In search of software engineering principles:

1996-1998 Delphi studies to develop a group consensus

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List of topics

- Introduction: Standards & Principles
- Delphi Studies – Objectives & Rounds
- Criteria and Participants
- Outcomes

Standards Strive to Balance Principles and Practice

Standards strive to integrate and organize strengths of *a priori* principles with 'best' practices observed in the messy real-world.

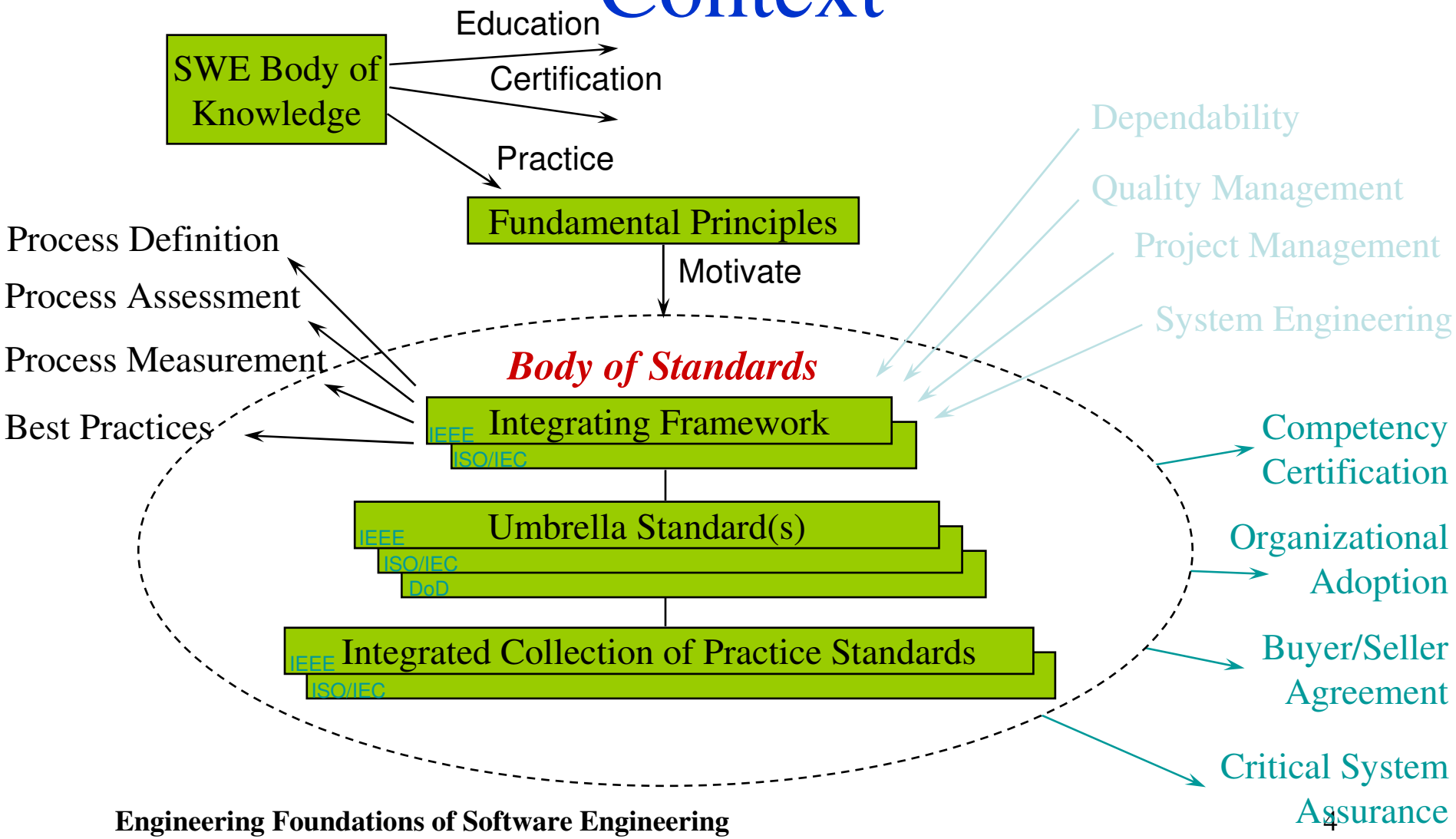
In many disciplines, *a priori* considerations are provided by science and mathematics. Sometimes they are provided by 'traditions' or by market forces. In software engineering, there is no agreement on such *a priori* and we have to discover and figure out what are its principles.

L1

Slide 3

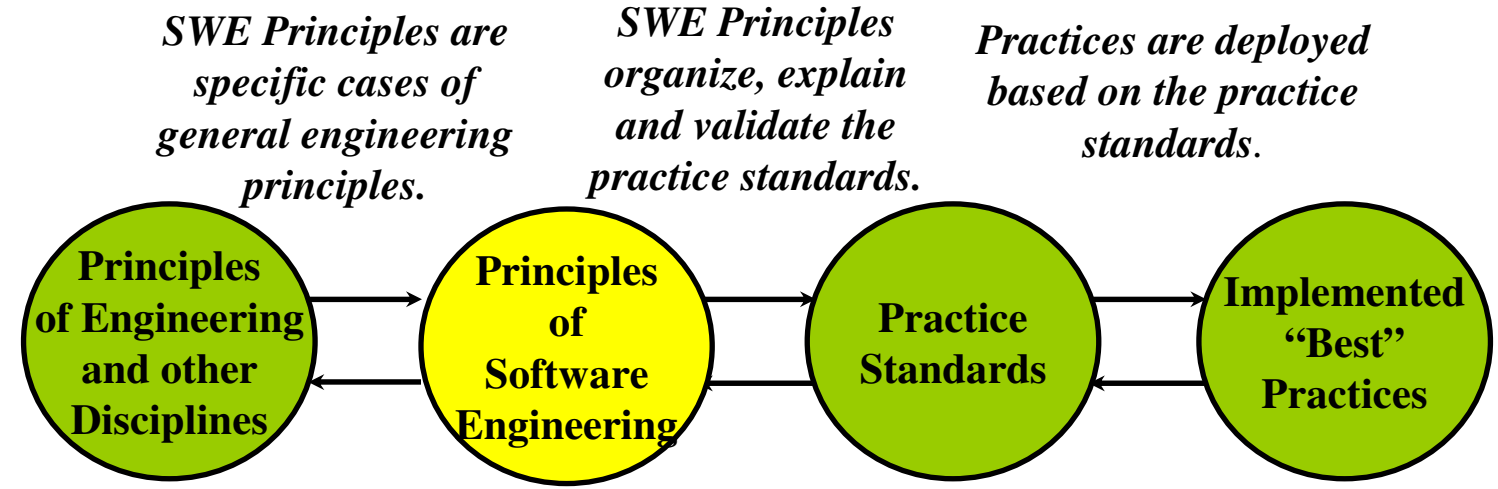
L1 We have to invent 'what'?
LOG, 20/08/2007

Software Engineering Standards Context



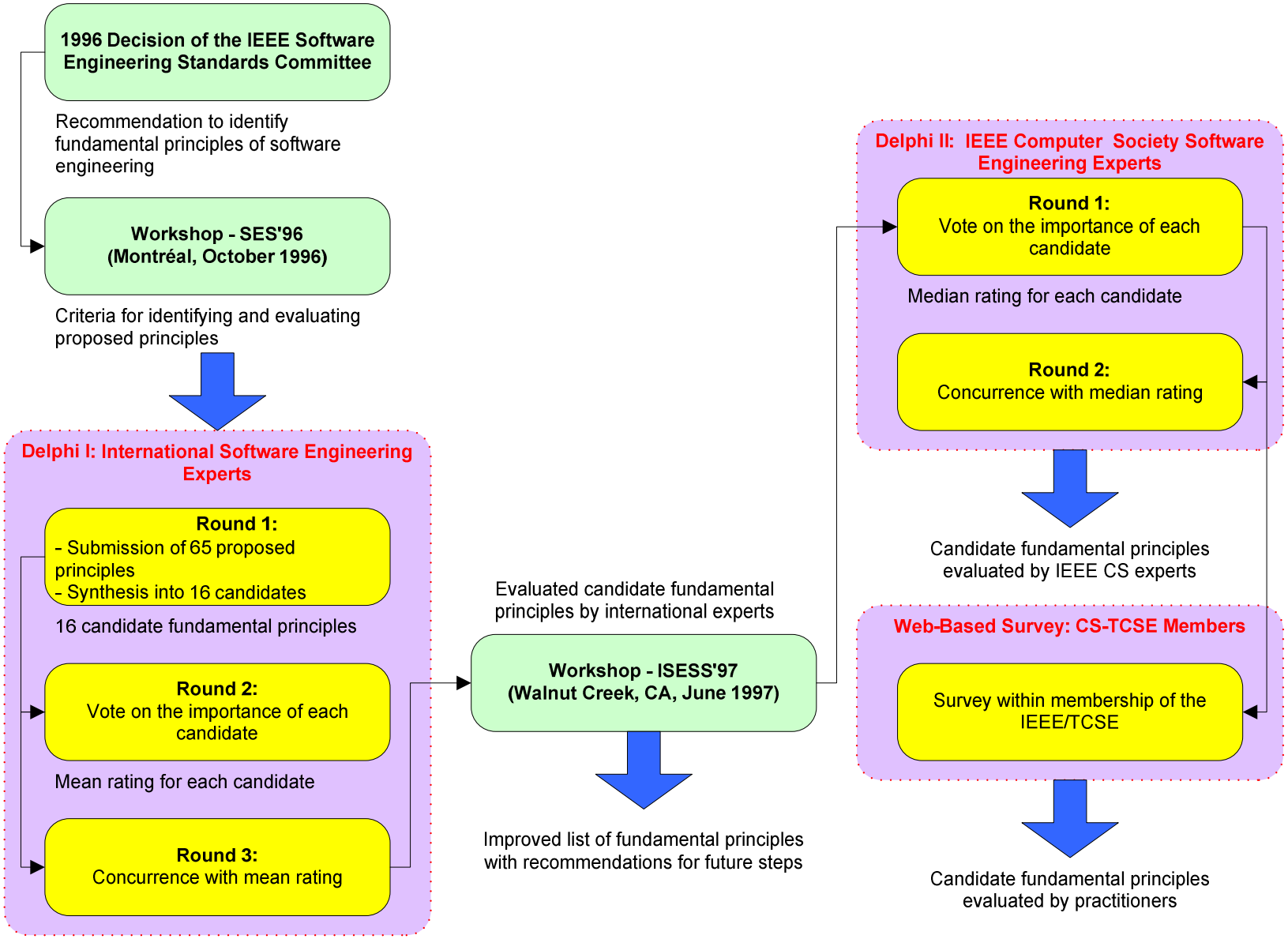
Fundamental Principles of Software Engineering

A collaborative Effort: IEEE Computer Society & Université du Québec (UQAM-ETS)



Source: [Jabir97]

The 1996-1998 Search Process



Criteria:
Principles must be ...

- Less specific than methodologies
- More durable than methodologies and techniques
- Extracted from practice
- Linked to at least one underlying concept of SE
- Not involve a trade-off
- Be specific enough to be able to demonstrate experimentally that not applying the principle leads to bad consequences (e.g. undesirable outcomes).

L2

Slide 7

L2 Est-ce le bon mot en anglais?
LOG, 20/08/2007

Objectives of Delphi I (Three rounds)

- Evaluation of criteria
- Identify and evaluate candidate principles
- Propose recommendations on criteria & principles

Participants

- M. Azuma, Waseda University, Japan
- F.P. Brooks, U. of North Carolina, USA
- R.N. Charette, ITHABI Corp., USA
- P. DeGrace, Consultant, USA
- C. Ghezzi, Politecnico di Milano, Italie
- T. Gilb, Result Planning Ltd, Norway
- B. Littlewood, City University, G-B

Participants

- S. MacDonell, U. of Otago, New-Zealand
- T. Matsubara, Matsubara Consulting, Japan
- J. Musa, Consultant, USA
- R. Pressman, R.S. Pressman & Associates, USA
- M. Shaw, Carnegie-Mellon U. USA
- Two participants chose to remain anonymous

ROUND 1

- Objectives
  - Get candidate principles
  - Get justifications
  - «Formulate what you would consider five Fundamental Principles of Software Engineering»
- Results
  - 13 participants contributed
  - 65 suggestions
- Outcome
  - Consolidated into 16 PFs

  (Including elimination of duplicates)

ROUND 2

- Objectives
  - Evaluate (on a scale 1-10) the 16 candidates
  - Get additional justifications on the score
- Results
  - 10 participants contributed

ROUND 3

- Objectives
  - Measure the level of consensus on the average scores from Round 2 outcome
  - 12 participants contributed

Fundamental Principles of SE

A. Apply and use quantitative measurements in decision-making

B. Build with and for reuse

C. Control complexity with multiple perspectives and multiple levels of abstraction

D. Define software artifacts rigorously

E. Establish a software process that provides flexibility

F. Implement a disciplined approach and improve it continuously

G. Invest in the understanding of the problem

H. Manage quality throughout the life cycle as formally as possible

I. Minimize software component interaction

J. Produce software in a stepwise fashion

K. Set quality objectives for each deliverable product

L. Since change is inherent to software, plan for it and manage it

M. Since tradeoffs are inherent to software engineering, make them explicit and document them

N. To improve design, study previous solutions to similar problems

O. Uncertainty is unavoidable in software engineering. Identify and manage it

Recommandations

- Validate the list through a second Delphi study with experts of the IEEE software engineering community
  - [Walnut Creek, CA, June 1997]
- Cross-check with practitioners
  - members of the IEEE Computer Society

Recommendations

- Improve the list by using it to analyze:
  - the current SE standards portfolio [Walnut Creek, CA, June 1997]
  - the SE body of knowledge as stated in current textbooks
  - the SE curriculum

Modifications for Delphi II

- Removal of three candidates
- Addition of:
  - *To improve design, study previous solutions to similar problems*
  - *Control complexity with multiple perspectives and multiple levels of abstraction*

Delphi II

- 72 experts of the Computer Society:
  - *Technical Council on Software Engineering*
  - Editorial committees:
    - '*Software*'
    - '*Transactions on Software Engineering*'
- 30 participants contributed
- Results very similar to Delphi I

Last step : Web-based Survey of practitioners

- Participants from 48 countries
- Employers: R&D, software development, education, ...
- Education level:
  - 43% : Ph.D.,
  - 35% : Masters,
  - 19% : Undergraduates

Last step: Web-based Survey

- # of years of experience in industry: :
  - 9% : 30+ years
  - 30% : 20-29 years
  - 48% : 10-19 years
  - 13% : 1-9 years

Data

- Quantitative:
  - Scores on each of the 15 candidate principles
  - Measures of consensus level relative to each score
- Qualitative:
  - Comments on candidate principles

Quantitative data analysis

- Average and median scores for each principle
- Assessment of consensus level on each principle
  - including standard deviation

Most popular

L. Since change is inherent to software, plan for it and manage it.(9.1-12)

G. Invest in the understanding of the problem. (8.7-10)

M. Since, trade-offs are inherent to software engineering, make them explicit and document them. (8.4-11)

P. Uncertainty is unavoidable in software engineering. Identify and manage it. (8.0-11)

Least popular...

N. The requirements must be firm and fixed (3.3 - 9)

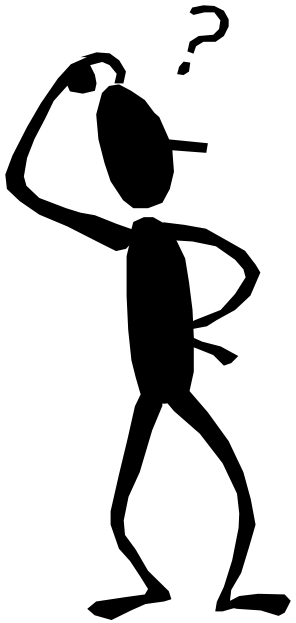
O. The tools, methods, and support systems must be designed and selected to support the software engineers. (4.2 - 10)

C. Deal with different individual aspects of the problems by concentrating on each separately. (4.9 - 6)

Conclusions

- Delphi method proved appropriate when expert opinion is the main source of information
- Results form Delphi study can be used for surveys or experimentation

Q & A



Some surprises...

A. Apply and use quantitative measurements in decision-making. (7.6 - 9)

F. Implement a disciplined approach and improve it continously. (6.9 - 7)

D. Define software artifacts rigourously. (6.4 -8)

H. Manage quality throughout the life cyle as formally as possible. (7.8 - 9)

Others...

B. Build with and for reuse. (8,0 - 9)

E. Establish a software process that provides flexibility. (7,6 - 10)

I. Minimize software components interaction. (7,3 - 11)

J. Produce software in a stepwise fashion. (7,7 - 8)

K. Set quality objectives for each deliverable product. (7,7 - 11)

Importance of 'Measurement' in SE: quantitative data analysis

- Selection of comments relative to measurement
- Issues identified from analysis of comments
- Links to literature
- Statement of research issues

Importance of 'Measurement' in SE : Analysis of qualitative data

Comments:

- « Measurement is important, but it should deliver value commensurate with the cost of collecting and analyzing information »
- « While I am a proponent of quantitative measurement, decisions should be based on the amount of information that is cost-effective to acquire given the importance ($) of the decision »

Importance of 'Measurement' in SE : Analysis of qualitative data

- *Issue*: Value attributed to measurement may not be higher that its costs
- *Link to literature*: How much effort should one invest in software defects measurement? (Weller 1994)
- *Question*: Is there a method to evaluate costs/benefits of measurement ?