Software Engineering from an Engineering Perspective

SWEBOK as a Study Object

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ADIS WORKSHOP – CEDIS 2007 Zaragoza (Spain) , Oct 11-14 2007

Agenda

- Introduction
- Vincenti Engineering Viewpoint
- Modeling of Engineering Knowledge
- Fundamental Design Concepts
- Analysis of SWEBOK using Engineering Concepts
- Discussion

Introduction

Software Engineering:

- *The application of a systematic, disciplined, quantitative approach to the development operation and maintenance of software the application of engineering to software*' IEEE 6120.12

Introduction

SWEBOK: Software Engineering Body of Knowledge

The SWEBOK Guide – 2004 version:

- Developed by domain experts
- Numerous review cycles
- Transparent process
- ISO technical reviews – ISO TR19759

Introduction

Software Engineering

- Much R&D on developing tools & techniques

But….

- What are its foundations as an engineering discipline?

Introduction

Research questions:

- Is the engineering perspective reasonably described in the SWEBOK Guide?
- How can we improve the SWEBOK Guide from an engineering perspective?

2- Vincenti

‘What engineers know and how they know about it’

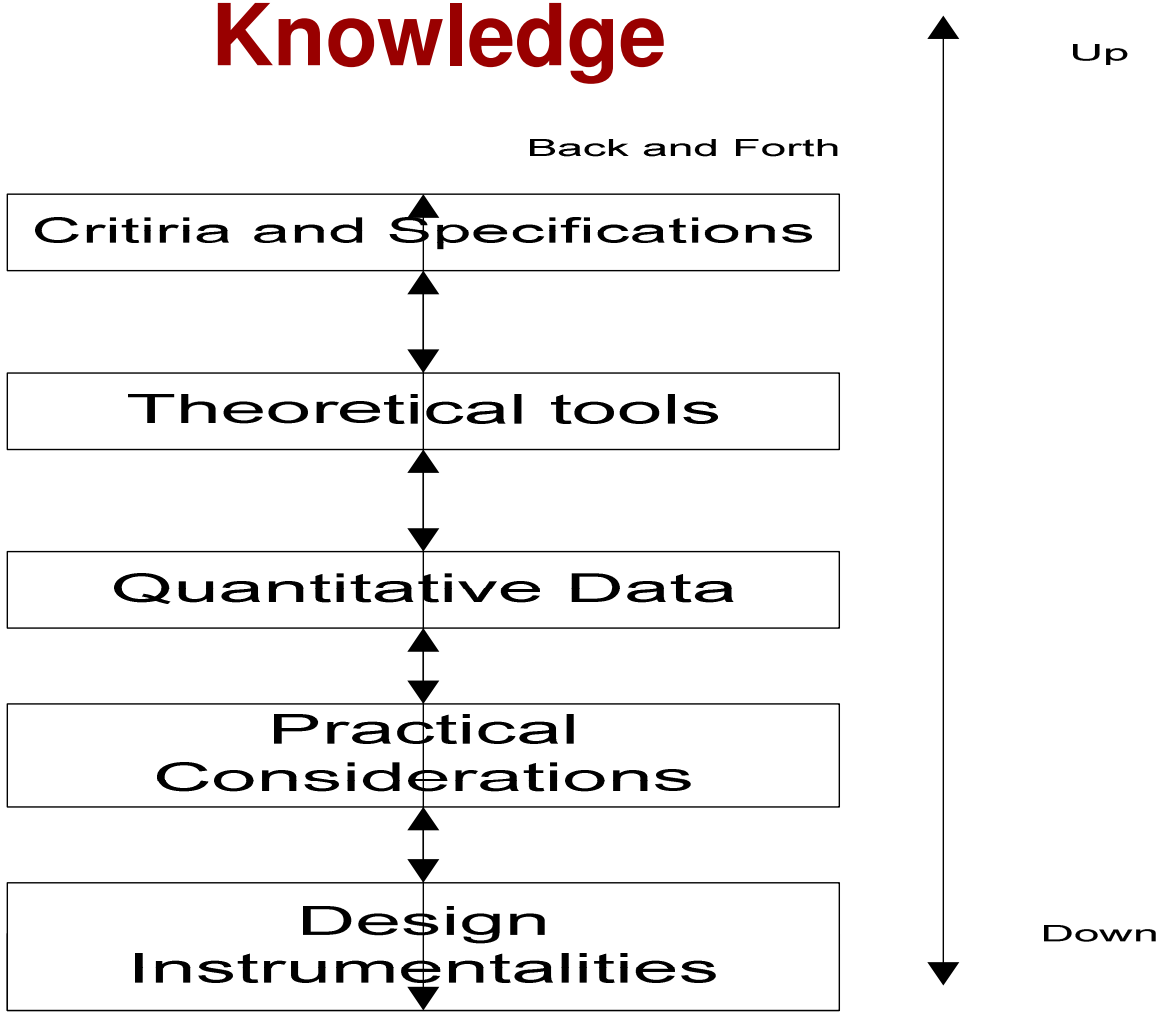
- By W.G. Vincenti. J Hopkins University Press 1980

- Based on the analysis of 5 case studies in the aeronautical industry over a period of 50 years

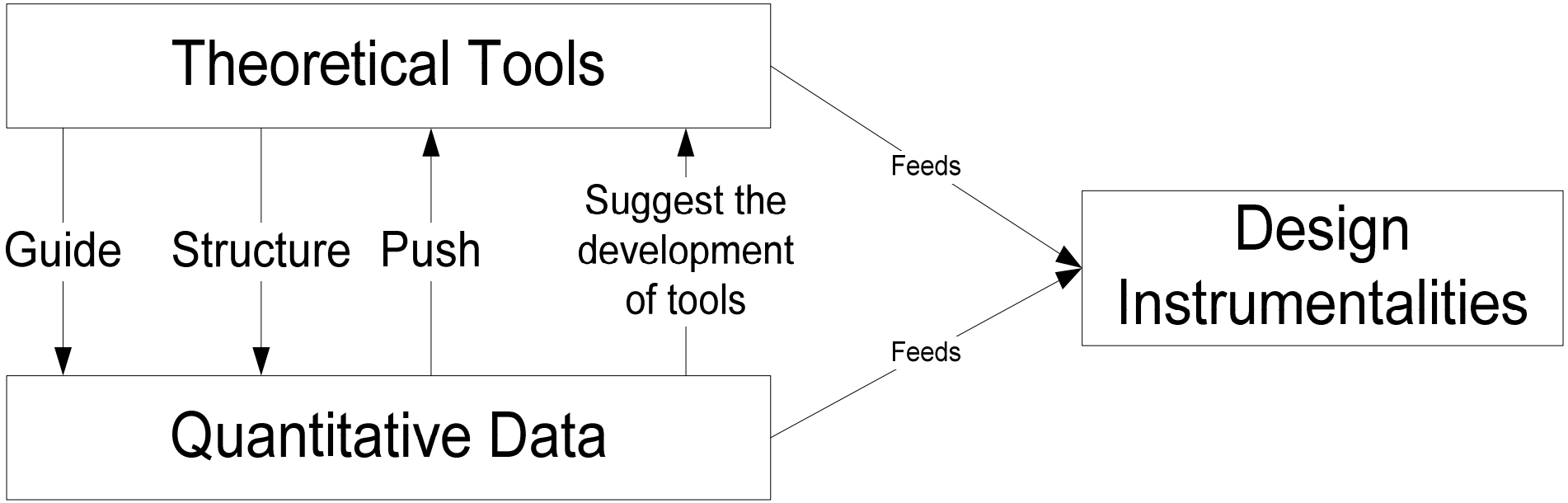
Vincenti: Engineering Knowledge Types

Engineering Knowledge Category	Goals
Fundamental design concepts	Designers embarking on any ***normal design*** bring with them ***fundamental concepts*** about the device in question.
Criteria and specification	To design a device embodying a given operational principle and normal configuration, the designer must have, at some point, ***specific requirements*** in terms of hardware.
Theoretical tools	To carry out their design function, engineers use a wide range of ***theoretical tools***. These include intellectual concepts as well as mathematical methods.
Quantitative data	Even with fundamental concepts and technical specifications at hand, mathematical tools are of little use without ***data*** for the ***physical properties*** or other ***quantities*** required in the formulas. Other kinds of data may also be needed to ***lay out details of the device*** or to ***specify manufacturing processes*** for production.
Practical considerations	To complement the theoretical tools and quantitative data, which are not sufficient. Designers also need ***less sharply defined considerations*** derived from experience.
Design instrumentalities	Besides the analytical tools, quantitative data and practical considerations required for their tasks, designers need to know ***how to carry out those tasks***. How to ***employ procedures*** productively constitutes an essential part of design knowledge.

Vincenti Classification of Engineering Knowledge



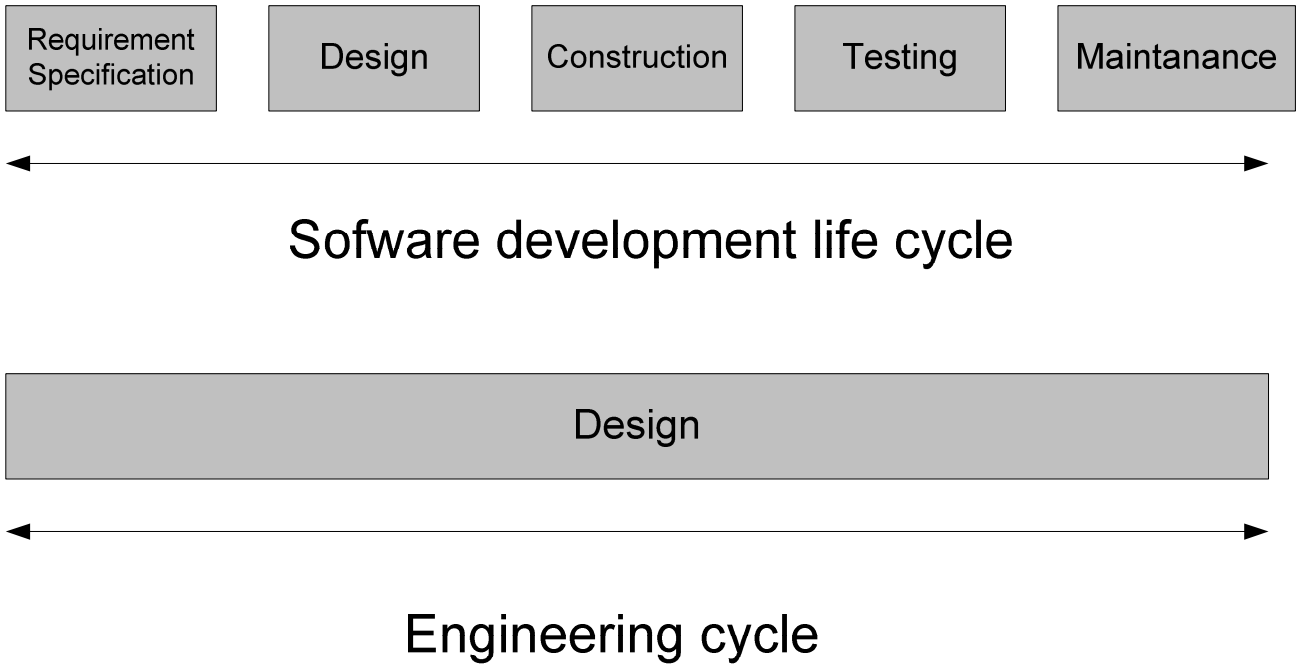
Relationships



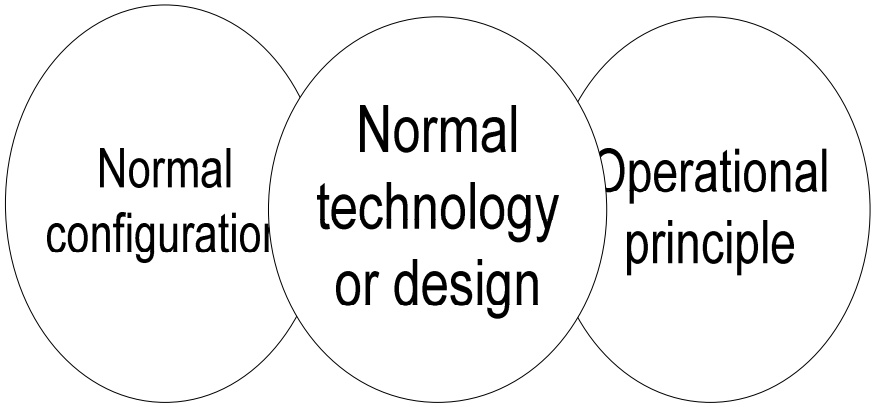
The Design Process in Engineering

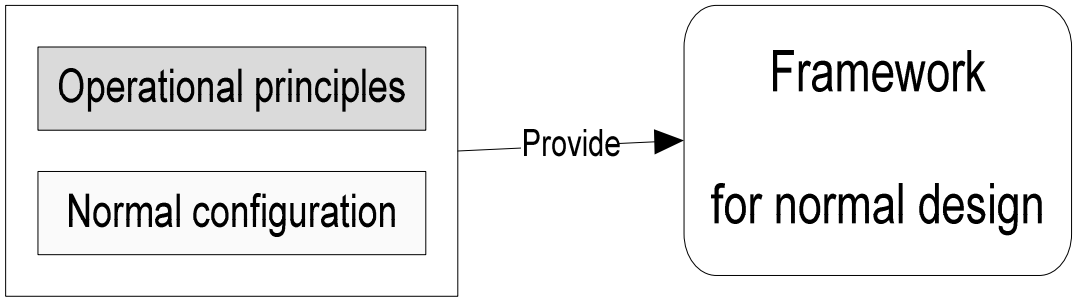
Levels	Description of the design process in Vincenti engineering perspective	Corresponding set of concepts in SWEBOK
1	Project Definition	Requirements
2	Overall design – component layout of the airplane to meet the project definition.	Specification
3	Major component design – division of project into wing design, fuselage design, landing gear design, electrical system design, etc.	Architecture of the system
4	Subdivision of areas of component design from level 3 according to the engineering discipline required (e.g. aerodynamic wing design, structural wing design, mechanical wing design)	Detailed design
5	Further division of the level 4 categories into highly specific problems	Construction

Design: Vincenti vs Software Eng.



Relationships – Normal Configuration & Design





SWEBOK: QUALITY Knowlege Area & Vincenti Knowledge Types

Engineering Knowledge Category	Corresponding Characteristics	SWEBOK – quality related concepts
Fundamental design concepts	• About the design • Designers must know the operational principle of the device • How the device works • Normal configuration • Normal design • Other features may be (opened?)	• Planning the software quality process • Quality characteristics of the software (QI), (QE), (QIU) • Software quality models • Quality assurance process • Verification process • Validation process • Review process • Audit process

SWEBOK: QUALITY Knowlege Area & Vincenti Knowledge Types

Criteria and specification	• Specific requirement of an operational principle • General qualitative goals • Specific quantitative goals laid out in concrete technical terms • The design problem must be "well defined". • Unknown or partially understood criteria • Assignment of values to appropriate criteria • This task takes place at the project definition level.	• Quality objective to be specified • Characteristics of quality tools • Software characteristics • Criteria for assessing the characteristics

SWEBOK: QUALITY Knowlege Area & Vincenti Knowledge Types

Theoretical Tools	• Mathematical methods and theories for making design calculation • Intellectual concepts for thinking about design • Precise and codifiable	• Verification process model • Formal methods • Testing • Theory measurement • Verification/proving properties • TQM (Total Quality Management)
Quantitative data	• Specify manufacturing process for production • Display the detail for the device • Data essential for design • Obtained empirically • Calculated theoretically • Represented in tables or graphs • Descriptive knowledge • Prescriptive knowledge • Precise and codifiable	• Quality measurement • Experimental data • Empirical study • E.g. the process of requirement inspection • Value and cost of quality

SWEBOK: QUALITY Knowlege Area & Vincenti Knowledge Types

Practical Considera-tions	• Theoretical tools and quantitative data are not sufficient. Designers also need considerations derived from experience. • It is are difficult to find them documented. • They are also derived from production & operation. • This knowledge is difficult to define. • Its defies codification • The practical consideration derived from operation is judgment. • Rules of thumb.	• Application quality requirements • Defect characterization

SWEBOK: QUALITY Knowlege Area & Vincenti Knowledge Types

Design Instrumenta-lities	• Knowing how • Procedural knowledge • Ways of thinking • Judgment skills	• Quality assurance procedures • Quality verification procedures • Quality validation procedures • SQM process tasks & techniques • Management techniques • Measurement techniques • Project planning and tracking • Quality assurance process • Verification process • Validation process • Review process • Audit process

Next Steps

- Analysis of all SWEBOK Knowledge Areas
- Identification for gaps, from an engineering perspective:
  - should open up new research avenues
- + work in progress on the Fundamental Principles of Software Engineering

Thank You !

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