Technical Debt

from metaphor to theory and practice

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Outline

- What is technical debt? Several viewpoints.
- The technical debt landscape
- Structural or architectural debt
- Research on technical debt
- "Managing" technical debt
- Summary, useful pointers

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Acknowledgements

- Research on TD partly funded by the Software Engineering Institute | Carnegie Mellon
  - Ipek Ozkaya, Rod Nord, Nanette Brown
  - They have also contributed to building this presentation over the last 2 years.
- UBC master students Erin Lim Kam-Yan and Marco Gonzalez-Rojas …
  - … with some industry partners

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Technical Debt

- Concept introduced by Ward Cunningham
- Often mentioned, rarely studied
- All experienced software developers "feel" it.
- Drags long-lived projects and products down

Origin of the metaphor

- Ward Cunningham, at OOPSLA 1992

"Shipping first time code is like going into debt. A little debt speeds development so long as it is paid back promptly with a rewrite…
The danger occurs when the debt is not repaid. Every minute spent on not-quite-right code counts as interest on that debt. Entire engineering organizations can be brought to a stand-still under the debt load of an unconsolidated implementation, object-oriented or otherwise."

Cunningham, OOPSLA 1992

Technical Debt (S. McConnell)

- Implemented features (visible and invisible) = assets = non-debt
- Type 1: unintentional, non-strategic; poor design decisions, poor coding
- Type 2: intentional and strategic: optimize for the present, not for the future.
  - 2.A short-term: paid off quickly (refactorings, etc.)
    - Large chunks: easy to track
    - Many small bits: cannot track
  - 2.B long-term

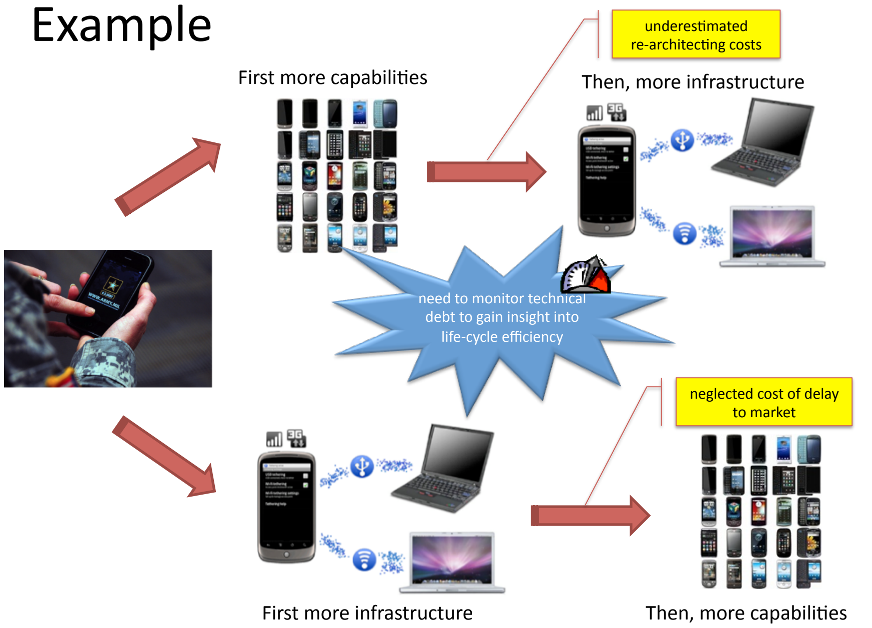
McConnell 2007

Technical Debt (M. Fowler)

	Reckless	Prudent
Deliberate	*"We don't have time for design"*	*"We must ship now and deal with consequences"*
Inadvertent	*"What's Layering?"*	*"Now we know how we should have done it"*

Fowler 2009, 2010

Example



Ozkaya, SEI,2010

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Technical Debt (Chris Sterling)

- Technical Debt: issues found in the code that will affect future development but not those dealing with feature completeness.

Or

- Technical Debt is the decay of component and intercomponent behaviour when the application functionality meets a minimum standard of satisfaction for the customer.

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Technical Debt (S. McConnell)

- TD: A design or construction approach that is expedient in the short term but that creates a technical context in which the same work will cost more to do later than it would cost to do now

McConnell 2011

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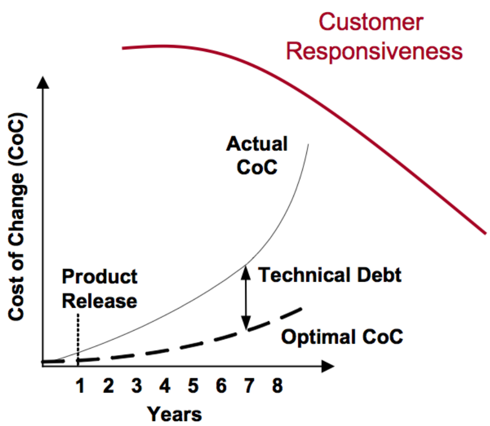
Tech Debt (Jim Highsmith)



- Once on far right of curve, all choices are hard
- If nothing is done, it just gets worse
- In applications with high technical debt, estimating is nearly impossible
- Only 3 strategies
  1. Do nothing, it gets worse
  2. Replace, high cost/risk
  3. Incremental refactoring, commitment to invest

 Source: Highsmith, 2009 12

Time is Money (I. Gat)

- Convert this in monetary terms:
  "Think of the amount of money the borrowed time represents – the grand total required to eliminate all issues found in the code"

Gat 2010

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Example: TD is the sum of…

• Code smells	167 person days
• Missing tests	298 person days
• Design	670 person days
• Documentation	67 person days

Totals

Work	1,202 person x days
Cost	$577,000

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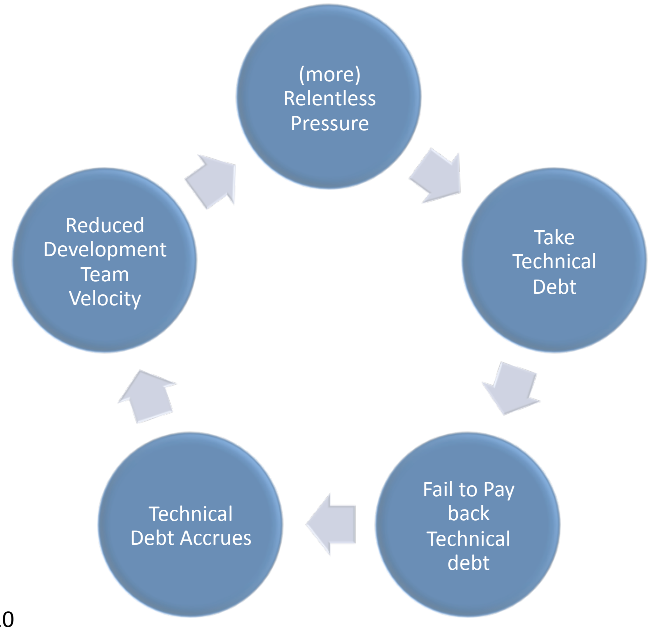

Israel Gat, 2010
http://theagileexecutive.com/2010/09/20/how-to-break-the-vicious-cycle-of-technical-debt/

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Causes of Technical Debt

TECHNOLOGY	PROCESS
• Technology limitations • Legacy code • COTS • Changes in technology • Project maturity	• Little consideration of code maintenance • Unclear requirements • Cutting back on process (code reviews) • Little or no history of design decisions • Not knowing or adopting best practices
PEOPLE	PRODUCT
• Postpone work until needed • Making bad assumptions • Inexperience • Poor leadership/team dynamics • No push-back against customers • “Superstars” – egos get in the way • Little knowledge transfer • Know-how to safely change code • Subcontractors	• Schedule and budget constraints • Poor communication between developers and management • Changing priorities (market information) • Lack of vision, plan, strategy • Unclear goals, objectives and priorities • Trying to make every customer happy • Consequences of decisions not clear

Lim et al. 2012

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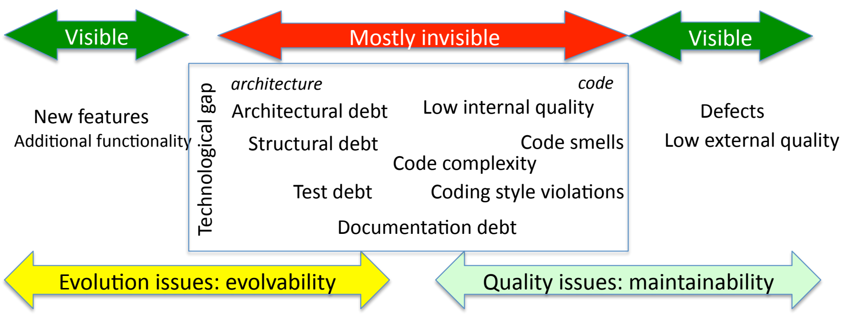
Technical debt landscape



Value of Software Architecture

A little détour

Value and cost

- Architecture has no (or little) externally visible "customer value"
- Iteration planning (backlog) is driven by "customer value"
- *Ergo:* architectural activities are often not given attention
- BUFD & YAGNI & Refactor!

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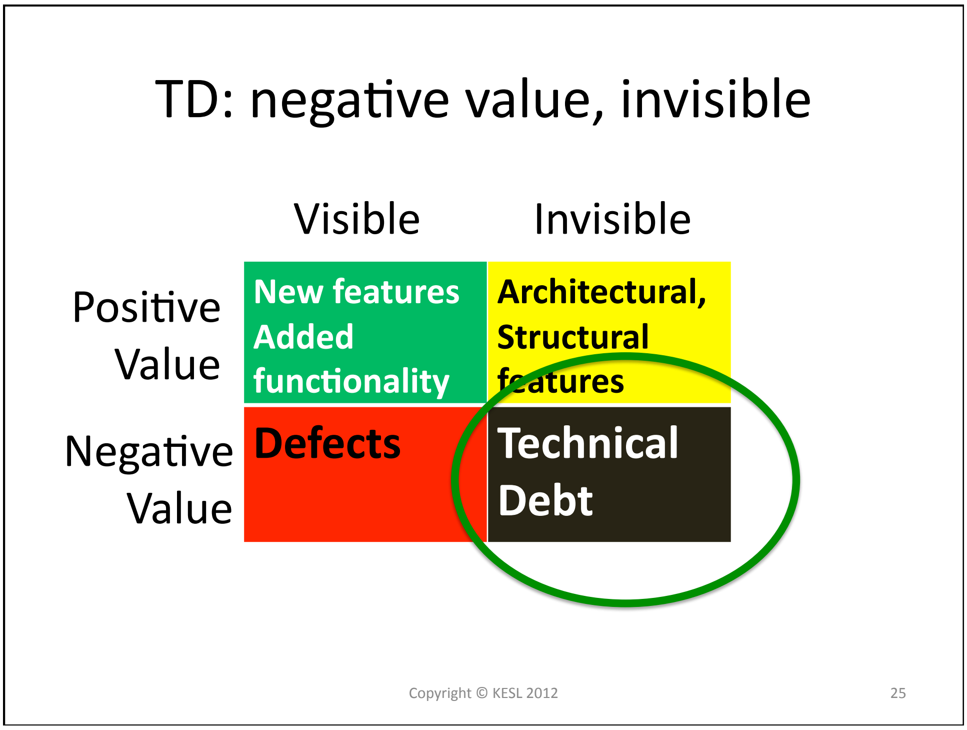
Value and cost

- Cost of development is not identical to value
- Trying to assess value and cost in monetary terms is hard and often leads to vain arguments

- Use “points” for cost and “utils” for value
- Use simple technique(s) to evaluation cost in points and value in utils.

What’s in your backlog?

	Visible	Invisible
Positive Value	**New features Added functionality**	**Architectural, Structural features**
Negative Value	**Defects**	**Technical Debt**


TD: negative value, invisible
Visible
Invisible
Positive Value
Negative Value
New features Added functionality
Architectural, Structural features
Defects
Technical Debt
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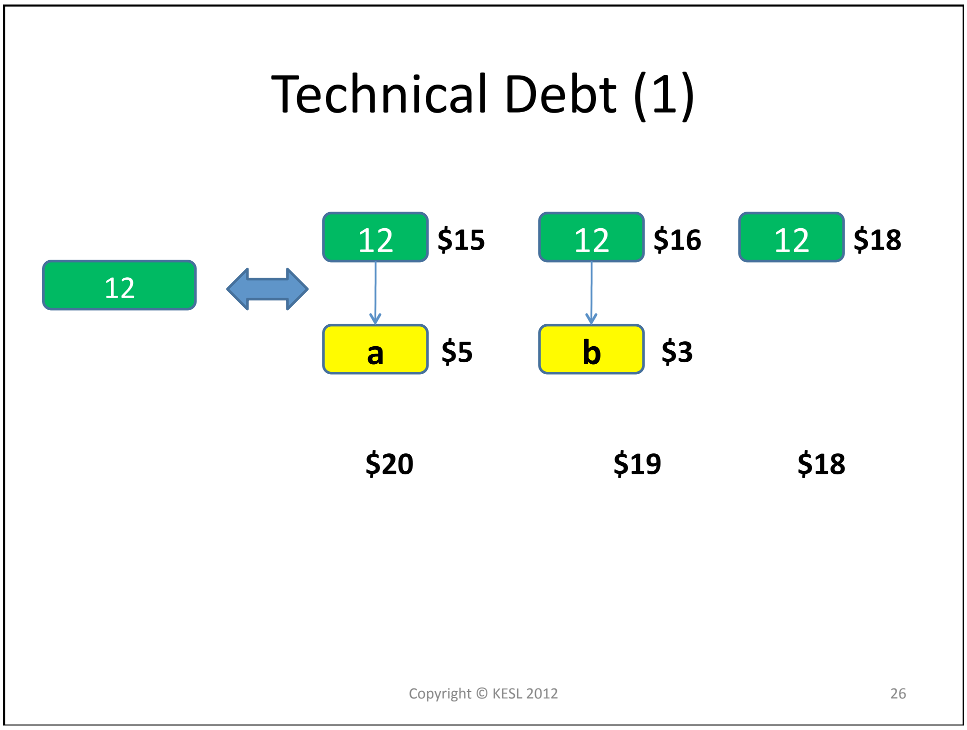
Technical Debt (1)
12
12
$15
a
$5
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b
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$20
$19
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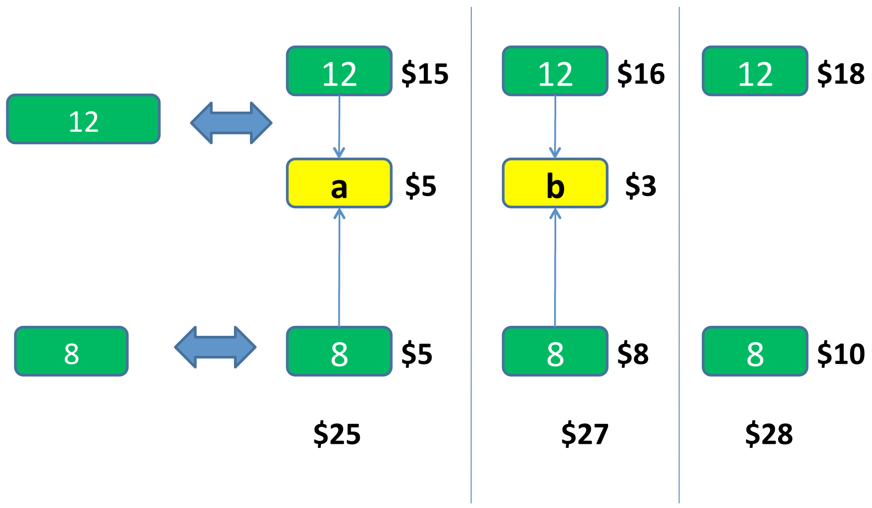
Technical Debt (2)



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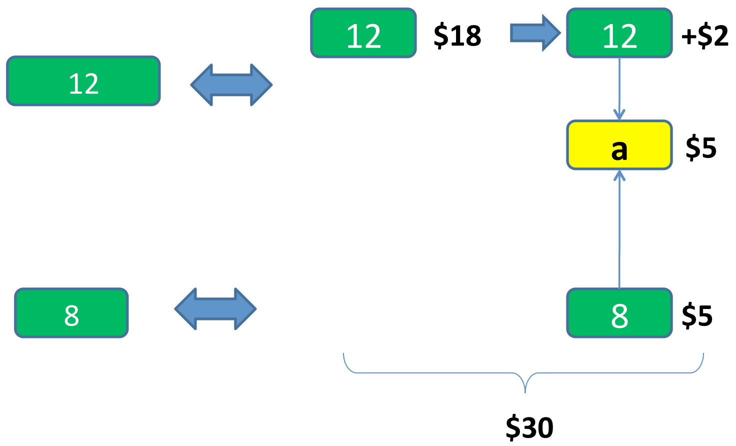
Technical Debt (3)



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Technical Debt

- Defect = Visible feature with negative value
- Technical debt = Invisible feature with negative value
- Cost …. of fixing
- Value …. of repaying technical debt, interests loss of productivity, etc.

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Interests (?)

- In presence of technical debt,
  cost of adding new features is higher;
  velocity is lower.
- When repaying (fixing), additional cost for retrofitting already implemented features
- Technical debt not repaid => lead to increased cost, forever
- Cost of fixing (repaying) increases over time

M. Fowler, 2009

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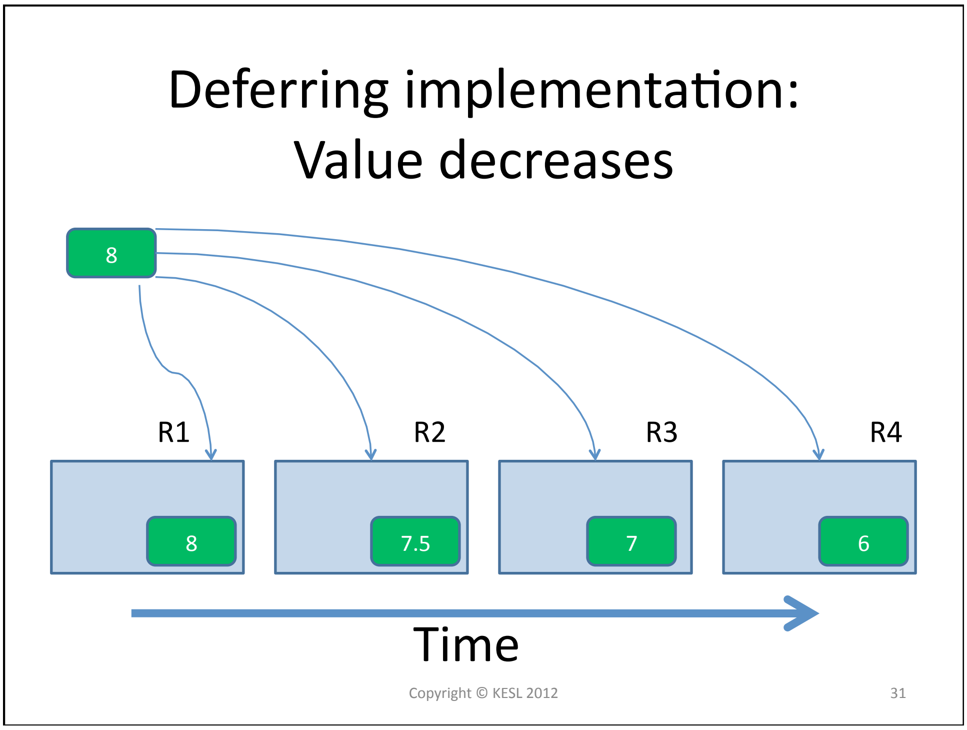
Deferring implementation:
Value decreases
8
R1
R2
R3
R4
8
7.5
7
6
Time
Copyright © KESL 2012
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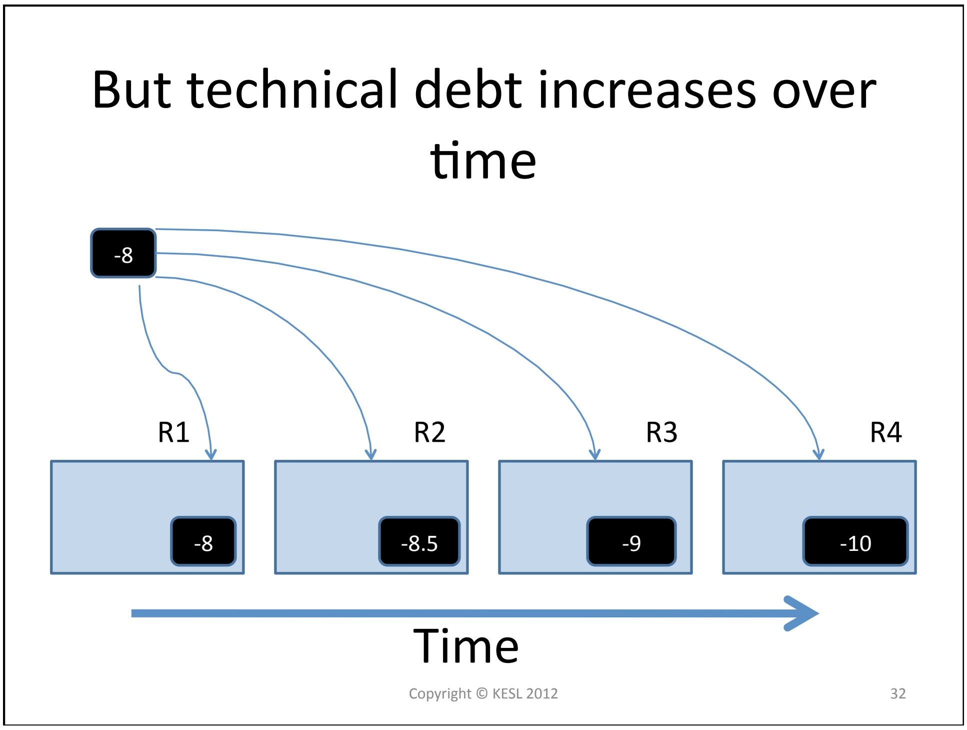
But technical debt increases over
time
-8
R1
R2
R3
R4
-8
-8.5
-9
-10
Time
Copyright © KESL 2012
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Advances

Areas of further investigation

Research on TD

- Characterize objectively and quantitatively the amount of technical debt in a given system
- Taxonomy of technical debt => Better detection
- Causes of technical debt => Improved prevention
- Project management strategies to control and to cope with technical debt

- Tools and methods to deal with code smells, etc.
- Application of Real Options, Dependency Structure Matrix, or other value-based technique

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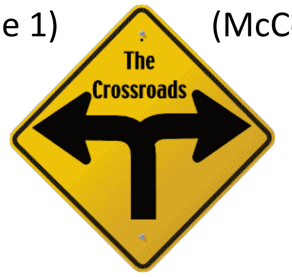
- Code level debt (McConnell type 1)
- Structural debt (McConnell type 2)



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Code level

- A.K.A., Code smells
- Much research, though fragmented
- Many tools to do static code analysis
- Example: Code replication (clones)
- Approach: detect + refactoring

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Tech Debt = Maintainability?

- Example:
  - SIG (Software Improvement Group), Amsterdam

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Debt at the Architectural Level

- Harder to detect with tools
- Less researched

- A few paths to explore:
  - Dependency structure matrices
  - Business Theories:
    - Real Option
    - Net present value

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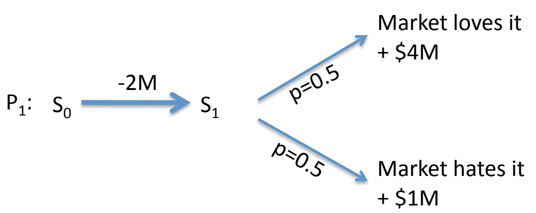
Real Options Theory

- Often mentioned, but rarely put in application in software

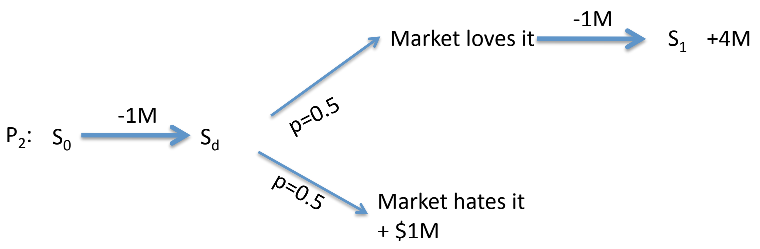
TD and Real Options



NPV (P_1) = -2M + 0.5x4M + 0.5x1M = 0.5M

Source: K. Sullivan, 2010
at TD Workshop SEI 6/2-3

TD and Real Options (2)



NPV (P_2) = -1M + 0.5x3M + 0.5x1M = 1M

Taking Technical Debt has increased system value.

Source: K. Sullivan, 2010

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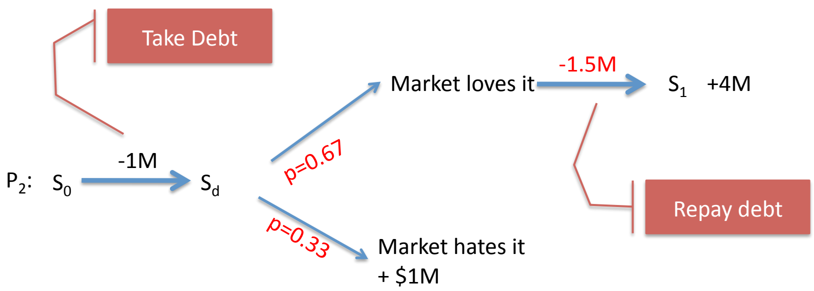
TD and Real Options (3)



NPV (P_3) = -1M + 0.67 x 2.5M + 0.33 x 1M = 1M

More realistically:
Debt + interest
High chances of success

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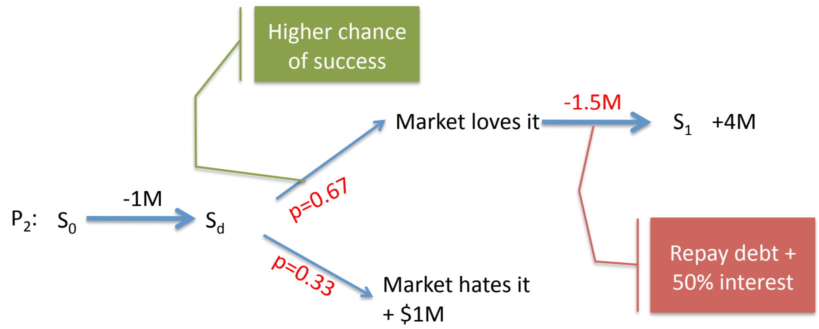
TD and Real Options (3)



NPV (P_3) = -1M + 0.67 x 2.5M + 0.33 x 1M = 1M

More realistically:
Debt + interest
High chances of success

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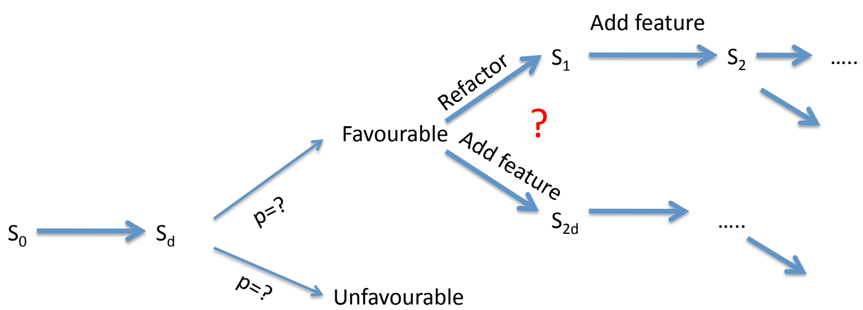
TD and Real Options (4)



Not debt really, but options with different values…
Do we want to invest in architecture, in test, etc…

Source: K. Sullivan, 2010

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Options Theory

- Often mentioned, but rarely put in application in software
- Not even scratched the surface
- Pay-off not obvious, though…
  - Too much guesswork involved to trust results,
  - Lot of work involved

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Debt at the Architectural level

- Design Structure Matrix (DSM)
  - a.k.a, Dependency Structure Matrix
- Domain Mapping Matrix (DMM)

- Tools to create and manipulate DSMs and DMMs

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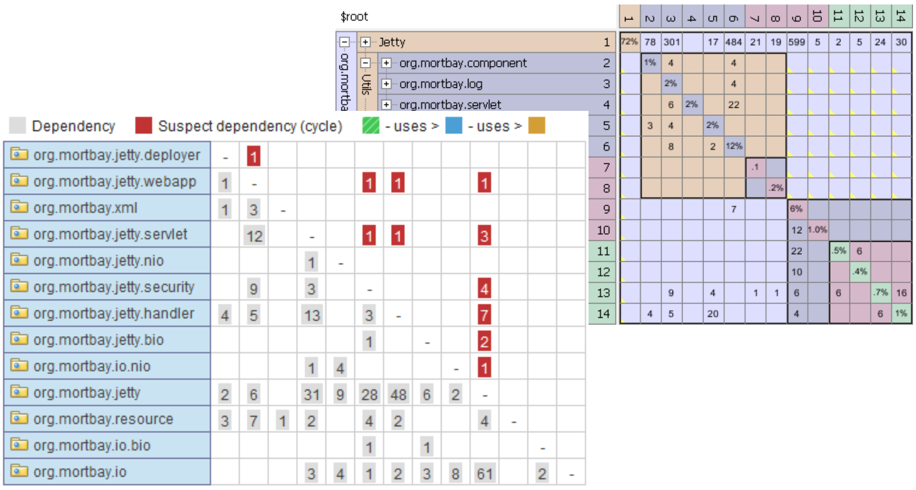
Dependency Structure Matrix

	A	B	C
A		Strength of B's dependency on A	
B	Strength of A's dependency on B		Strength of C's dependency on B
C			

Dependencies for MS-Lite

		Alarm Notificat 1	L&R Engine 2	Alarm Engine 3	Alarm Manage 4	Logon 5	Client Updates 6	Rule Processo 7	Adapter Mana 8	User Session 9	Data Access 10	Cache 11	FSS Adapter 12	Data Persisten 13	Publish-Subsc 14
US 01	1						X			X					X
US 02	2						X			X					X
US 03	3			X				X		X					
US 04	4	X		X	X			X		X					X
US 05	5				X						X				
US 06	6		X					X		X					X
US 07	7		X	X										X	
US 08	8					X					X				
US 09	9								X				X		
ACT 14	23								X						
ACT 15	24								X				X		X
ACT 16	25								X				X		X
ACT 17	26						X			X		X			X
ACT 18	27	X					X								
ACT 19	28	X													
ACT 20	29					X					X				
ACT 21	30									X					

Dependency Structure Matrix



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Propagation cost

- "Density" of the DSM
  - Proposed by McCormack et al. in 2006
  - Several limitations as a tool to measure T.D.
- Improved PC:
  - Boolean to continuous value (=dependency "strength")
  - Changes not uniformly spread throughout the code
  - Less sensitive to size of code

McCormack et al. 2006

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Exploring other variations

- Size of components
  - Add some weighting factor related to the size of the component A and B, where A depends on B
- Nothing very useful so far; need more experimentation and validation on large real systems

Nord et al. 2012

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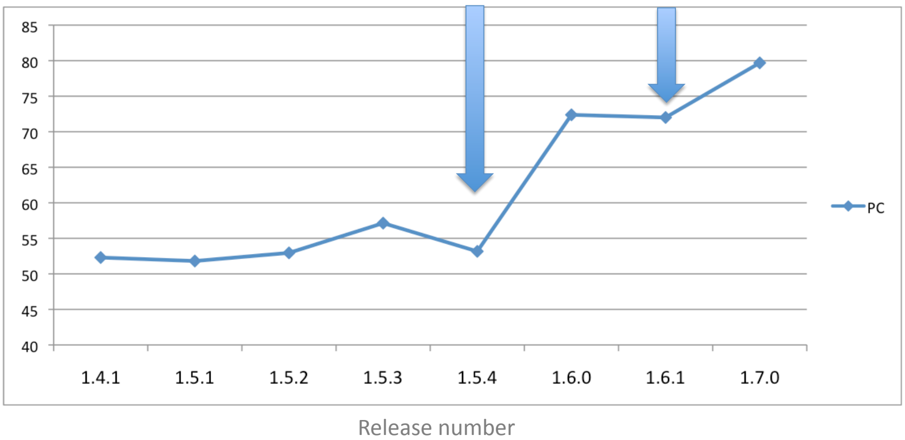
Example of PC: Evolution of Ant

Technical debt reduction



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DSM

- Value of DSM not fully explored yet
  - Concept of propagation cost
  - Concept of density
  - Need to integrate values and costs
- Tools to produce or manipulate DSM
  - SonarJ
  - Lattix
- "What if" scenarios

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"Tackling" technical debt

Tackling Technical Debt

Attitude, approaches found:

1. Ignorance is bliss
2. The elephant in the room
3. Big scary $$$$ numbers
4. Five star ranking
5. Constant reduction
6. We're agile, so we are immune!

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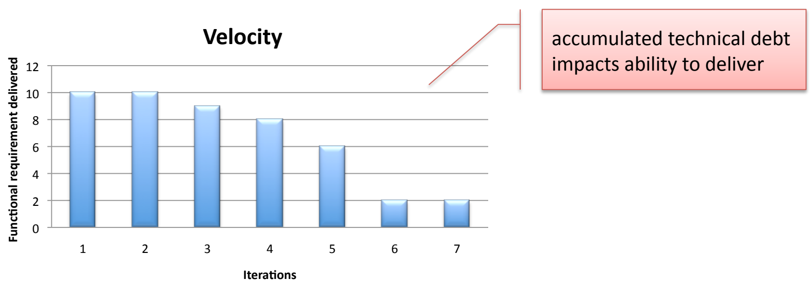
Ignorance is bliss

You're just slower, and slower, but you do not know it, or do not know why



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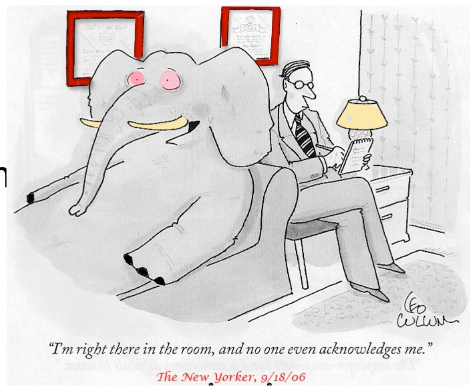
The elephant in the room

- Many in the org. know about technical tech.
- Indifference: it's someone else's problem
- Organization broken down in small silos
- No real whole product mentality
- Short-term focus



Big scary $$$$ numbers

- Code smells 167 person days
- Missing test 298 person days
- Design 670 person days
- Documentation 67 person days

Totals

Work	1,202 person x days
Cost	$577,000

Static analysis + Consulting

- Cutter Consortium: Gat, et al.
  - Use of Sonar, etc.
  - Focused on code analysis
  - TD = total value of fixing the code base
- CAST software
- ThoughtWorks

Debt analysis engagements
Debt reduction engagements

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Issues

- Fits the metaphor, indeed.
- Looks very objective… but…
- Subjective in:
  - What is counted
  - What tool to use
  - Cost to fix

Not all fixes have the same resulting value.
Sunk cost are irrelevant, look into the future only.
What does it mean to be “Debt free”??

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Five star ranking

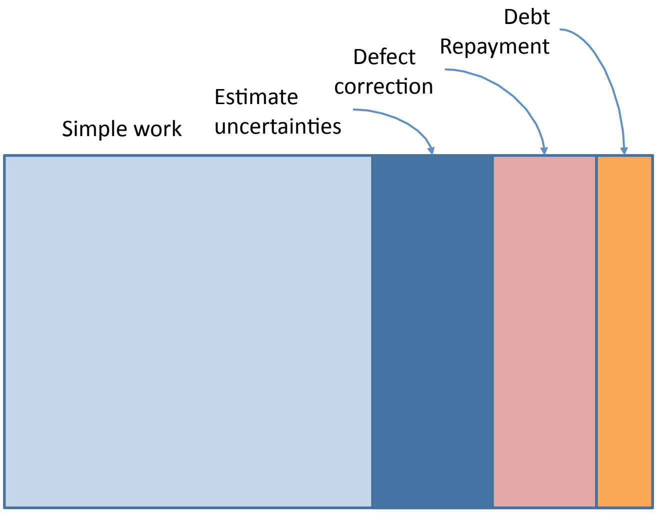
- Define some *maintainability* index
- Benchmark relative to other software in the same category
- Re-assess regularly (e.g., weekly)
- Look at trends, correlate changes with recent changes in code base

- SIG (Software Improvement Group), Amsterdam
- Powerful tool behind

Constant debt reduction

- Make technical debt a visible item on the backlog
- Make it visible outside of the software dev. organization
- Incorporate debt reduction as a regular activity
- Use buffer in longer term planning for yet unidentified technical debt
- Lie (?)

Buffer for debt repayment



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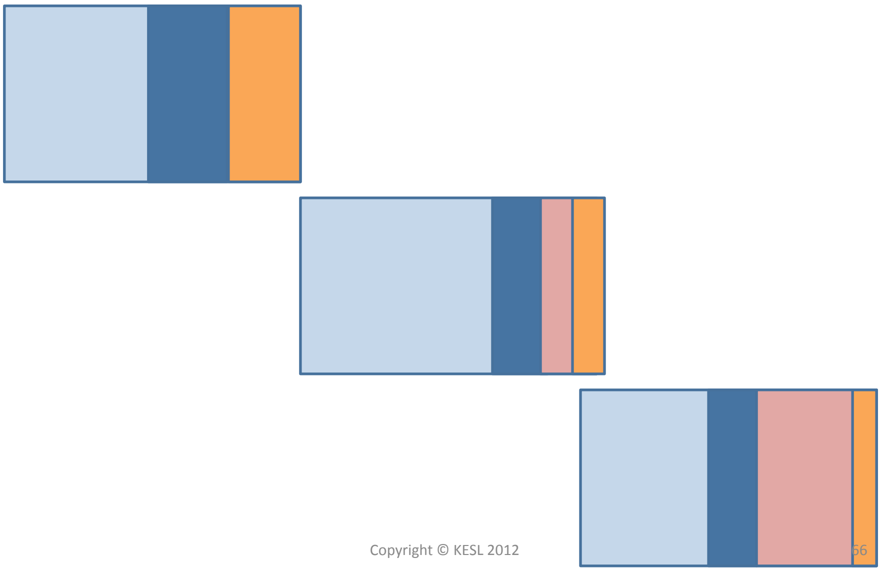
A later release



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We are agile, so we're immune!

In some cases we are agile and therefore we run faster into technical debt

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Agile mottos

- "Defer decision to the last responsible moment"
- "YAGNI" = You Ain't Gonna Need It
  - But when you do, it is technical debt
  - Technical debt often is the accumulation of too many YAGNI decisions
- "We'll refactor this later"
- "Deliver value, early"
- *Again the tension between the yellow stuff and the green stuff*
- *You're still agile because you aren't slowed down by TD yet.*

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TD: a few suggestions

- Inform

- Identify debt; name it
- Classify debt: code quality, or structural
- Assign value and cost (immediate and future)
- Make it visible (put in backlog)
- Prioritize with other backlog elements

Remember

- Technical debt is not a defect
- Technical debt is not necessarily a bad thing

	Visible	Invisible
Positive Value	**Visible Feature**	**Hidden, architectural feature**
Negative Value	**Visible defect**	**Technical Debt**

Also…

- A suitable system architecture is not likely to spontaneously emerge out of weekly refactorings
- *How much architecture do you need or have?*

- Some novel projects need an
  - Architecture owner

    together with
  - Product owner, and ScrumMaster

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Conclusion

- Technical debt is more a *rhetorical* category than a *technical* or ontological category.
- The concept resonates well with the development community, and sometimes also with management.
- It bridges the gap between business decision makers and technical implementers.
- It's only a metaphor; do not push it too far.

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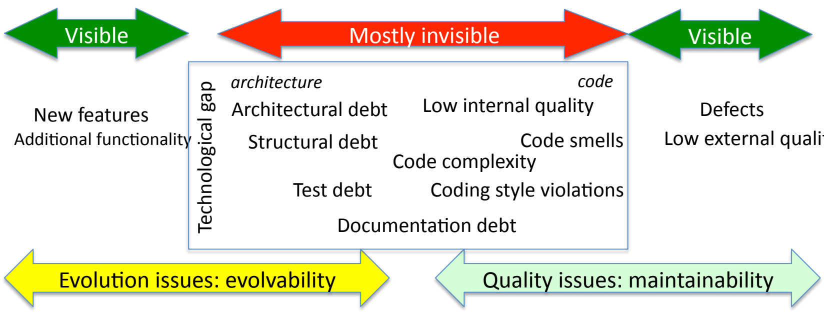

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Upcoming events

- Special issue of IEEE Software on Technical debt November 2012
- Possibly a 4th workshop on Technical Debt at ICSE 2013, in San Francisco
  - Or some other venue…
    - Saturn 2013
    - CompArch 2013

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Other pointers

techdebt report http://techdebt.org

ontechnicaldebt http://www.ontechnicaldebt.com/

@OnTechnicalDebt

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Acknowledgements

- Research on TD partly funded by the Software Engineering Institute | Carnegie Mellon
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  - … with some industry partners

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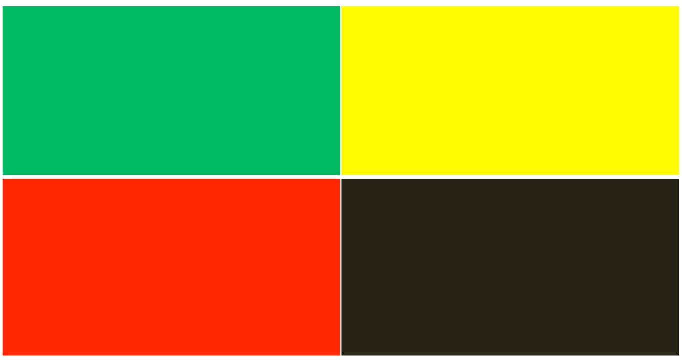

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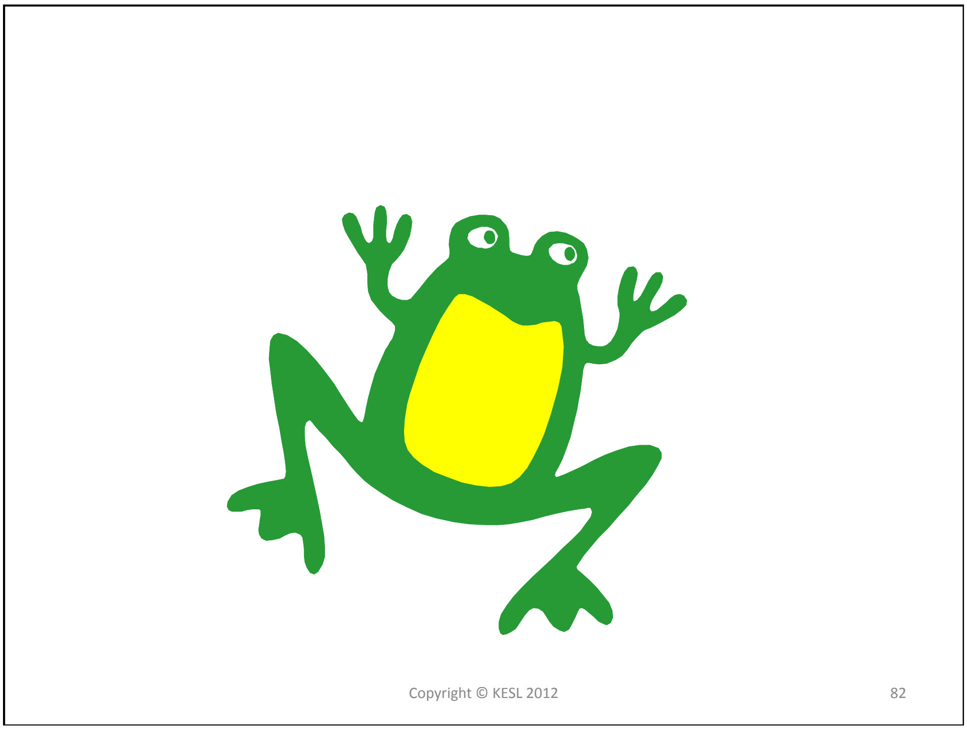
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