The Impact Project: Tracing the Source of Software Engineering Technology to its Origins

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Where Does Software Technology Come From?

• Who should get the credit?
  – What credit should they get?
• How to award credit?
  – What measures?
  – How to determine them?
• Does this really matter?
  – To whom?
  – For what reasons?
Credit is due to:

- Commercializers
- Researchers
- Tech Transfer agents
- Early adopters
- Scientific and Technical Communities
- Students with new degrees
- New Hires
- ETC.

What are the natures of their contributions? How to value them?
Contributions Differ

- Initial conceptualization of idea
- Evangelism
- Prototype demonstration
- Public promulgation
- Nurturing by community activities
- Indoctrination and training (students)
- Product commercialization
How to Evaluate These?

- Qualitatively
- Quantitatively
- Different perceptions by different parties
- Difficulties in assessing contributions
Facile answers are misleading

• It comes from:
  – Sun, Microsoft, IBM, Rational, the web,
• Yes, but!
  – Where did they get it from? And how?
• It comes from Dr. X’s research
  – Published a seminal paper
• Yes, but!
  – Someone else cleaned it up, crafted code
• It was “in the air”
  – How did it get there? Who nurtured it?
Why should we care?
(as users, beneficiaries)

- Some technology isn’t great
  - Why are we stuck with it?
  - Why isn’t it better?
- Some technology seems useful
  - How can we get more of same?
  - How can we speed its appearance?
  - Are there institutions that need to be
    - Strengthened
    - Demolished
Why Should We Care? (As Researchers)

• Altruistic reasons
  – More effective tech transfer
  – Better technologies in use

• More self-serving reasons
  – Self-image
  – Academic status
  – Positive Attitude
  – Funding prospects
Software Engineering Myths

- Software engineering research has had minimal impact on practice
- Software engineering research results have effected minimal increases in productivity
- Software engineering research has been a poor investment, giving little return
- Industry leads, research follows
  - (Industry cleans up; research sweeps up)

(Some myths are false, some are not)
Software Engineering Facts

(Some “facts” are false, some are not)

• Theory:
  – Software engineering research problems are hard, fundamental, and enduring
  – The research community has an increasingly strong grip on these problems

• Practice:
  – Software practice has achieved orders of magnitude productivity increases
  – Research results have driven much of this
More “Facts”

• We don’t know what the truth really is
• We are not really sure how to decide what “the truth” really is
• We really need to find out…….
The Impact Project: Tracing the Source(s) of Technology to its Origins

- Focus is on Software Technology
- Start with technologies in widespread use
- Trace back to how they came into widespread use
- Document and analyze
  - What facilitates/inhibits technology flow?
  - How to make more good things happen more easily and more often
Impact Project Structure

- Software community volunteer effort
- Modest sponsorship by:
  - ACM Sigsoft, US NSF, IEE, Japan
- Collection of reports on key areas
- Appearing 2002 onwards
Selected Report Topics

- Configuration Management
- Reviews and Walkthroughs
- Design Methods and Tools
- Programming Environments
- Modern Programming Languages
- Cost and Economic Modeling
- Testing and Evaluation
- ..... And more.....
Project Products

- **Set of reports**
  - Organized around subject areas
  - Range of sizes
    - Full (25-30 pages?): journal quality
    - Condensed (3-5 pages?): magazine style
    - Popular press (?): Scientific American?
    - Abstracts (one pager, one paragraph)

- **Briefing materials**
  - For all occasions
Project Organization

• Steering Group:
  – L. Osterweil, J. Kramer, C. Ghezzi, A. Wolf

• Subject Area-Based Author Groups
  – 12-20 Subject areas
  – 8-10 Authors per subject area
  – 1 or 2 CoLead Authors per subject area
  – Inclusive, open to broad community participation

• Panel of Distinguished Reviewers
Status Report on Software Configuration Management Study

Alexander L. Wolf
Department of Computer Science
University of Colorado at Boulder
Team

• Lead Authors
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  – G. Clemm, Rational (Clear Case, Odin)
  – R. Conradi, U. Trondheim (EPOS)
  – A. van der Hoek, UCI (NUCM)
  – W. Tichy, U. Karlsruhe (RCS)
  – D. Wiborg-Weber, Continuus (CCM)
What is SCM?

- Managing a repository of components
  - Version Control; Product Models; Composition and Selection
- Helping engineers in their usual activities
  - Building (derived object control); Work Space Control
- Controlling and supporting the process
  - Change Control; Cooperative Work; Process Support
SCM Is in Wide Use

• Ovum estimates:
  – 25% mainframe; 15%-20% workstations; 5%-10% PC

• Gartner estimates:
SCM Impact Study Plan

- Examine characteristics/features of leading products in SCM market
- Assume that products used in practice
- Trace characteristics/features back to research ideas and prototypes
- Try to establish arguments for/against influence of research on practice (via products)
Complex Interplay between Research and Commercialization

- Research initiative was shared between academia and industry
- Some research tools were seriously used in practice
  - Make, RCS, Odin, Adele ...

- NUCM
- Proteus Vesta
- Dacs ICE
- Asgard

- ClearCase Continuus

- EPOS

- PVCS
- CCC/Harvest
- NSE
- DSEE

- Make
- RCS
- Jasmine

- from A. van der Hoek

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Other Factors As Well

- Role of Community Nurturing
  - Product architects present at nearly all SCM workshops (1988-2001)
  - Cagan, Clemm, Dart, Leblang, Wiborg-Weber

- Movement of key people precipitated progress
Impact of Software Engineering Research on Modern Programming Languages

A work in progress

Barbara G. Ryder and Mary Lou Soffa
Approach

- Focus on languages currently in widespread use: e.g., Java, C++, Ada, Perl
- Find origins of, and influences on, essential features of these languages
Challenges

- PL and SE have a complex, close, synergistic relationship
- Hyp 1: SE research impacted PL design
- Hyp 2: PL impacted SE research and practice
- SE(PL) research also influenced SE(PL)
  - Parnas on modularity -> OO design
  - Simula 67 -> C++, Java
Modularity and Information Hiding

- Roots of OO languages – (modules, objects, inheritance, dynamic method binding) – Simula 67
- Parnas (1972) was one of the first to recognize value of modularity (code + data)
- Parnas first to come up with notion of information hiding (1972)
- Refined notion of encapsulation appeared in CLU in 1977
Exceptions

- Introduction of exceptions - ON conditions in PL/I in early 1970’s
- J. Gannon, J.J. Horning (CACM 1975) explore issues in PL design for reliability
- J. Goodenough (CACM 1975) defines exception conditions and proposes PL features for handling
- Mesa, Mitchell et al (1979) and Ada, J. Ichbiah et al. (Ada Rationale 1979)
- CLU, B. Liskov, A. Snyder (IEEE-TSE 1979) offers clean definition of handling
Some Broader Lessons

• Vendors tend to see value (impact) in
  – algorithms (e.g., differencing)
  – pieces of reusable code (e.g., RCS)

• But not in
  – concepts (e.g., hierarchical workspaces)
  – architectures (peer-to-peer repositories)
  – Which are often seen as “engineering common sense”
  – “Research had very little influence …”
  – “We do not sell ideas, but tools. We (re)invented everything we needed…”
More Lessons

• Researchers tend to see impact in
  – Precedence
  – Concepts
  – Prototypes

• But tend to devalue importance of
  – Efficiency
  – Usability
  – Reliability
  – seeing them as “engineering common sense”
  – “We invented almost everything …”
  – “Tools are only an engineering issue …”
Still More Lessons

- Both are right, both are wrong
- A good idea is had more than once
- Vendors have disincentives for distributing credit for ideas
- Researchers have incentives for claiming credit for ideas
- Research and productization both require *engineered creativity*
Final Observations

• Cultural chasms between research and commercialization
  – Probably deeper than either realizes

• Each needs the other more than it realizes
  – Causes more damage than realized

• Archeology is hard
  – But very timely now
  – Can get contentious

• History is hard too
  – Especially for non-historians
“Those who refuse to study history are doomed to relive it”
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“History teaches us that History teaches us nothing”