Future of End-User Software Engineering: Beyond the Silos

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June 18, 2015

Why is there an "EUSE" area?

- It started with End-User Programming (creating new programs).
- Today, end users write lots of programs [Scaffidi et al.].
  - Using IDEs like...

Settings for EUSE: End Users' "IDEs"

- CoScripter [Cypher et al.]
- Labview [National Instruments]
- Spreadsheets

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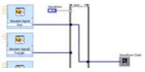

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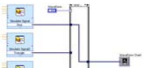

But: Programs are not dependable!

- End-user programming empowers to...
  - ...use bad programs to make bad decisions?
  - Compounded by overconfidence.
- Hurricane Katrina [Scaffidi et al].
- West Baraboo, Wisc: spreadsheet: underestimated borrowing cost by $400,000 [EUSPRIG].
- Faulty business web applications ➔ lost revenue, credibility [Bulldog Reporter].

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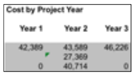

Cost by Project Year

Year 1	Year 2	Year 3
42,389	43,589	46,226
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0	40,714	0

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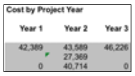

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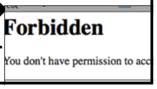

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➔End-User Software Engineering (2003)

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Is it possible to bring the benefits of rigorous software engineering methodologies to end users?

First(?) EUSE example: WYSIWYT

- What You See Is What You Test [Rothermel/Burnett]
- For end users & spreadsheets, what is testing?
  - Test: A <u>decision</u> if some output is right given the input.

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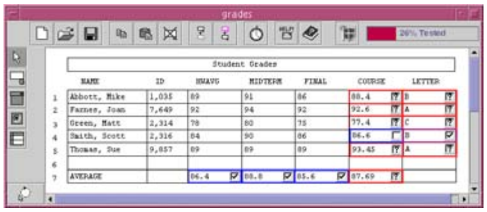
    Test Adequacy: Have “enough” tests been performed?

√√√√√

√: User Notices a Correct Value...



Student Grades

	NAME	ID	HWAVG	MIDTERM	FINAL	COURSE	LETTER
1	Abbott, Mike	1,035	89	91	86	88.4 ?	B ?
2	Farnes, Joan	7,649	92	94	92	92.6 ?	A ?
3	Green, Matt	2,314	78	80	75	77.4 ?	C ?
4	Smith, Scott	2,316	84	90	86	86.6 □	B ☑
5	Thomas, Sue	9,857	89	89	89	93.45 ?	A ?
6							
7	AVERAGE		86.4 ☑	88.8 ☑	85.6 ☑	87.69 ?	

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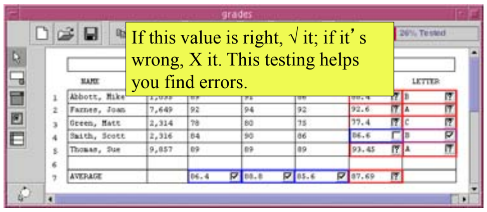

If this value is right, √ it; if it’s wrong, X it. This testing helps you find errors.

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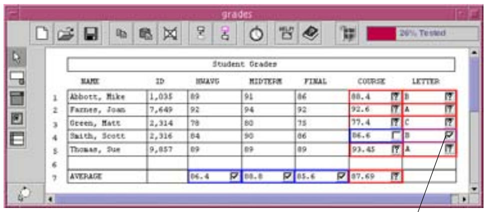

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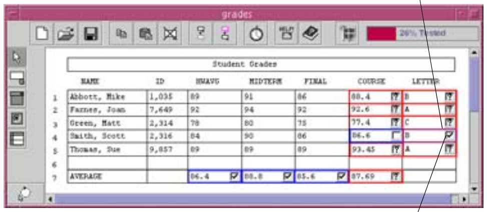
Cell turns more blue (more “tested”).



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Testing also flows upstream, Coloring other affected cells too.

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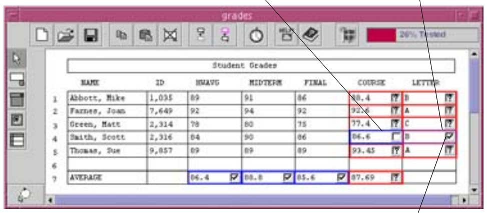

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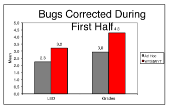
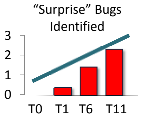
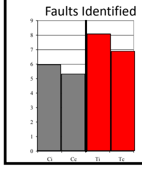
Empirical Results (WYSIWYT + derivatives)

- Over 30 empirical studies:
  - Useful, usable, effective!







But… A Future Beyond the Silos?

- Silo: “a system, process, ... that operates in *isolation* from others”
- Silo risk:
  - tunnel vision
  - lost potential for big, outside-the-box gains.
- Challenges/benefits for a de-siloed future EUSE:
  - Who challenges
  - When challenges
  - Why & How challenges

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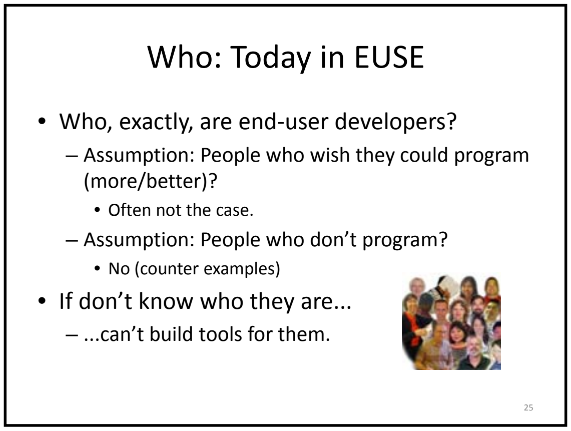
De-Siloing the “Who”

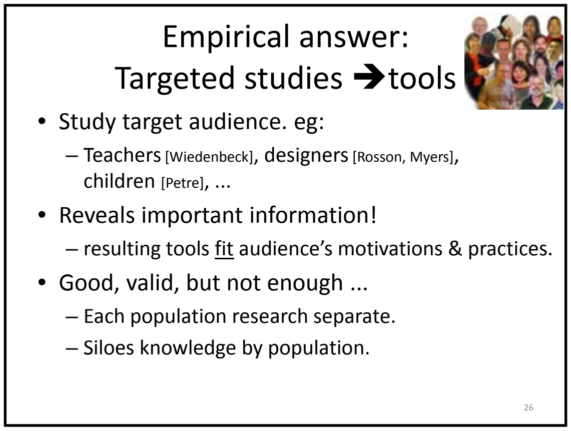
Who: The Basics

- EUSE draws from both SE and HCI
  - From HCI, it inherits the importance of “Who”
- 2 Key Requirements of EUSE:
  - 1. Cannot assume SE skills
  - 2. EUSE tools/techniques must fit:
    - interests,
    - motivations,
    - practices



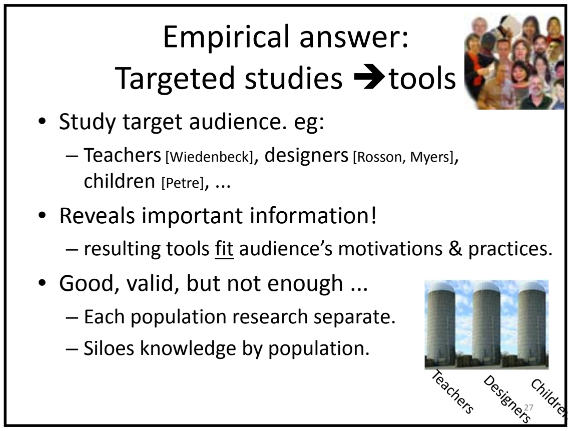
Who: Today in EUSE

- Who, exactly, are end-user developers?
  - Assumption: People who wish they could program (more/better)?
    - Often not the case.
  - Assumption: People who don't program?
    - No (counter examples)
- If don't know who they are...
  - ...can't build tools for them.



Empirical answer: Targeted studies ➔tools

- Study target audience. eg:
  - Teachers [Wiedenbeck], designers [Rosson, Myers], children [Petre], ...
- Reveals important information!
  - resulting tools fit audience's motivations & practices.
- Good, valid, but not enough ...
  - Each population research separate.
  - Siloes knowledge by population.



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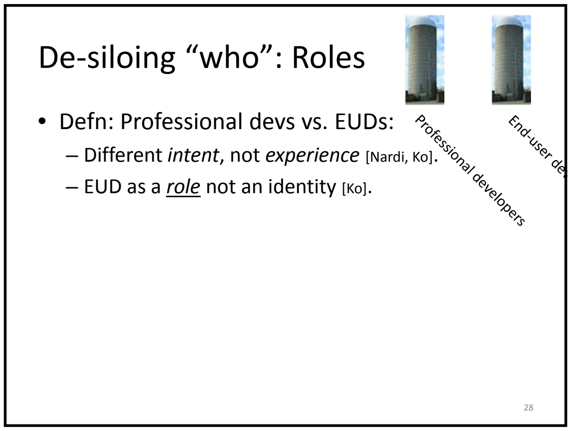
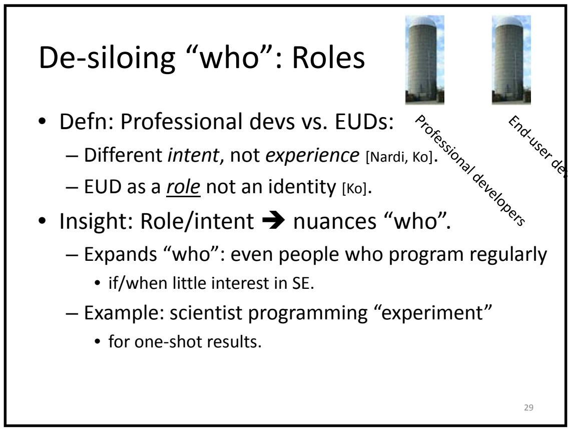
Childre



De-siloing "who": Roles

- Defn: Professional devs vs. EUDs:
  - Different *intent*, not *experience* [Nardi, Ko].
  - EUD as a *role* not an identity [Ko].

Professional developers
End-user de



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  - Example: scientist programming "experiment"
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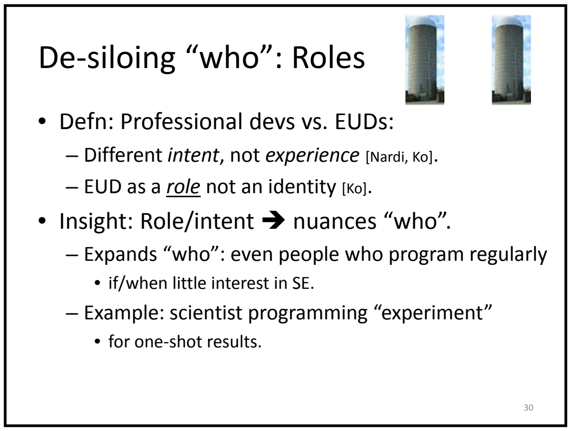

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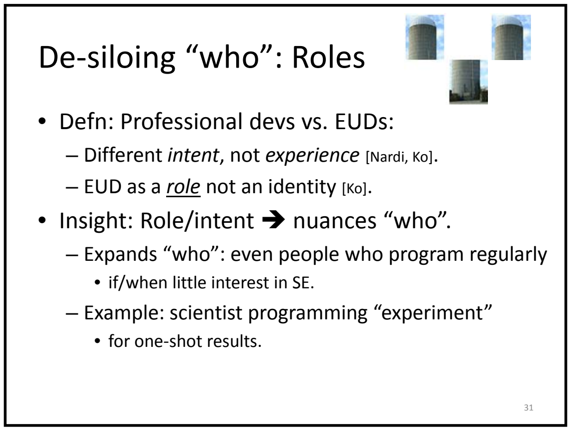

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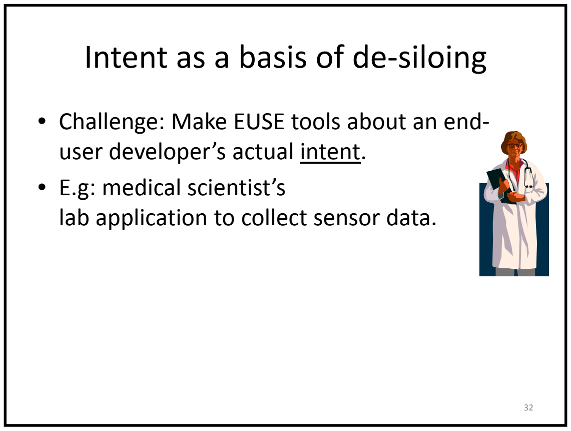

Intent as a basis of de-siloing

- Challenge: Make EUSE tools about an end-user developer’s actual intent.
- E.g: medical scientist’s lab application to collect sensor data.

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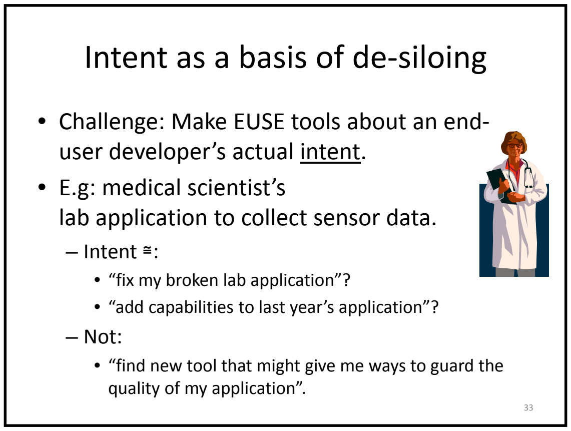

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- E.g: medical scientist’s lab application to collect sensor data.
  - Intent ≅:
    - “fix my broken lab application”?
    - “add capabilities to last year’s application”?
  - Not:
    - “find new tool that might give me ways to guard the quality of my application”.

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Attention Investment (Blackwell)

- A common SE assumption:
  - “If we build it, they will come”

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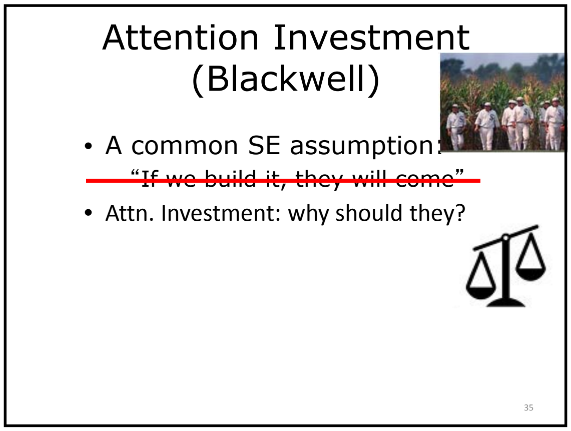

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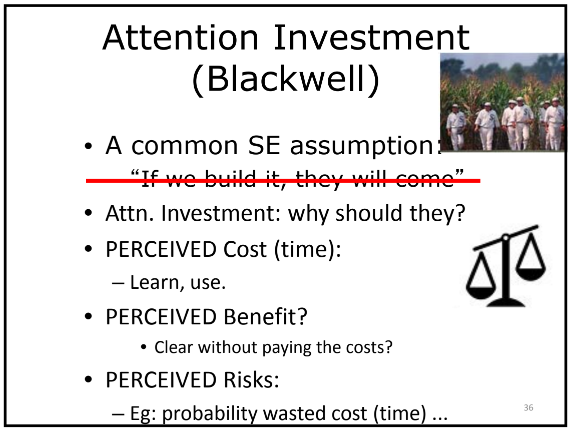

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- Attn. Investment: why should they?
- PERCEIVED Cost (time):
  - Learn, use.
- PERCEIVED Benefit?
  - Clear without paying the costs?
- PERCEIVED Risks:
  - Eg: probability wasted cost (time) ...

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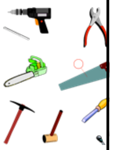
Intent and Attention Investment

- Lab example (intent=fix bug quickly):
- Suppose scientist wants
  more powerful problem-solving tool
  - and spots a tool that might help.



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- Ventures to touch one:
  - First impression*:* perceived <u>cost</u> to learn+use.
  - Also perceived <u>risk</u> (probability): tool won’t help.
  - If perceived <u>costs & risks</u> > <u>benefits</u>,
    unlikely to use the tool [Blackwell].

So, what does that tell us?

- For EUSE tools to target intent-based “who”:
  - (1) must connect to EUD’s intent
    - *whenever* arises

+

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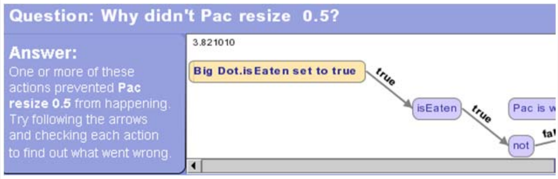
+

  - (2) must *entice* EUD to take appropriate SE steps
    - by making explicit <u>at that moment</u> likely
      costs, benefits, risks.

How: 3 intent-based strategies

- 1. *Research-then-serve* existing intent.
  E.g. EUSE debugging: E.g. “why” debugging [Ko, Myers]



Question: Why didn't Pac resize 0.5?

Answer:
One or more of these actions prevented **Pac resize 0.5** from happening. Try following the arrows and checking each action to find out what went wrong.

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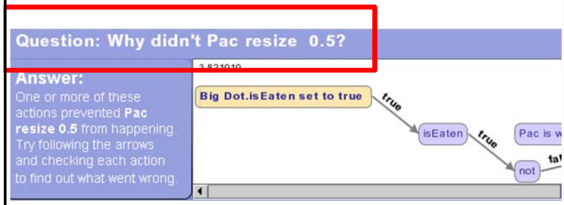
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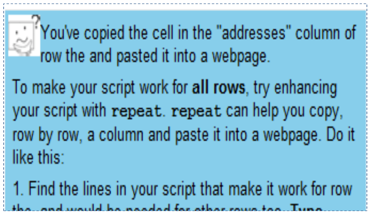
How: 3 intent-based strategies (cont.)

- 2. *Infer-then-serve* intent.
- E.g. EUSE debugging/design:
  IdeaGarden [Cao, Kwan, Fleming, Scaffidi, Burnett, ...]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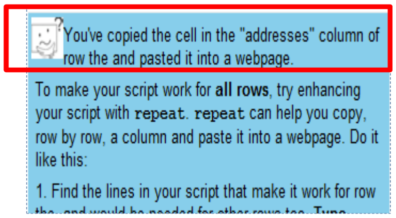
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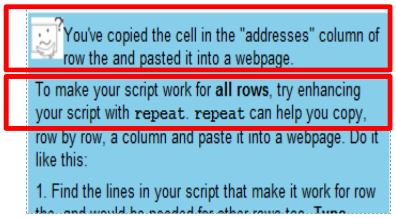
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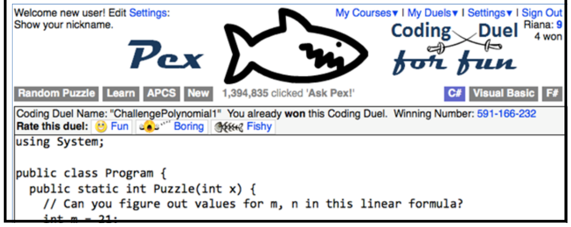
How: 3 intent-based strategies (cont.)

- 3. Try to *generate* intent.
- E.g. Pex4Fun (gamify programming) [Tillman et al.]


Welcome new user! Edit Settings:
Show your nickname.
My Courses▾ | My Duels▾ | Settings▾ | Sign Out
Riana: 9
4 won
Pex
Coding Duel
for fun
Random Puzzle
Learn
APCS
New
1,394,835 clicked 'Ask Pex!'
C#
Visual Basic
F#

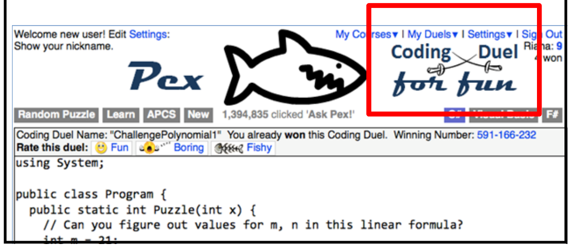
Coding Duel Name: "ChallengePolynomial1" You already **won** this Coding Duel. Winning Number: 591-166-232
Rate this duel: Fun Boring Fishy

```
using System;

public class Program {
  public static int Puzzle(int x) {
    // Can you figure out values for m, n in this linear formula?
    int m = 21;
```

How: 3 intent-based strategies (cont.)

- 3. Try to *generate* intent.
- E.g. Pex4Fun (gamify programming) [Tillman et al.]


Welcome new user! Edit Settings:
Show your nickname.
My Courses▾ | My Duels▾ | Settings▾ | Sign Out
Riana: 9
4 won
Pex
Coding Duel
for fun
Random Puzzle
Learn
APCS
New
1,394,835 clicked 'Ask Pex!'
F#

Coding Duel Name: "ChallengePolynomial1" You already **won** this Coding Duel. Winning Number: 591-166-232
Rate this duel: Fun Boring Fishy

```
using System;

public class Program {
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Intent-based strategies (cont.)

- These examples have in common:
  - (1) target EUD intent
    - as of “right now”
  - (2) draw EUD into doing just a little
    - when can benefit them directly
    - make clear potential costs, benefits, risks
  - (3) give EUD supports just in time, in their own environment
    - allows them to <u>succeed</u> at SE behaviors
- These strategies work! (empirical)
  - seem to point ways forward.

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De-Siloing the “When”

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Today’s EUSE: Beyond Coding

- Adds support for lifecycle stages to EUP:
  - Testing (WYSIWYT) [Rothermel/Burnett]
  - Design [Rosson]
  - Assertions [Shaw]
  - Reverse engineering [Cunha]
  - Refactoring [Dig, Elbaum, Stolee]
  - Fault/smell/error prevent/detect [Dou, Erwig, Hermans, Scaffidi]

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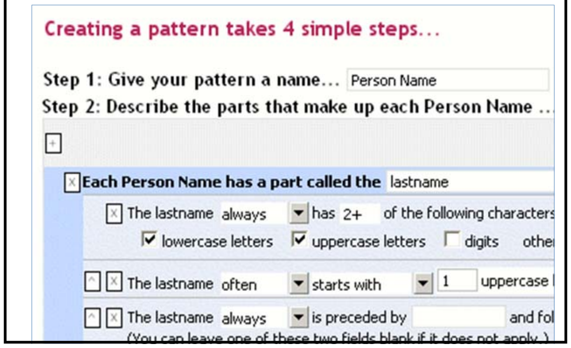
Today’s EUSE: Beyond Coding



Creating a pattern takes 4 simple steps...

Step 1: Give your pattern a name... Person Name

Step 2: Describe the parts that make up each Person Name ...

☒ Each Person Name has a part called the lastname

☒ The lastname always ▼ has 2+ of the following character

☑ lowercase letters ☑ uppercase letters □ digits othe

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(You can leave one of these two fields blank if it does not apply.)

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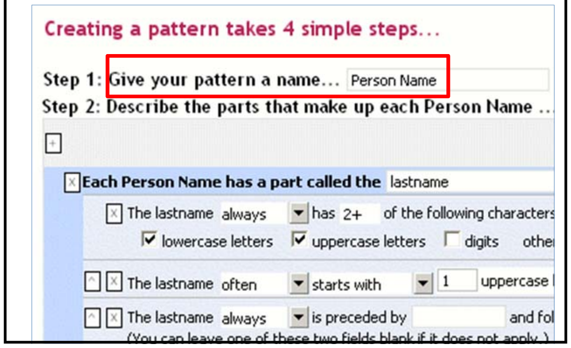

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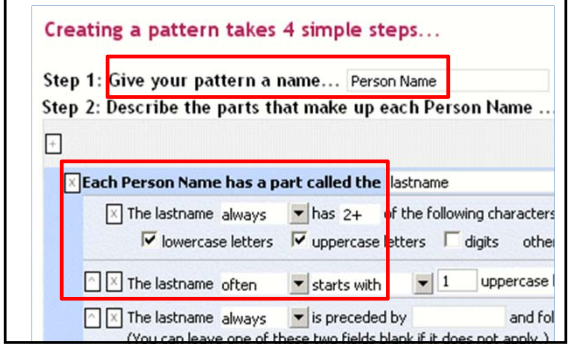

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Challenge: Not Just "Beyond Coding"

- Step 1 (some of this already here):
  - interactive
  - incremental
  - don't trap me in a "mode"
- may require novel reasoning algorithms (e.g. [Dou, Groce, Hermans, Ko, Rothermel]).

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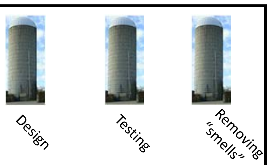
Challenge: Beyond "Beyond Coding"



- Step 2: Beyond the Silos
  - these approaches silo tools and research into lifecycle phases.
- Challenge:
  - transcend one-lifecycle-phase-at-a-time research silos in favor of bigger visions
  - frame EUSE problem in terms of human <u>activity</u> (not SE lifecycle phase)

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Frieda's story

- What Frieda does:
  - 1. Company issues this year's annual budget-tracking update.
  - 2. At first, Frieda has 4 variants:
    - last-year company budget-tracking spreadsheet.
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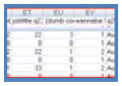

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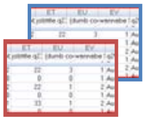

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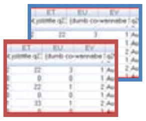

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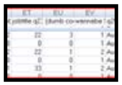

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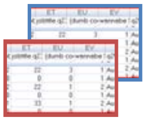

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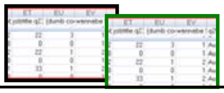

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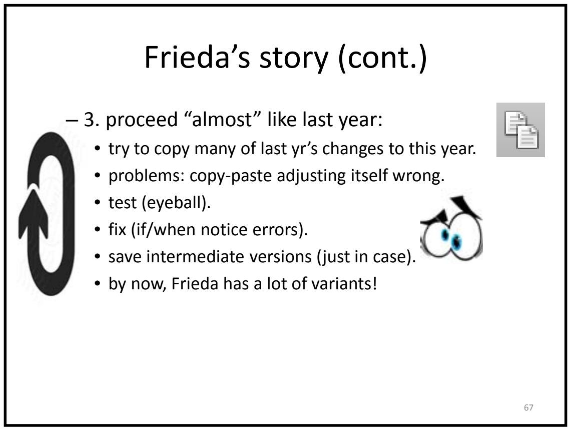

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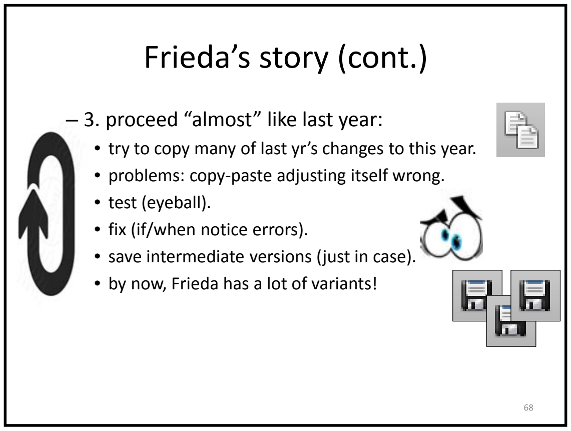

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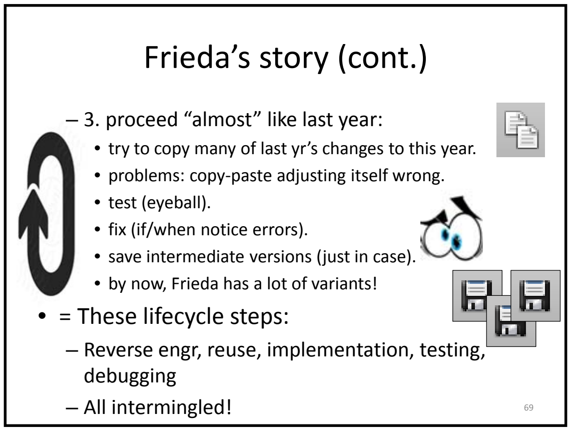

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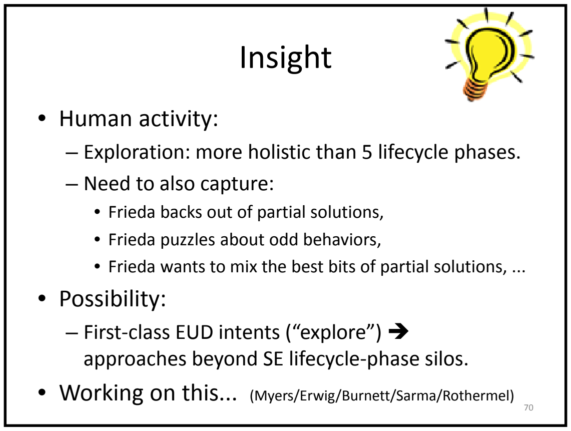
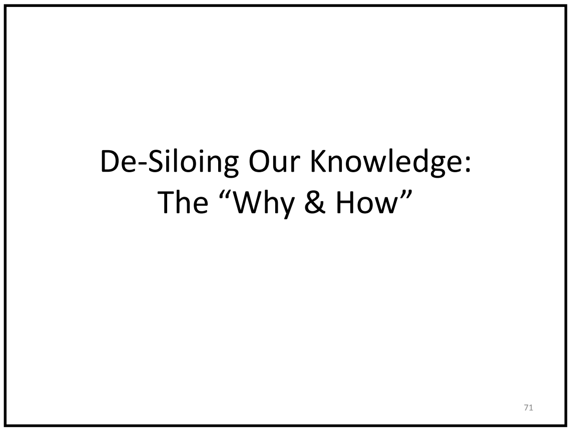
- = These lifecycle steps:
  - Reverse engr, reuse, implementation, testing, debugging
  - All intermingled!

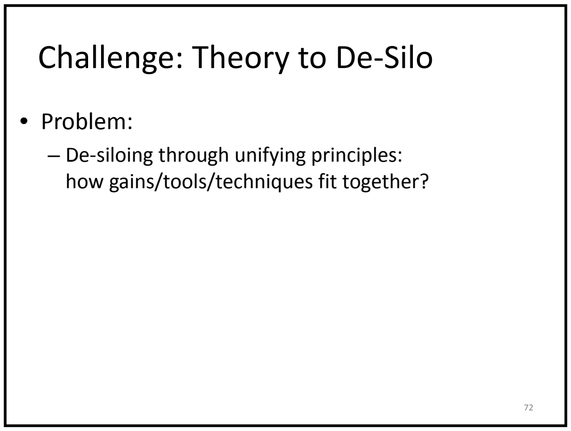


Insight

- Human activity:
  - Exploration: more holistic than 5 lifecycle phases.
  - Need to also capture:
    - Frieda backs out of partial solutions,
    - Frieda puzzles about odd behaviors,
    - Frieda wants to mix the best bits of partial solutions, ...
- Possibility:
  - First-class EUD intents ("explore") ➔ approaches beyond SE lifecycle-phase silos.
- Working on this... (Myers/Erwig/Burnett/Sarma/Rothermel)



De-Siloing Our Knowledge: The "Why & How"



Challenge: Theory to De-Silo

- Problem:
  - De-siloing through unifying principles: how gains/tools/techniques fit together?

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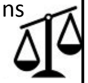
- Problem:
  - De-siloing through unifying principles: how gains/tools/techniques fit together?
- Opportunity: Harness theories
  - on how humans reason & problem-solve.
- Why:
  - 1.Strategic insights—even for newer toolbuilders. Patterns, predictions, ... [Herbsleb, Shaw].
  - 2. Help empirical study designs & result interpretation.
  - 3. Connect tools after the fact.

Example 1: Theory ➔ Strategic Insights



- Recall: Attention Investment [Blackwell] explains how EUDs <u>decide</u>
  - whether to try a new tool/feature
- Has shaped/predicted acceptance of EUSE tools [Bogart, Burnett, Fleming, Kwan, Ruthruff, ...]
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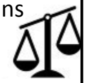

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Example 2: Theory Aiding Empirical Studies

- The Design:
  - Work design theory:
    - ➔ types of questions to ask [Murphy-Hill ICSE'14]
  - Human error theory:
    - ➔ an empirical framework used in EUSE [Ko et al.]
- The Interpretation:
  - ➔ <u>Why</u> statistical gender differences in feature usage in EUSE debugging tools [Beckwith]

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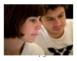
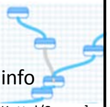


Example 3: Connecting the Dots



- Information Foraging Theory:
  - predator/prey theory on how people seek info
  - reveals behaviors in various EUSE settings [Kuttal/Sarma]
  - showed commonalities & design patterns
    - > 20 different SE tools [Fleming]
    - spanning debugging, refactoring, and reuse

Onward...

What EUSE has to say to SE

- Makes problems / needs visible.
- New vision: developer-tool partnership:
  - Dev's motivations > what tool "wants" of them.
  - First-class focus on intent.
  - Benefits professional devs!

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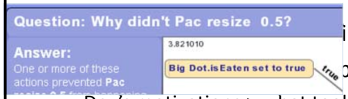

Question: Why didn't Pac resize 0.5?

Answer:
One or more of these actions prevented Pac

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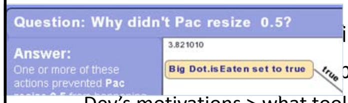

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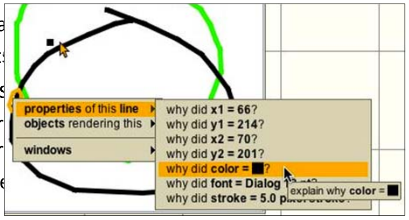

Conclusion

- Why de-silo
  - Transformative gains require getting outside the box.

Conclusion (cont.)

- Who challenge: EUD as an intent
  - Opens door to intent-oriented operations
    - Manipulate & reward intent, infer intent, target intent...
- When challenge: Beyond lifecycle silos
  - Opportunistic, incremental, interactive, not "moded in"
- Why & how challenge:
  - Theory: a foundation, a strategic guide, a connector

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- Why & how challenge:
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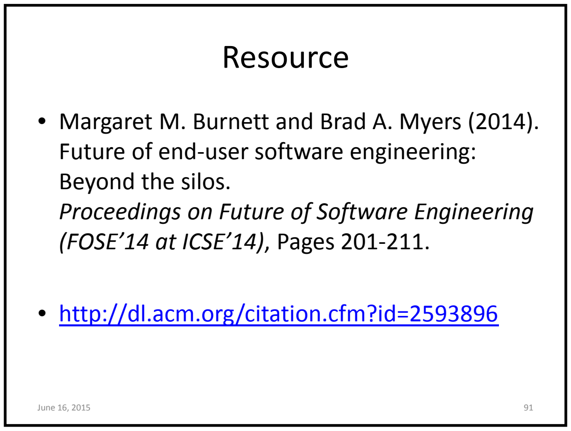
- Not easy, but worth it!
  - Big visions, beyond one silo at a time!



Resource

- Margaret M. Burnett and Brad A. Myers (2014). Future of end-user software engineering: Beyond the silos. *Proceedings on Future of Software Engineering (FOSE'14 at ICSE'14)*, Pages 201-211.

- http://dl.acm.org/citation.cfm?id=2593896