang Emmerich

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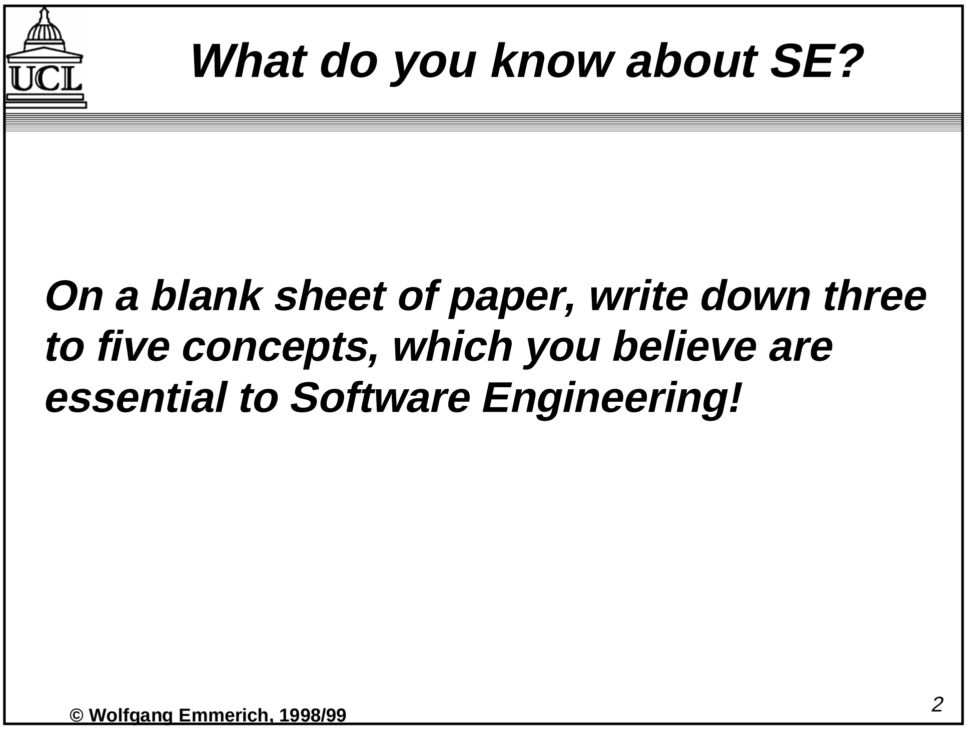

What do you know about SE?

On a blank sheet of paper, write down three to five concepts, which you believe are essential to Software Engineering!

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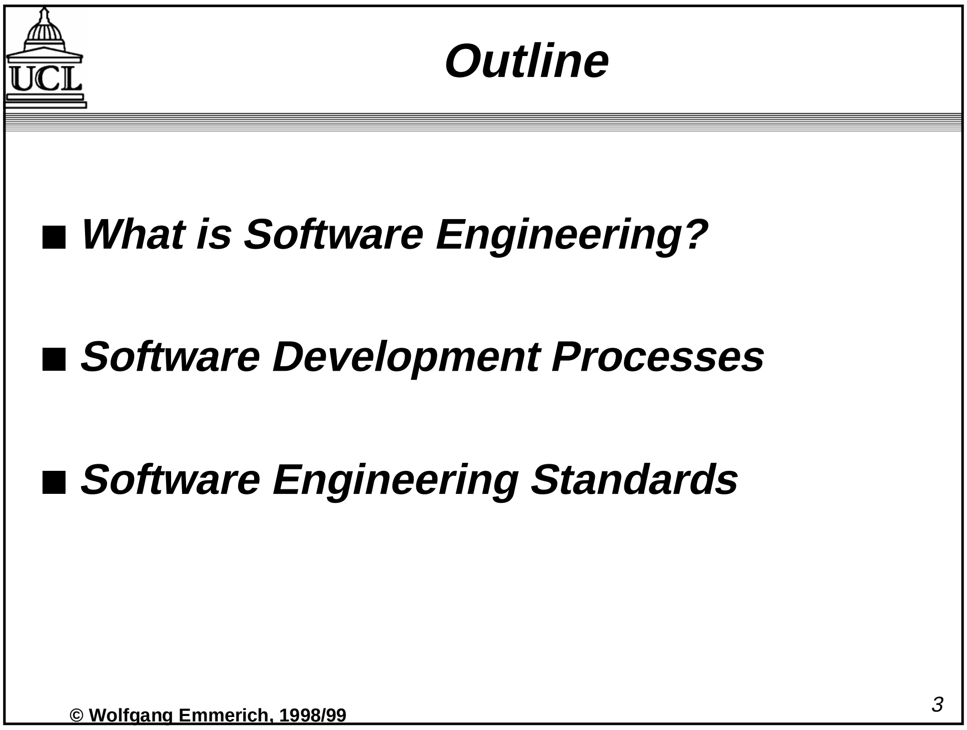
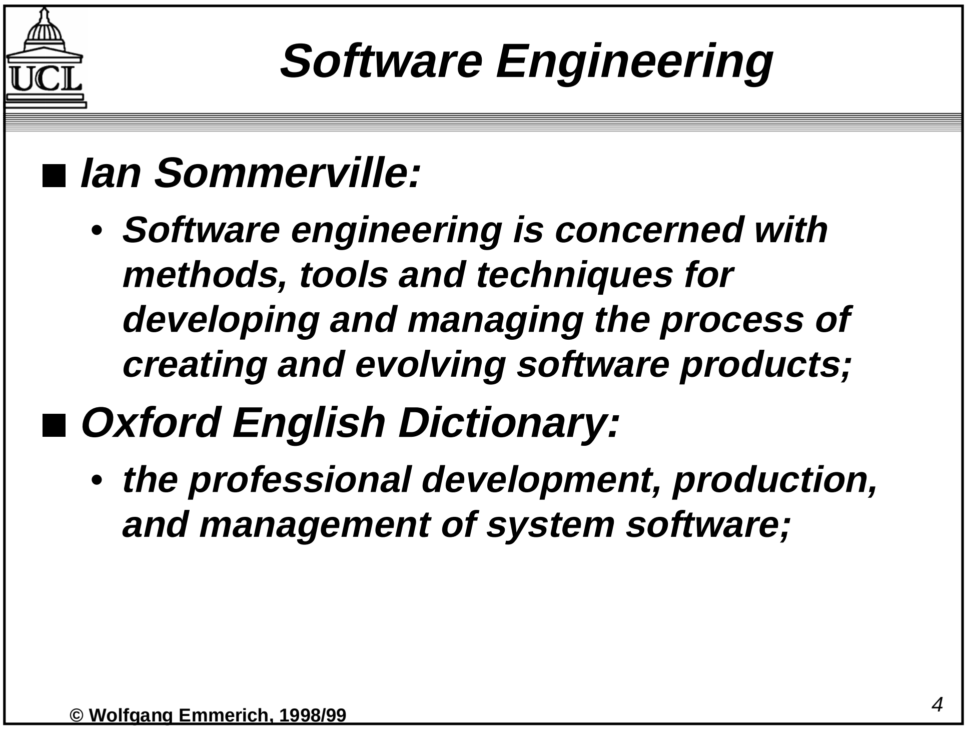


Outline

- What is Software Engineering?
- Software Development Processes
- Software Engineering Standards



Software Engineering

- Ian Sommerville:
  - Software engineering is concerned with methods, tools and techniques for developing and managing the process of creating and evolving software products;
- Oxford English Dictionary:
  - the professional development, production, and management of system software;

Why Software Engineering?

- ***The economies of ALL developed nations are dependent on software***
- ***More and more systems are software controlled***
- ***Software engineering is concerned with theories, methods and tools for professional software development***
- ***Software engineering expenditure represents a significant fraction of GNP in all developed countries***

Software Costs

- ***Software costs often dominate system costs. The costs of software on a PC are often greater than the hardware cost***
- ***Software costs more to maintain than it does to develop. For systems with a long life, maintenance costs may be several times the development costs***
- ***Software engineering is concerned with cost-effective software development***

Software Products

- ***Generic products***
  - ***Stand-alone systems which are produced by a development organisation and sold on the open market to any customer***
- ***Bespoke (customised) products***
  - ***Systems which are commissioned by a specific customer and developed specially by some contractor***
- ***Most software expenditure is on generic products but most development effort is on bespoke systems***

Software Product Attributes

- ***Maintainability: SW should be evolvable to meet changing requirements***
- ***Dependability: SW should not cause physical/economic damage upon failure***
- ***Efficiency: SW should not make wasteful use of system resources***
- ***Usability: SW should have an appropriate user interface and documentation***

Outline

- *What is Software Engineering?*
- *Software Development Processes*
- *Software Engineering Standards*

Software Development Process

- ***Structured set of activities required to develop a software system***
  - ***Requirements Analysis***
  - ***Design***
  - ***Implementation***
  - ***Validation***
  - ***Evolution***
- ***Activities vary depending on organisation and type of system being developed***
- ***Must be modelled to be managed***

Process characteristics

- Understandability: Is the process defined and understandable
- Visibility: Is the process progress externally visible
- Supportability: Can the process be supported by CASE tools
- Acceptability: Is the process acceptable to those involved in it

Process characteristics

- Reliability: Are process errors discovered before they result in product errors
- Robustness: Can the process continue in spite of unexpected problems
- Maintainability: Can the process evolve to meet changing organisational needs
- Rapidity: How quickly can the system be produced

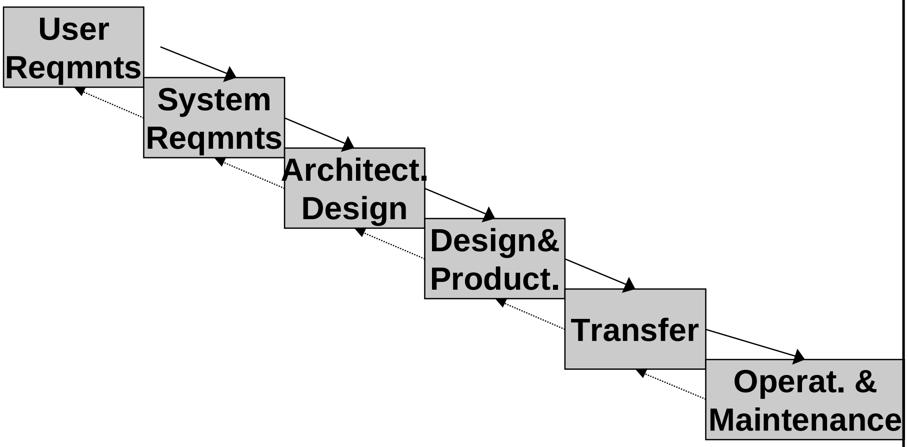
Software process models

- Normally, specifications are incomplete/anomalous
- Very blurred distinction between specification, design and manufacture
- No physical realisation of the system for testing
- Software does not wear out - maintenance does not mean component replacement

Generic software process models

- The waterfall model
  - Separate and distinct phases of specification and development
- Evolutionary development
  - Interleaved specification and development
- Incremental development
  - Development of increments
- Formal transformation
  - A mathematical system model is formally transformed to an implementation

Waterfall Approach



User Reqmnts

System Reqmnts

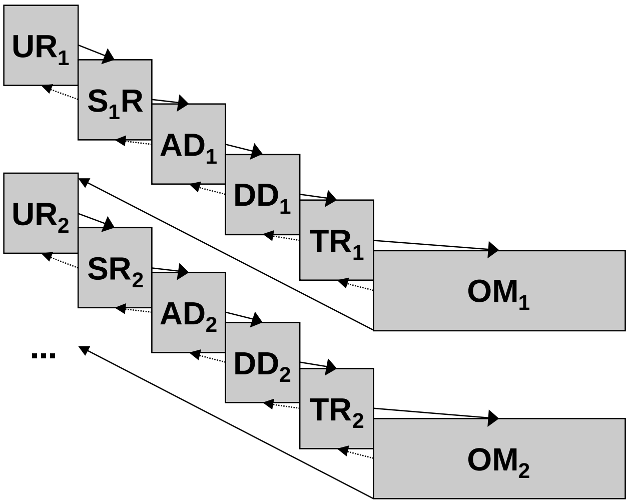
Architect. Design

Design& Product.

Transfer

Operat. & Maintenance

Evolutionary Development



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TR_1

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UR_2

SR_2

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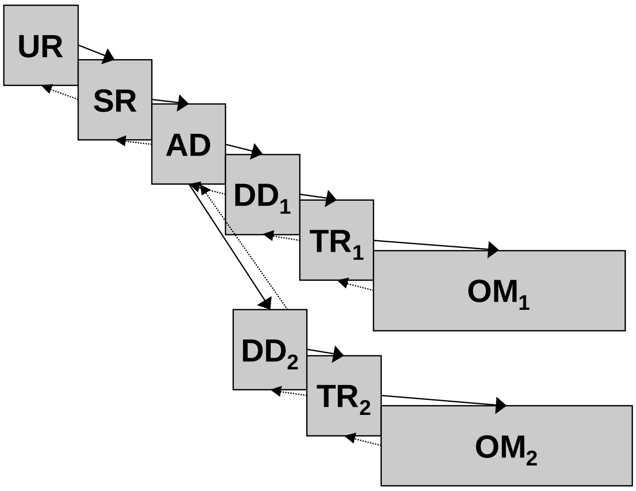
Incremental Development



Risk management

- ■ ***Perhaps the principal task of a manager is to minimise risk***
- ■ ***The ’risk’ inherent in an activity is a measure of the uncertainty of the outcome of that activity***
- ■ ***High-risk activities cause schedule and cost overruns***
- ■ ***Risk is related to the amount and quality of available information. The less information, the higher the risk***

Process model risk problems

- ***Waterfall***
  - ***High risk for new systems because of specification and design problems***
  - ***Low risk for well-understood developments using familiar technology***
- ***Evolutionary***
  - ***Low risk for new applications because specification and program stay in step***
  - ***High risk because of lack of process visibility***

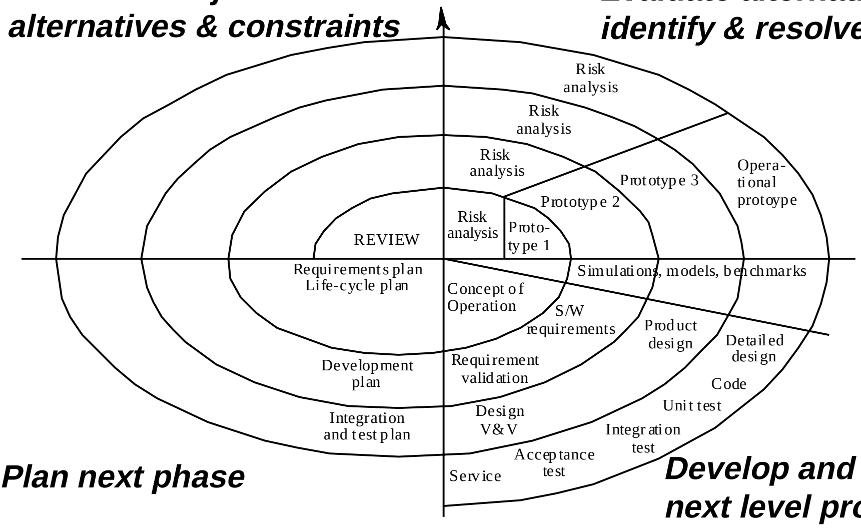
Hybrid process models

- ***Large systems are usually made up of several sub-systems***
- ***The same process model need not be used for all subsystems***
- ***Prototyping for high-risk specifications***
- ***Waterfall model for well-understood developments***

Boehm’s Spiral model

Determine objectives alternatives & constraints

Evaluate alternatives identify & resolve risks



Plan next phase

Develop and verify next level product

Phases of the Spiral Model

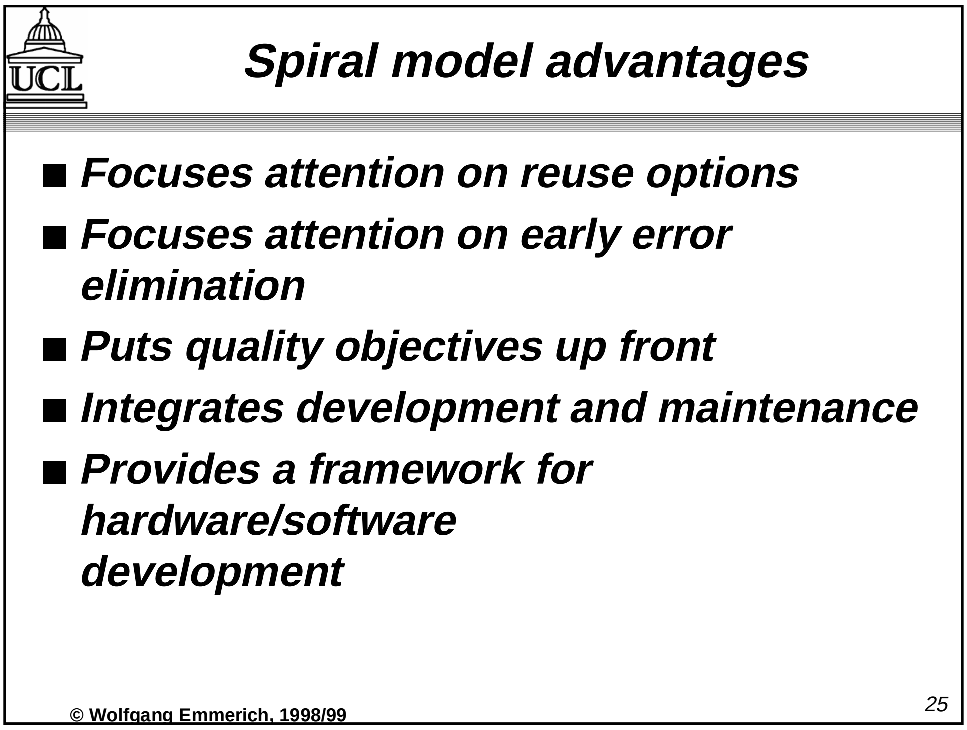
- *Objective setting: Specific objectives for the project phase are identified*
- *Risk assessment and reduction: Key risks are identified, analysed and information is sought to reduce these risks*
- *Development and validation: Find model for next development phase*
- *Planning: Review project and plans next round of the spiral*

Template for a spiral round

- Objectives
- Constraints
- Alternatives
- Risks
- Risk resolution
- Results
- Plans
- Commitment

Spiral model flexibility

- Well-understood systems (low technical risk) - Waterfall model. Risk analysis phase is relatively cheap
- Stable requirements and formal specification. Safety criticality - Formal transformation model
- High UI risk, incomplete specification - prototyping model
- Hybrid models accommodated for different parts of the project



Spiral model advantages

- Focuses attention on reuse options
- Focuses attention on early error elimination
- Puts quality objectives up front
- Integrates development and maintenance
- Provides a framework for hardware/software development

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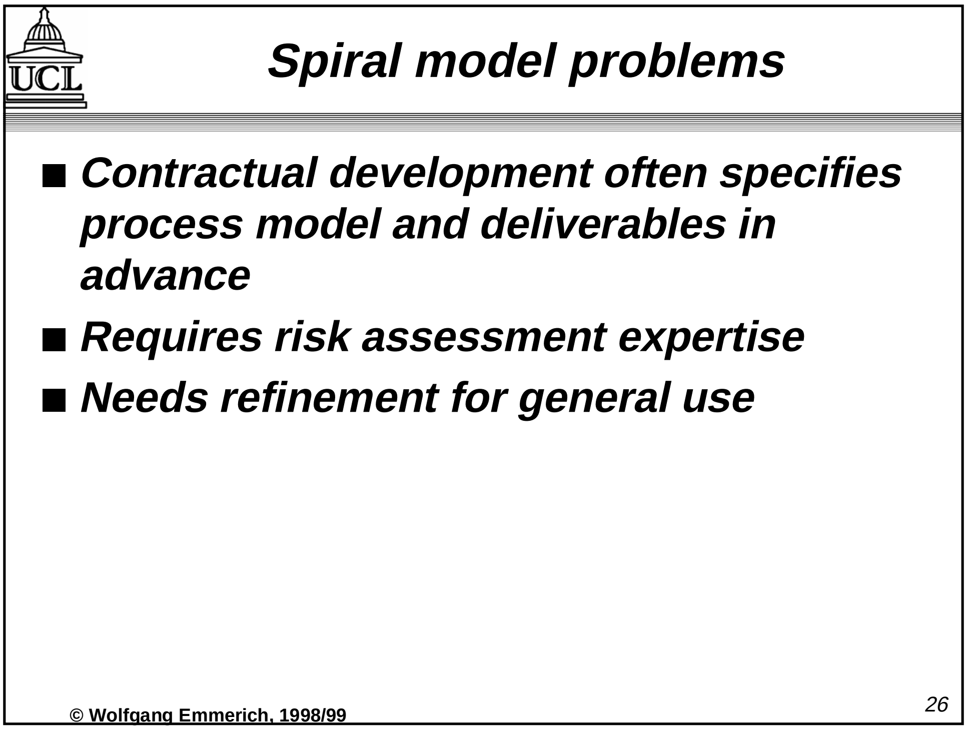

Spiral model problems

- Contractual development often specifies process model and deliverables in advance
- Requires risk assessment expertise
- Needs refinement for general use

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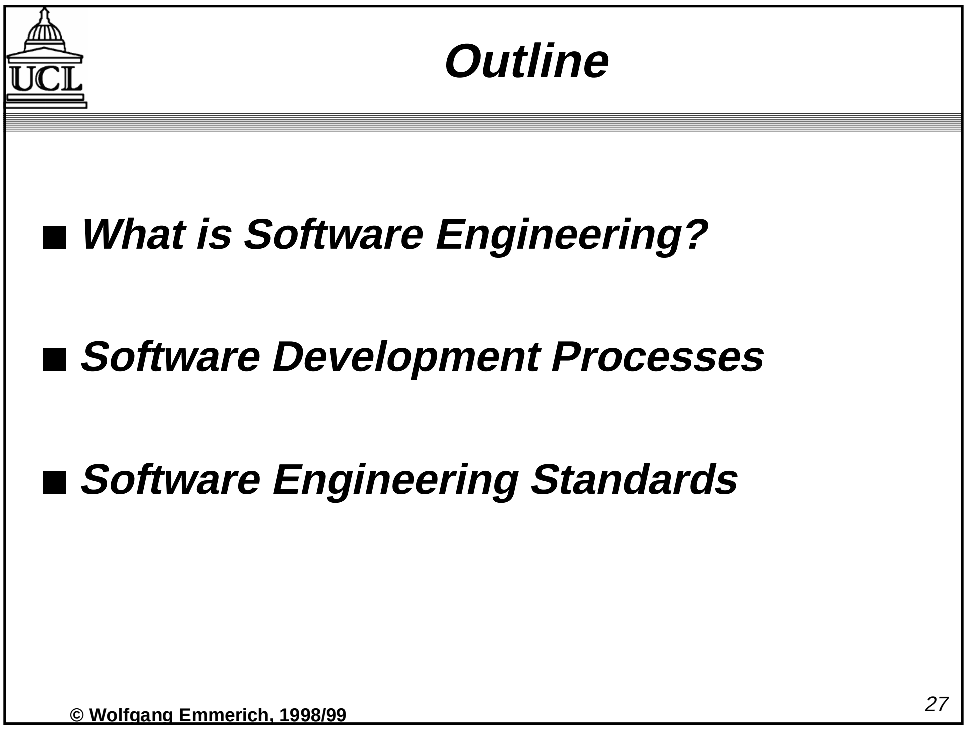

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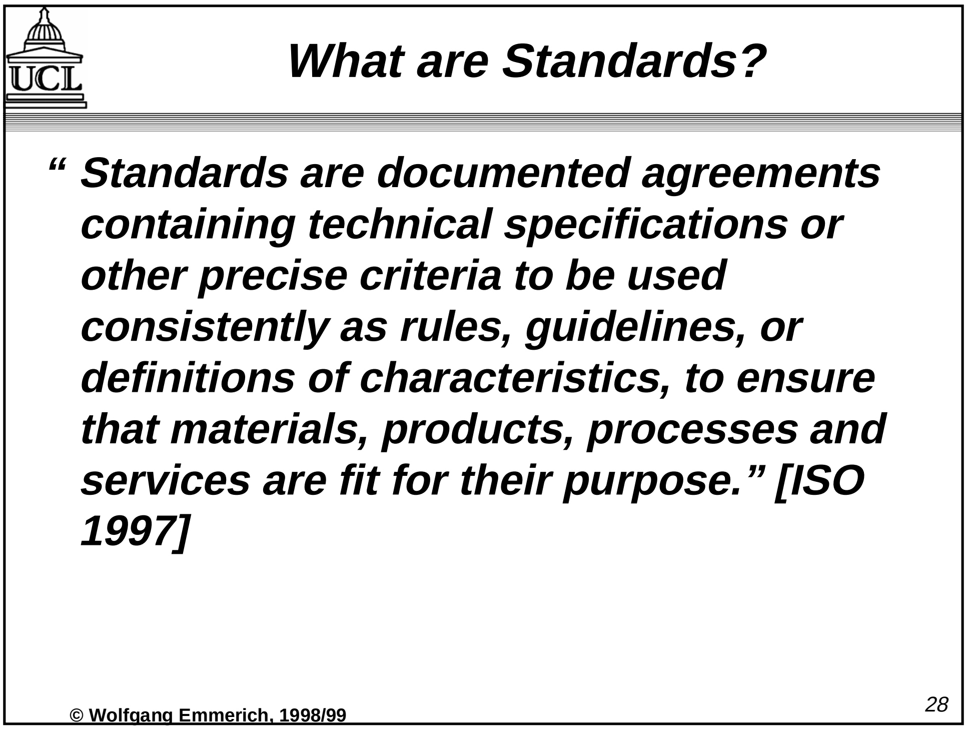

What are Standards?

“ Standards are documented agreements containing technical specifications or other precise criteria to be used consistently as rules, guidelines, or definitions of characteristics, to ensure that materials, products, processes and services are fit for their purpose.” [ISO 1997]

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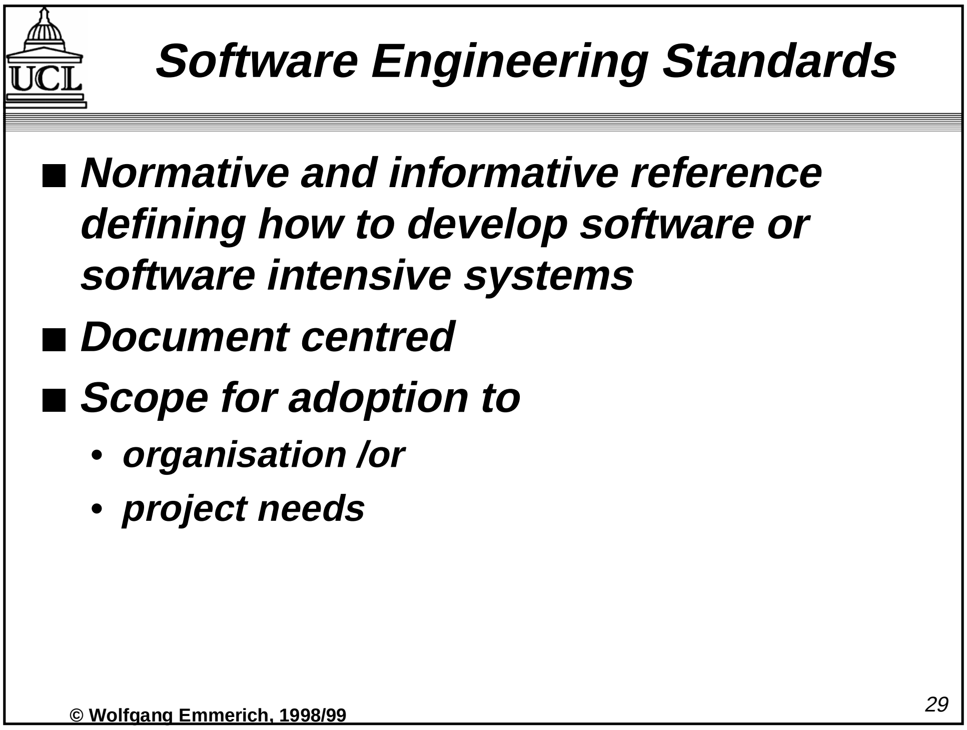
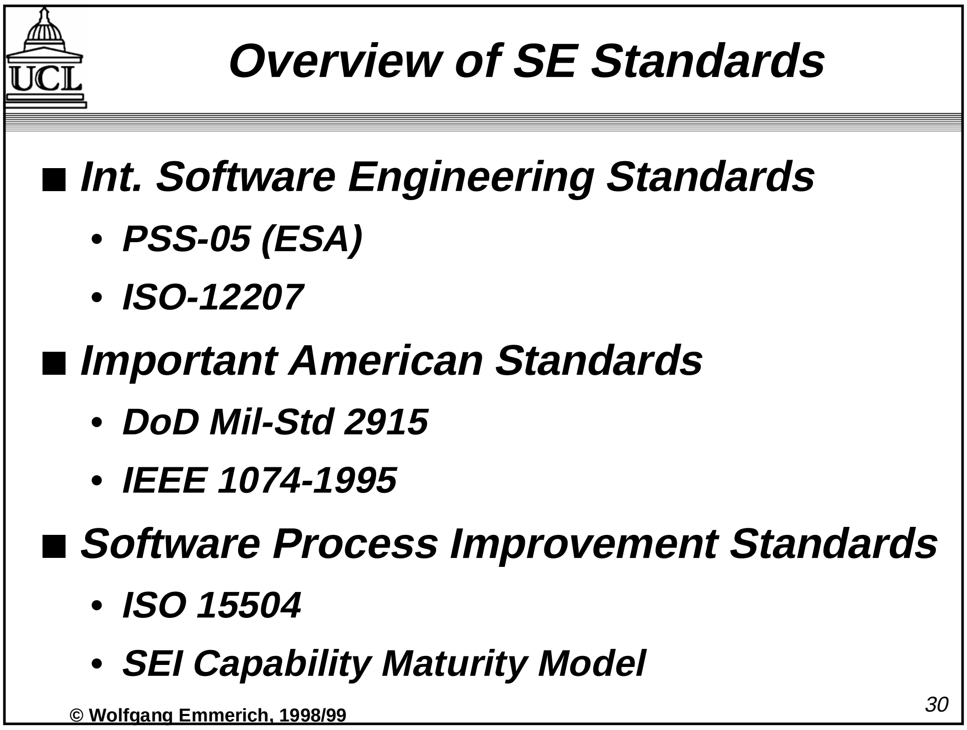


Software Engineering Standards

- Normative and informative reference defining how to develop software or software intensive systems
- Document centred
- Scope for adoption to
  - organisation /or
  - project needs



Overview of SE Standards

- Int. Software Engineering Standards
  - PSS-05 (ESA)
  - ISO-12207
- Important American Standards
  - DoD Mil-Std 2915
  - IEEE 1074-1995
- Software Process Improvement Standards
  - ISO 15504
  - SEI Capability Maturity Model

PSS-05

PSS-05 defines practices for:

- ***production phases,***
- ***software lifecycle and***
- ***management phases.***

A PSS-05 practice can be:

- ***mandatory ("shall"),***
- ***recommended ("should") and***
- ***guiding ("may").***

PSS-05 Production Phases

- ***User requirements***
- ***Software requirements***
- ***Architectural design***
- ***Detailed design & production of code***
- ***Transfer of software to operations***
- ***Operations and maintenance***

PSS-05 Production Phases

PSS-05 practices determine for each phase:

- *Input documents*
- *Activities to be conducted*
- *Output documents*

PSS-05 Example Practices for SR Phase

- *For incremental delivery, each software requirement shall include a measure of priority so that the developer can decide the production schedule.*
- *Critical functions should be identified.*
- *The SRD shall be compiled according to the table of contents provided in Appendix C.*

PSS-05 Software Lifecycle

- Three lifecycle approaches are prescribed
- Process Engineer can select one of
  - Waterfall
  - Incremental Delivery
  - Evolutionary Development

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PSS-05 Management Phases

- Software project management (SPM)
- Software configuration management (SCM)
- Software verification and validation (SVV)
- Software quality assurance (SQA)

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PSS-05 Document Templates

- Standard includes a dozen document templates
- Documents have to conform to structure of templates
- PSS-05 templates are based on IEEE Stds. 730, 828, 829, 830, 1012, 1016, 1058 and 1063.

PSS-05 Template Sample: SRD

1 Introduction

2 General Description

2.1 Relation to current projects

Describe the relationship to other projects

...

3 Specific Requirements

List the specific requirements, with attributes. Subsections may be regrouped around high-level functions.

3.1 Functional requirements

3.2 Performance requirements

3.2 Interface requirements

3.3 Operational requirements

3.5 Resource requirements

3.6 Verification requirements

...

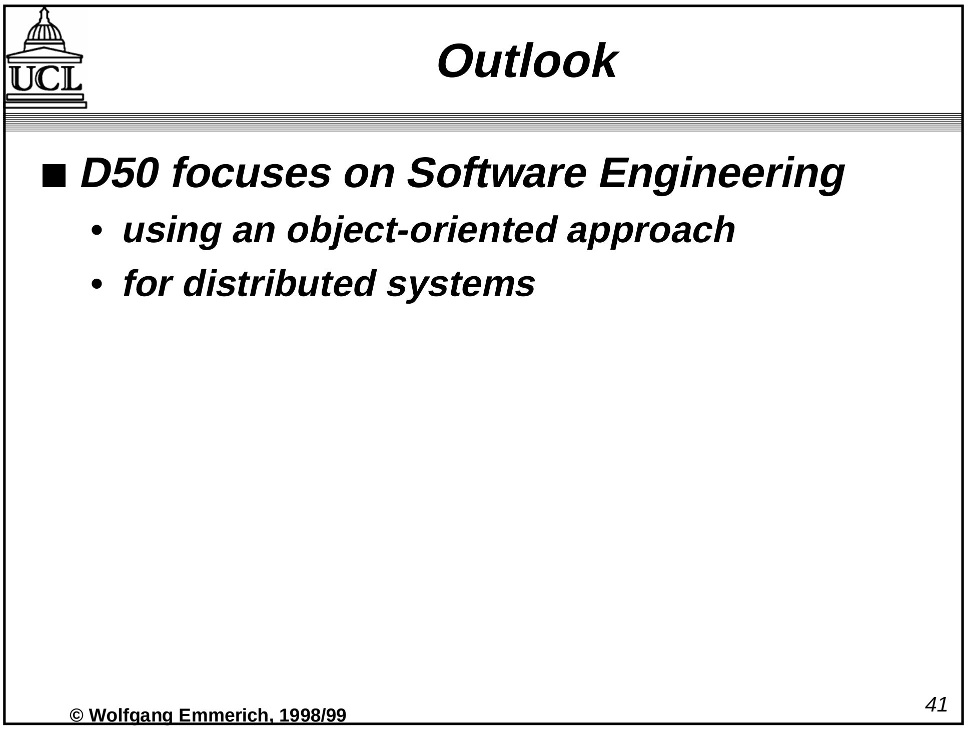
...

Key Points

- Software engineering is concerned with the theories, methods and tools for developing, managing and evolving software products
- The software process consists of those activities involved in software development

Key points

- The waterfall model considers each process activity as a discrete phase
- Evolutionary development considers process activities as concurrent
- The spiral process model is risk-driven
- Software engineering standards determine refine software processes



Outlook

- **_D50 focuses on Software Engineering_**
  - **_using an object-oriented approach_**
  - **_for distributed systems_**