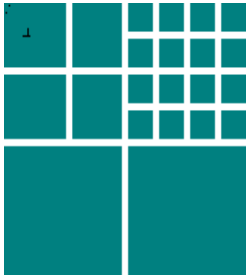

The Experimental Software Engineering Group: A Perspective

Victor R. Basili

Institute for Advanced Computer Studies

Department of Computer Science

University of Maryland

and

Fraunhofer Center - Maryland

Research Assumptions

- The study of software engineering is a laboratory science
- Understanding the discipline involves learning, i.e.,
  - observation
  - reflection, encapsulation of knowledge, model building
  - experimentation
  - model evolution over time
- The essential problem in software engineering is:
  - What is the appropriate process for developing a system with a specific set of properties given a set of constraints in a specific environment**?**
- Our essential question is:
  - **Can empirical studies help address that problem?**

Building a Basis for Empirical Study

- Can we measure and differentiate?
  - Can we measure and differentiate software products?
  - Can we empirically study the effects of processes?
  - Can we differentiate their effects, measure the differences?

- Can we improve the product and project?
  - Can we improve productivity and quality by manipulating process?

- Can we improve the process?
  - Can we use empirical studies to define improved processes and techniques?
  - Can we define techniques with different goals and empirically validate that they satisfy those goals?
  - Can a particular reading technique detect more of a particular class of defect than another reading technique?

Can we measure and differentiate?

- Questions of Interest
  - Can we measure and differentiate software products?
  - Can we empirically study the effects of processes?
  - Can we differentiate their effects, measure the differences?
- Study Context
  - University-based projects, student projects
  - Professional programmers
- Study methods
  - Individual Case Studies, Controlled Experiments
- UM Community
  - Joe Turner, Bob Reiter, Dave Hutchens, Rick Selby, Chris Lott, Oliver Laitenberger, Sivert Sorumgaard, ...
  - Filippo Lanubile, Adam Porter, Walcelio Melo, ...

Can we measure and differentiate?

Results

- Differentiated the effects of structured methods
- Developed and studied the effect of **Iterative Enhancement** Method
- Classified Experiments and Experimental Designs
- Differentiated the effects of **testing vs. reading** techniques
- Differentiated the effects of Mill's **Cleanroom** methodology

Can we improve the product?

- Questions of Interest
  - Can we improve productivity and quality by manipulating process empirically study the effects of processes?
- Study Context
  - NASA/GSFC flight software projects (SEL)
- Study methods
  - Controlled Experiments, Case Studies, Multiple Projects
  - Qualitative Analysis
- UM/NASA/CSC Community
  - Dave Weiss, John Bailey, Rick Selby, Lionel Briand, Bill Thomas, Carolyn Seaman, Manoel Mendonca, Daniil Yakimovitch, Mike Stark, ...
  - Marvin Zelkowitz, Frank McGarry, Bill Agresti, Dieter Rombach, Rose Pajerski, Jon Valett, Scott Green, Gianluigi Caldiera, ...

Can we improve the product?

Results

- Developed the **Goal/Question/Metric Paradigm**
- Developed the **Quality Improvement Paradigm**
- Developed the **Experience Factory Organization**
- Demonstrated continuous improvement in the NASA/**Software Engineering Laboratory**
  - Decreased **Development Defect rates** by
  - **75%** (87 - 91) **37%** (91 - 95)
  - Reduced **Cost** by
  - **55%** (87 - 91) **42%** (91 - 95)
  - Improved **Reuse** by
  - **300%** (87 - 91) **8%** (91 - 95)

Can we improve the process?

- Questions of Interest
  - Can we use empirical studies to define improved process and techniques?
  - Can we define techniques with different goals and empirically validate that they satisfy those goals?
  - Can a particular reading technique detect more of a particular class of defect than another reading technique?
- Study Context
  - Industry, University, Individuals, ….
- Study methods
  - controlled experiments, case studies, observational studies
- Community
  - Forrest Shull, Zhijun Zhang, Jeff Carver, ...
  - Guilherme Travassos, Ben Shneiderman, …

Can we improve the process?

Results

- **Developed five families of reading techniques**
  - parameterized for use in different contexts and
  - evaluated experimentally in those contexts

- **Several have evolved based on various forms of empirical studies**
  - **Perspective Based Reading (PBR):**
  - **for detecting defects in requirements documents in English**
  - **Object Oriented Reading :**
  - **for detecting defects in object oriented design in UML**

Can we improve the process?

Results

- Developed an approach for combining the results of several experiments to build our knowledge about software processes
  - We can **effectively design and study techniques** that are procedurally defined, document and notation specific, goal driven, and empirically validated for use
  - We can demonstrate that a **procedural approach** to a software engineering task could be more effective than a less procedural one under certain conditions (e.g., depends on experience)
  - A procedural approach to reading based upon **specific goals** will find defects related to those goals, so reading can tailored to the environment

Changes in Empirical Study Components

- Study Context
  - University Projects, Industry, Government, International Organizations
- Study methods
  - controlled experiments, case studies, structured interviews, observational studies
- Analysis Methods
  - correlations, regressions --> pattern recognition models
  - quantitative analysis --> qualitative analysis
- Measurement
  - interval and ratio, nominal and ordinal
  - characterize, evaluate, predict, control
- Study Goals
  - effect, feasibility, improvement

Building a Community

- We have created an environment in which
  - Many students worked on some aspect of the problem, building on the work of others
  - Many visitors brought and left with expertise
    - Ross Jeffrey, Giovanni Cantone, Markku Oivo, Sandro Morasca, Filippo Lanubile, Maurizio Morisio, Reider Conradi, ...
- Interchange occurred through (almost) weekly group meetings
- which have lead to international collaborations (ISERN)
- the Journal on Empirical Software Engineering (JESE)
- and the Fraunhofer Center for Experimental Software Engineering