Experimental Models of Technology Transfer

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Goal of activity

- To understand how experimental validation of new technology plays a role in technology transfer
  - Models of experimental validation - 1996
  - Perceptions among research and practitioner communities - 1998

Research validation methods

- Case study
- Dynamic analysis
- Field study
- Legacy data
- Lessons learned
- Literature search
- Project monitoring
- Replicated
- Simulation
- Static analysis
- Synthetic
- Theoretical analysis

Industrial transition methods

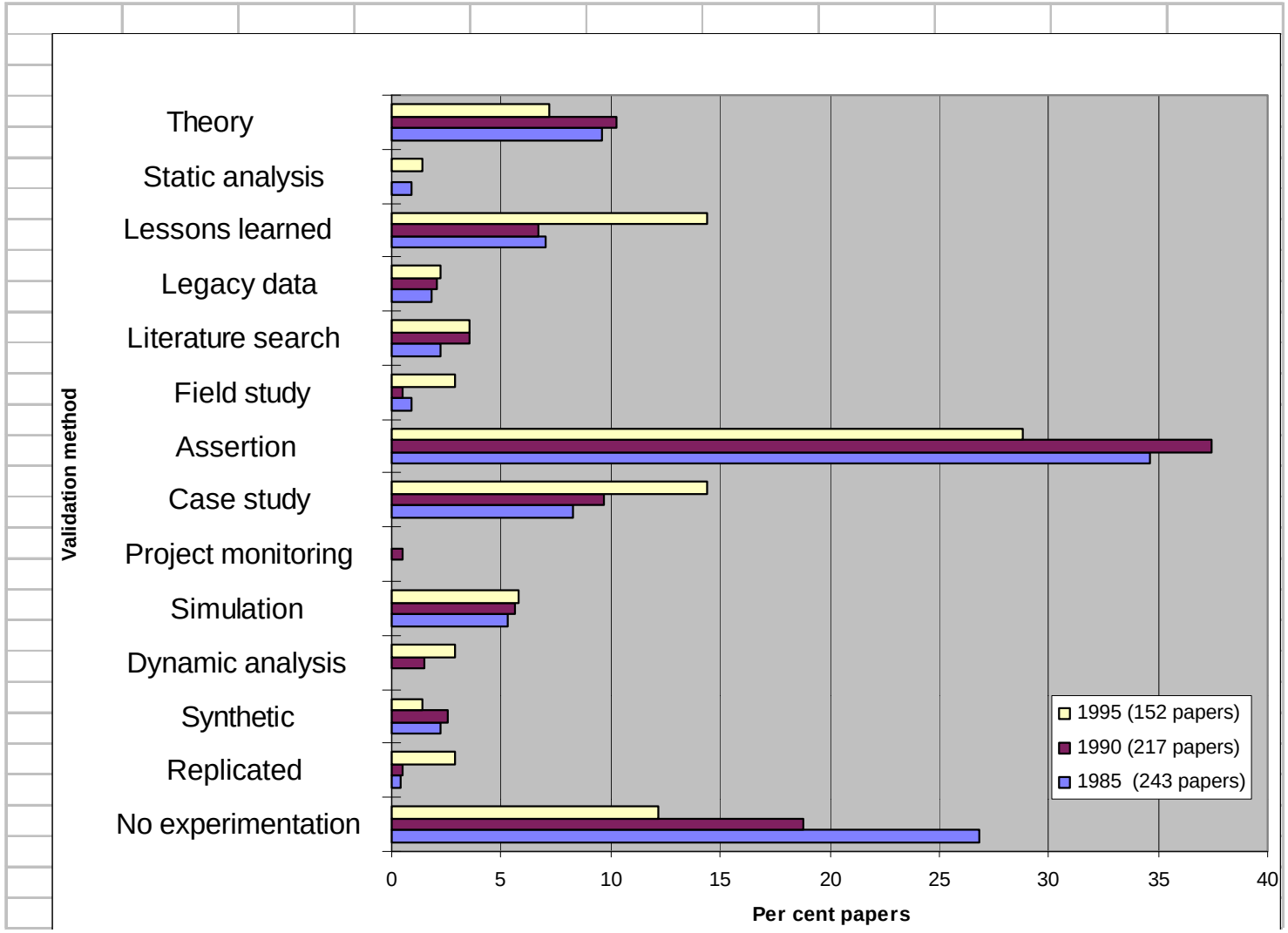
- Case study
- Data mining
- Demonstrator project **
- Feature benchmark
- Field study *
- Measurement
- Pilot study **
- Research literature
- Shadow (replicated) proj.
- State of the art
- Survey *
- Theoretical analysis
- Vendor opinion
- Training +
- People +

Evaluation of 612 journal papers

(May, 1998 IEEE Computer)

Method	ICSE	Soft.	TSE	ICSE	Soft.	TSE	ICSE	Soft.	TSE	
Not applicable	6	6	3	4	16	2	5	7	1	50
No experimentation	13	10	38	7	8	22	7	3	7	115
Replicated	1	0	0	0	0	1	1	0	3	6
Synthetic	3	1	1	0	1	4	0	0	2	12
Dynamic analysis	0	0	0	0	0	3	0	0	4	7
Simulation	2	0	10	0	0	11	1	1	6	31
Project monitoring	0	0	0	0	1	0	0	0	0	1
Case study	5	2	12	7	6	6	4	6	10	58
Assertion	12	13	54	12	19	42	4	14	22	192
Field study	1	0	1	0	0	1	1	1	2	7
Literature search	1	1	3	1	5	1	0	3	2	17
Legacy data	1	1	2	2	0	2	1	1	1	11
Lessons learned	7	5	4	1	4	8	5	7	8	49
Static analysis	1	0	1	0	0	0	0	0	2	4
Theory	3	1	18	1	0	19	3	0	7	52
Yearly totals	56	40	147	35	60	122	32	43	77	612

Relative use of each method



1998 Study

- Determine perceptions of which methods should be most effective
- Perform survey over internet
- Obtain results from researchers and practitioners alike
- Concept based upon WESS ‘97 paper by J. Daly, K. El Emam, and J. Miller

Sample populations

- Invitations to participate randomly generated
- Research population - U.S.-based authors from research software engineering conferences with email addresses
- Industrial population - U.S.-based authors from industrial software engineering conferences with email addresses
- Professional MS degree students with industrial experience, filled out research form
- 150 invitations sent to each group, about 50 agreed and were sent form, about half returned form
- 44 of 46 students returned form
- Total data: 62 research forms, 25 industrial forms

Survey questions

Rate from 1-20 relative difficulty of each method according to the 7 criteria (1 easy, 20 impossible, 10 maximum practical):

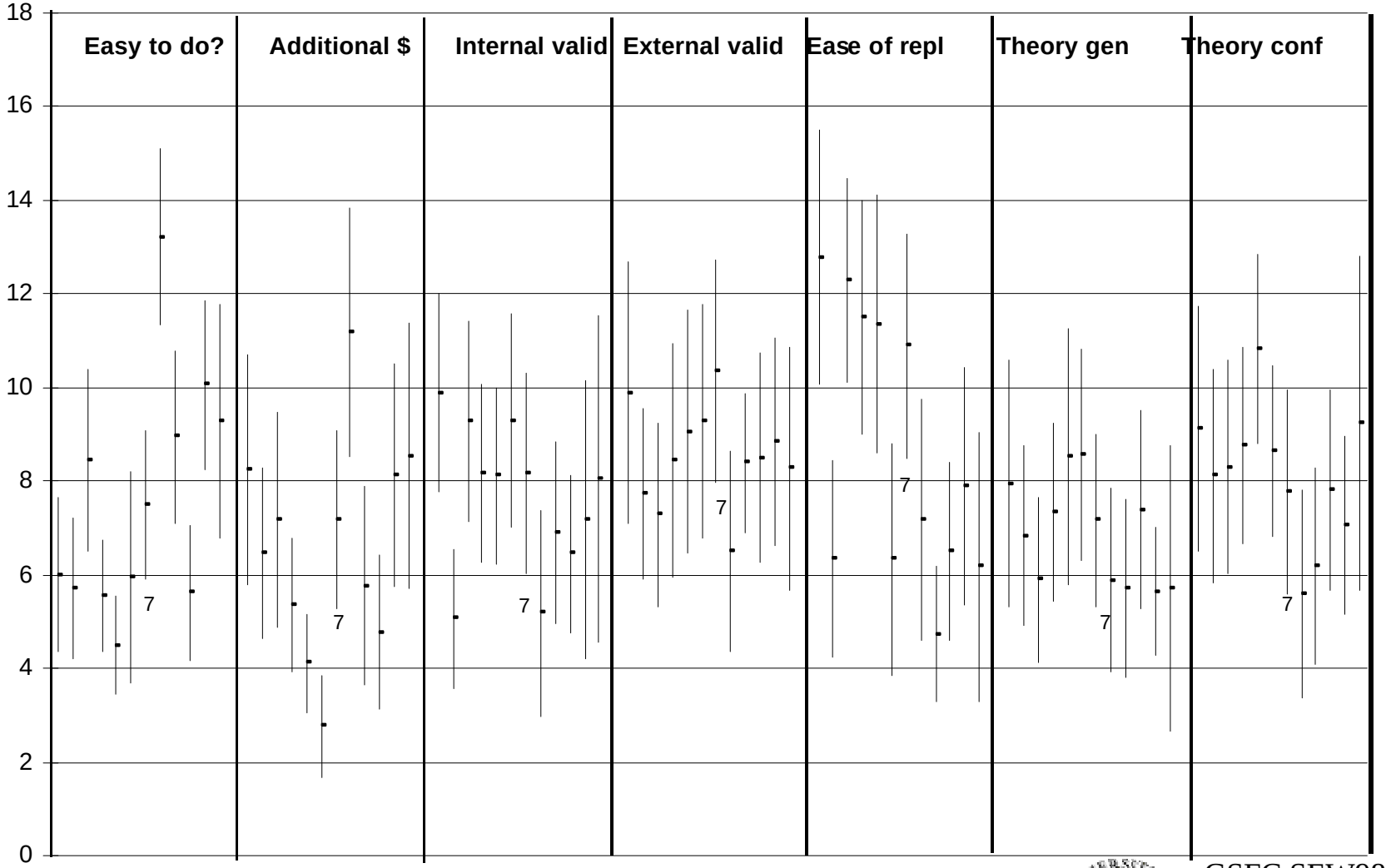
- How easy is it to use this method in practice?
- What is cost of adding one extra subject to study?
- What is the internal validity of the method?
- What is the external validity of the method?
- What is the ease of replication?
- What is the potential for theory generation?
- What is the potential for theory confirmation?

Summary of participants

Sample	Survey	Sample size	Years exper.	Acad. Pos.	Indust. R&D	Indust. Devel.	Other (e.g., Consult.)
1 (Research)	Research	18	18.6	9	3	3	3
2 (Industry)	Industry	25	19.1	0	5	8	12
3 (Students)	Research	44	6.6	1	5	27	11

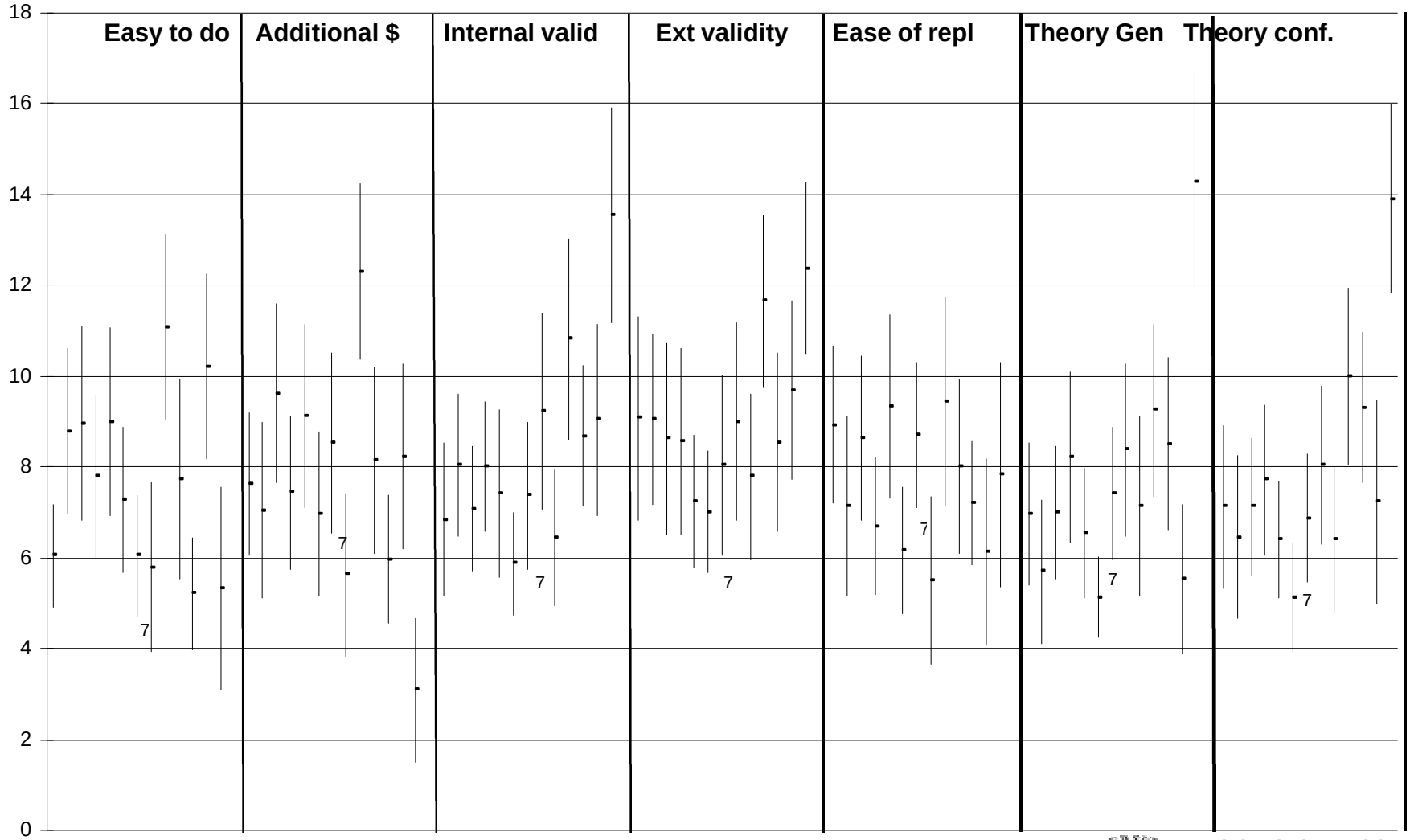
Research group results

1-case study 2-dynamic analysis 3-field study 4-lessons learned 5-legacy data 6-project monitoring 7-literature search 8-replicated experiment 9-simulation 10-static analysis 11-synthetic study 12-theoretical analysis



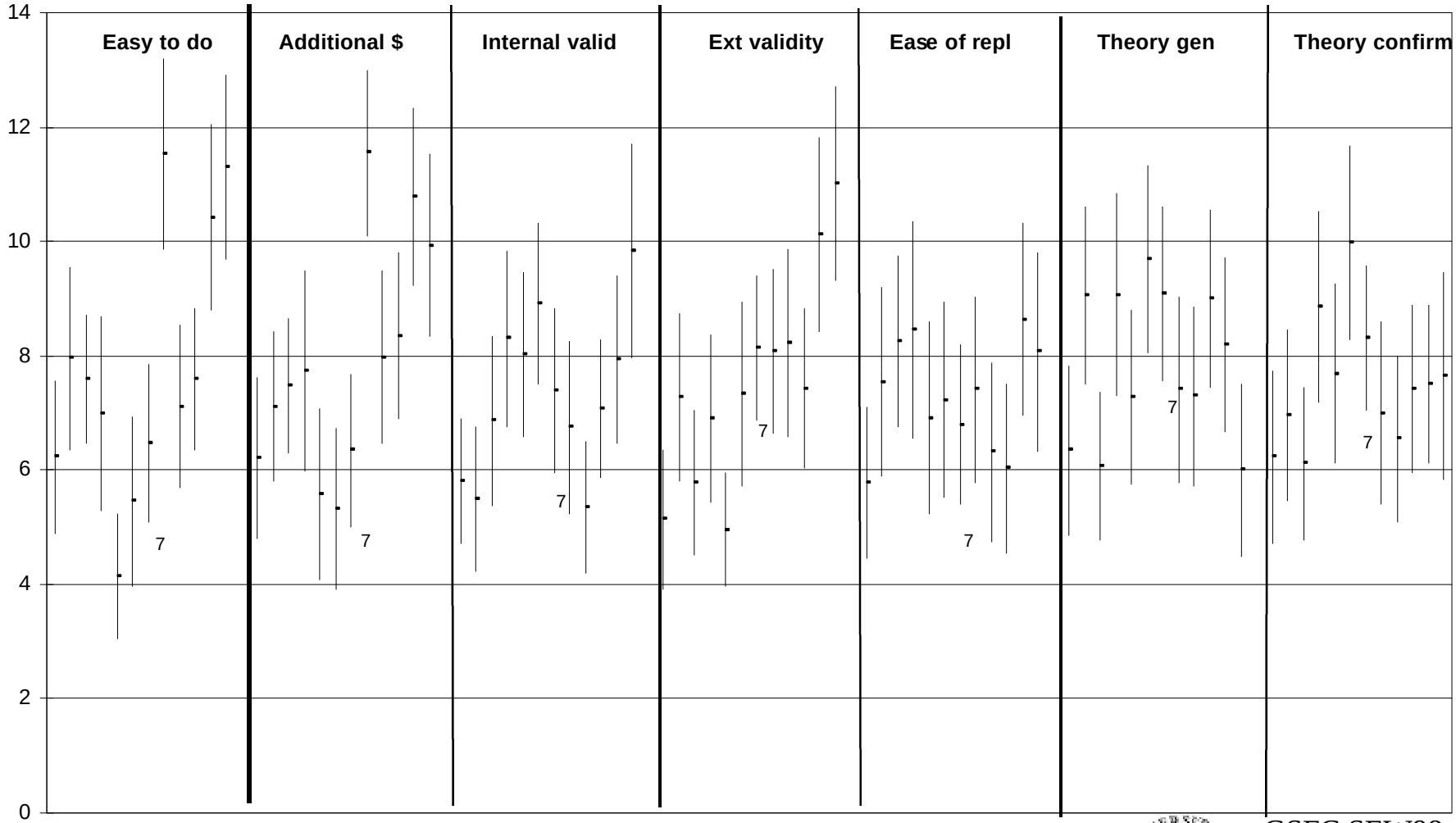
Industrial group results

1-case study 2-data mining 3-demonstrator projects 4-feature benchmark 5-field study 6-measurement 7-pilot study 8-research literature 9-shadow(replicated) project 10-state of the art 11-survey 12-theoretical analysis 13-vendor opinion



Student group results

1-case study 2-dynamic analysis 3-field study 4-lessons learned 5-legacy data 6-project monitoring 7-literature search 8-replicated experiment 9-simulation 10-static analysis 11-synthetic study 12-theoretical analysis



Technique Distribution

- Practical techniques - Better than average - Each method whose upper confidence interval was below the average value for all techniques
- Impractical - Worse than average - Each method whose lower confidence interval was above the average value for all methods
- Neutral - All other methods

Research Technique Distribution -Researchers

	Easy	Addit. $	Int. Val.	Ext. Val. Theory Gen.	Ease of Repl.	Theory Conf.
Practical	Dyn. anal Les. learned Legacy data Static anal.	Legacy data Proj. mon. Static anal.	Dyn. anal. Replicated		Dyn. anal. Simulation Static anal.	Replicated
Impractical	Replicated Synthetic	Replicated	Case study		Case study Field study Les. learned	Legacy data

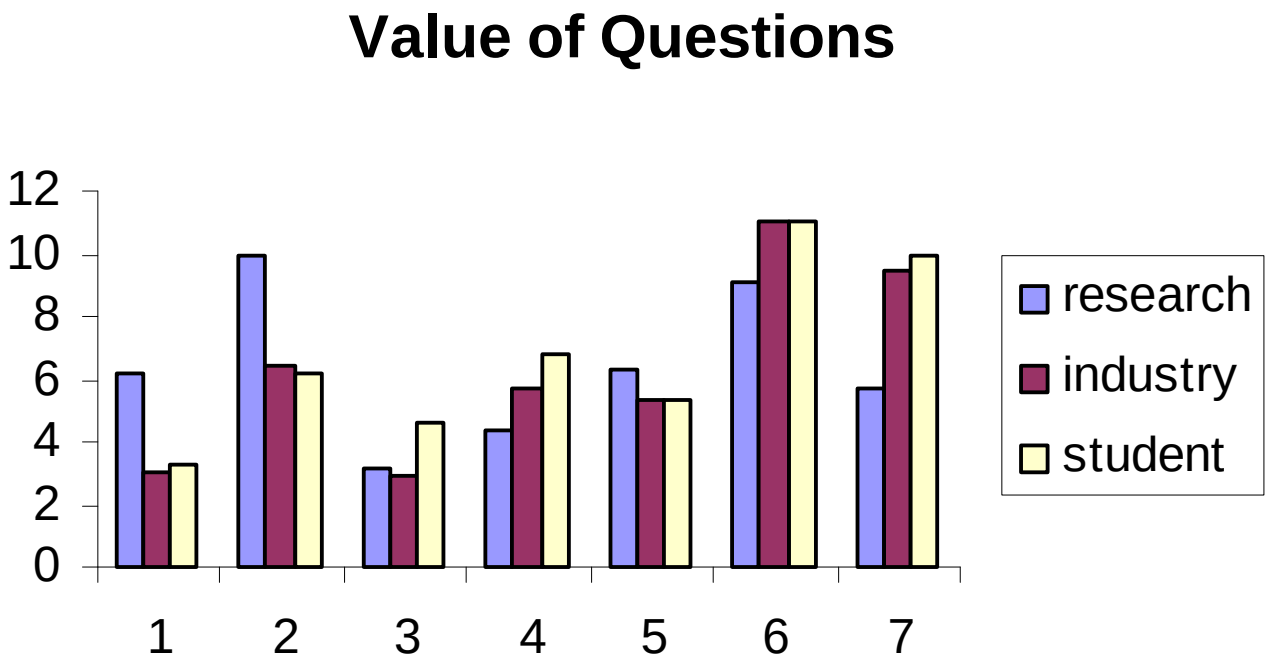
Research Technique Distribution - Industry(Students)

	Easy	**Addit. $**	**Int. Val.**	**Ext. Val.**	**Ease of Repl.**	**Theory Gen.**	**Theory Conf.**
Practical	Case study Legacy data Proj. mon.	Case study Legacy data Proj. mon. Lit. search	Case study Dyn. anal. Simulation	Case study Legacy data	Case study	Case study Field study Theory anal.	Field study
Impractical	Replicated Synthetic Theory anal.	Replicated Synthetic Theory anal.	Proj. mon. Theory anal.	Synthetic Theory anal.		Proj. mon.	Proj. mon.

Industry Technique Distribution - Industry

	Easy	**Addit $.**	**Int. Val.**	**Ext. Val.**	**Ease of Repl.**	**Theory Gen.**	**Theory Conf.**
Practical	Case study Pilot study Survey Vendor opinion	Lit. Res. Survey Vendor opinion	Measure	Field study Measure	Measure Lit. res.	Data mining Measure Theory anal.	Field study Measure
Impractical	Replicated	Replicated	State of art Vendor opinion	State of art Vendor opinion		Vendor opinion	State of art Vendor opinion

Relative importance of criteria
(when making a decision)



1=easy to do; 2=additional $; 3=int. validity; 4=ext. validity; 5=ease of repl.; 6=theory gen.; 7=theory conf.

Composite measure
(sum individual criteria)

Sample 1 Research group		Sample 3 Student group		Sample 2 Industry group	
Simulation	288	Case study	284	Measurement	258
Static analysis	292	Legacy data	314	Data mining	305
Dynamic analysis	298	Field study	315	Theoretical analysis	324
Project monitoring	301	Simulation	333	Literature research	325
Lessons learned	339	Dynamic analysis	355	Case study	326
Legacy data	345	Static analysis	361	Field study	327
Synthetic study	346	Literature search	370	Pilot study	329
Theoretical analysis	348	Replicated experiment	387	Feature benchmark	338
Field study	363	Project monitoring	388	Survey	343
Literature search	367	Lessons learned	391	Demonstrator project	345
Replicated experiment	368	Theoretical analysis	405	Replicated project	361
Case study	398	Synthetic study	418	State of art	407
				Vendor opinion	469

Composite measures

- For the research community, tools-based techniques dominate the rankings
- For the student community, those techniques that confirm a technique in the field dominate the rankings
- For the industrial group, measurement and data mining clearly dominates the ranking even though rarely done in practice
- For the industrial group, state of the art and vendor opinion came last, so why resort to that so often?

Current plan

- Develop new survey instrument on actual experiences in transferring a technology
- Working with Shari Lawrence Pfleeger
- Obtain large industrial sample
  - Models of experimental validation - 1996
  - Perceptions among research and practitioner communities - 1998
  - Experiences of experimental validation - planned

Conclusions

- Conflicting views: Researchers use tools; industry wants field experiences- Need for better understanding of needs of both communities (publications vs. practicality)
- Measurement viewed as important, but anecdotal evidence that not practiced much
- It would aid both communities if those techniques near the top of the rankings had better tool support
- Need evaluation process to determine most effective method for a given new technology