Business Value of Lean & Agile Methods

Using Return on Investment (ROI) and Real Options Analysis

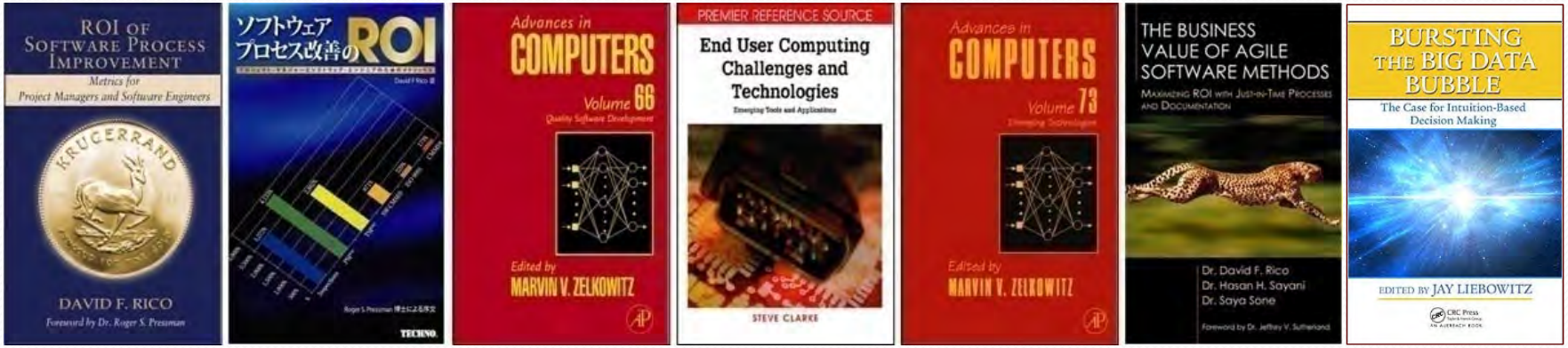
Dr. David F. Rico, PMP, CSEP, FCP, FCT, ACP, CSM, SAFE, DEVOPS

Twitter: @dr_david_f_rico
Website: http://www.davidfrico.com
LinkedIn: http://www.linkedin.com/in/davidfrico

Agile Capabilities: http://davidfrico.com/rico-capability-agile.pdf
Agile Cost of Quality: http://www.davidfrico.com/agile-vs-trad-coq.pdf
DevOps Return on Investment (ROI): http://davidfrico.com/rico-devops-roi.pdf
Dave's NEW Leadership Video: http://www.youtube.com/watch?v=70LRzOk9VGY
Dave's NEW Business Agility Video: http://www.youtube.com/watch?v=hTvtsAkL8xU
Dave's NEWER Scaled Agile Framework SAFe 4.5 Video: http://youtu.be/1TAuCRq5a34
Dave's NEWEST Development Operations Security Video: http://youtu.be/X22kJAvx44A
DoD Fighter Jets versus Amazon Web Services: http://davidfrico.com/dod-agile-principles.pdf

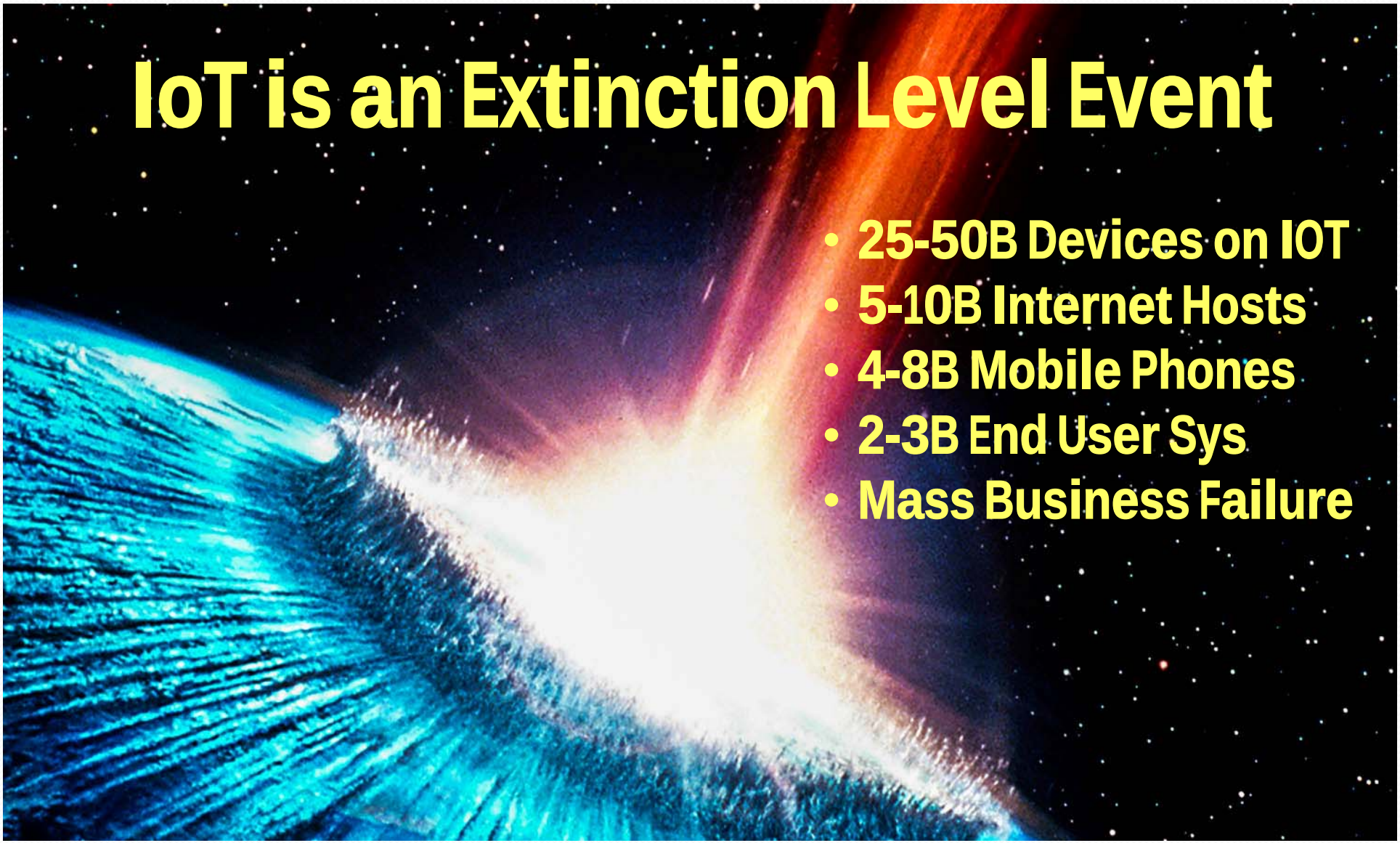
Author Background

- Gov't contractor with 35+ years of IT experience
- B.S. Comp. Sci., M.S. Soft. Eng., & D.M. Info. Sys.
- ☞ Large gov't projects in U.S., Far/Mid-East, & Europe

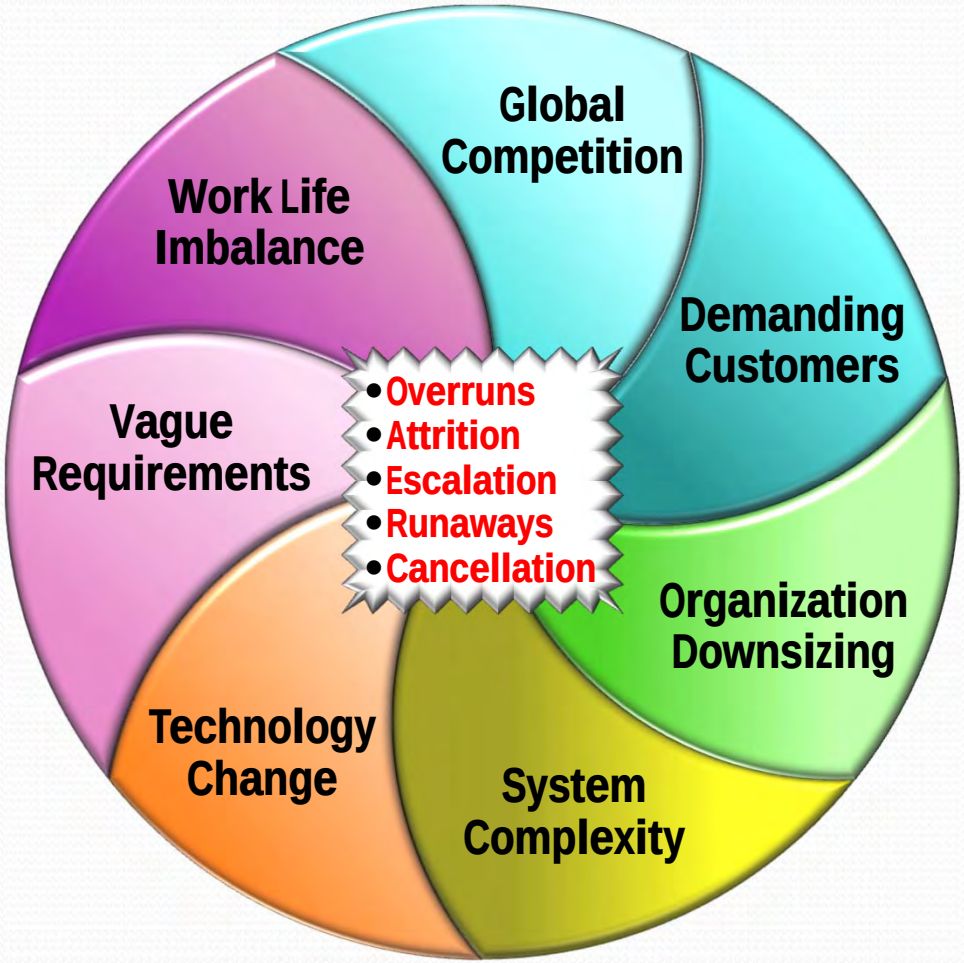


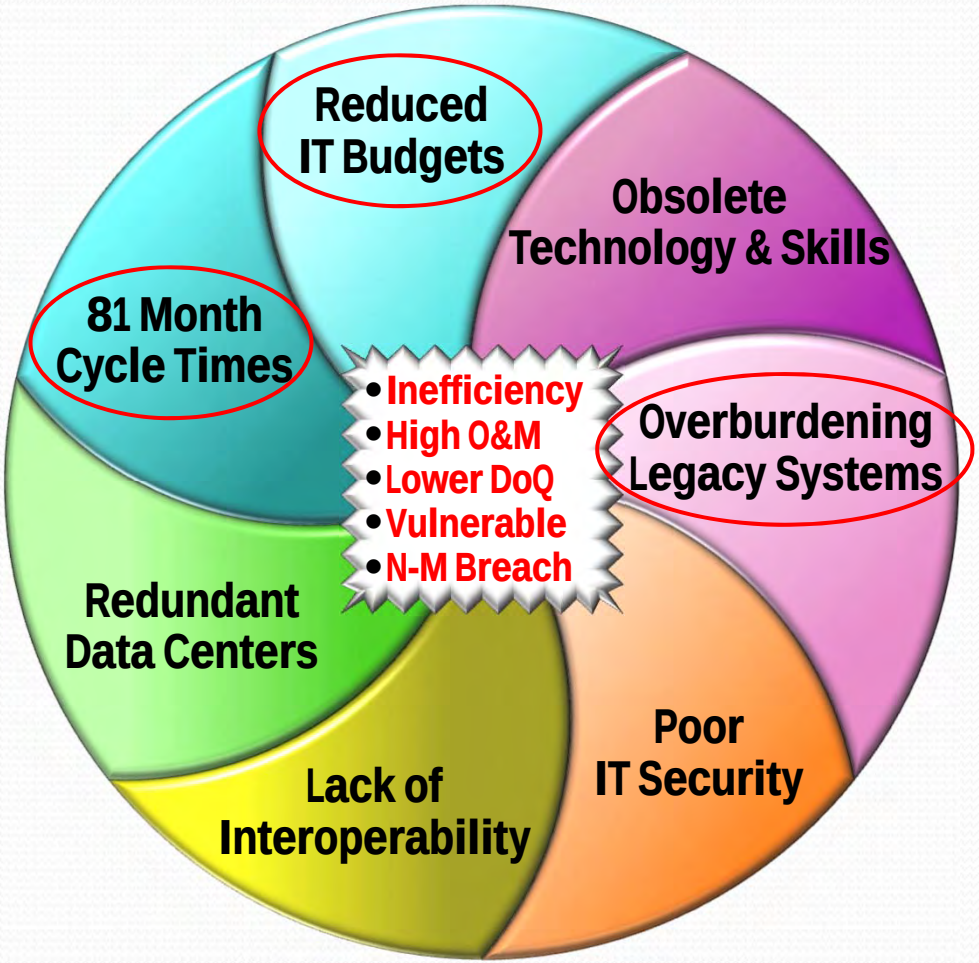
→ ***Career systems & software engineering methodologist***
→ *Lean-Agile, Six Sigma, CMMI, ISO 9001, DoD 5000*
→ *NASA, USAF, Navy, Army, DISA, & DARPA projects*
→ *Published seven books & numerous journal articles*
→ *Intn'l keynote speaker, 200+ talks to 14,500 people*
→ *Specializes in metrics, models, & cost engineering*
→ *Cloud Computing, SOA, Web Services, FOSS, etc.*
→ *Professor at 7 Washington, DC-area universities*

Internet of Things—Dinosaur Killer



Today's Whirlwind Environment

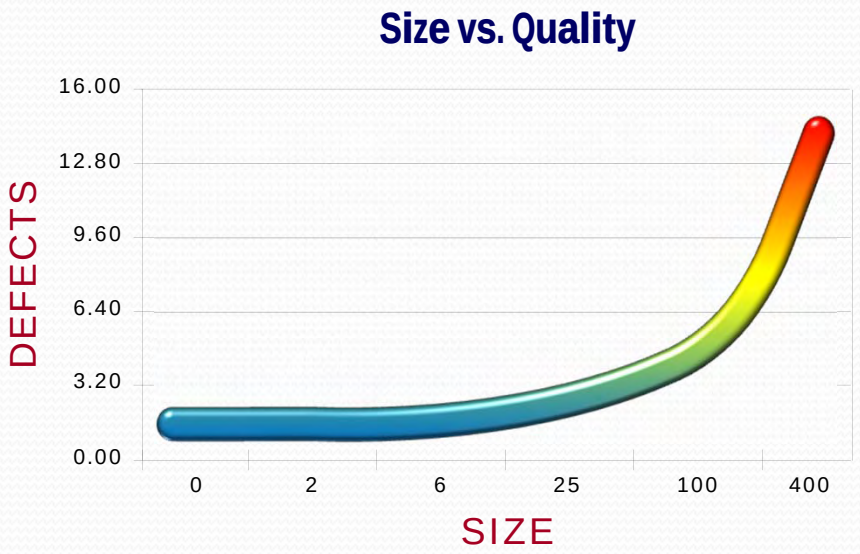


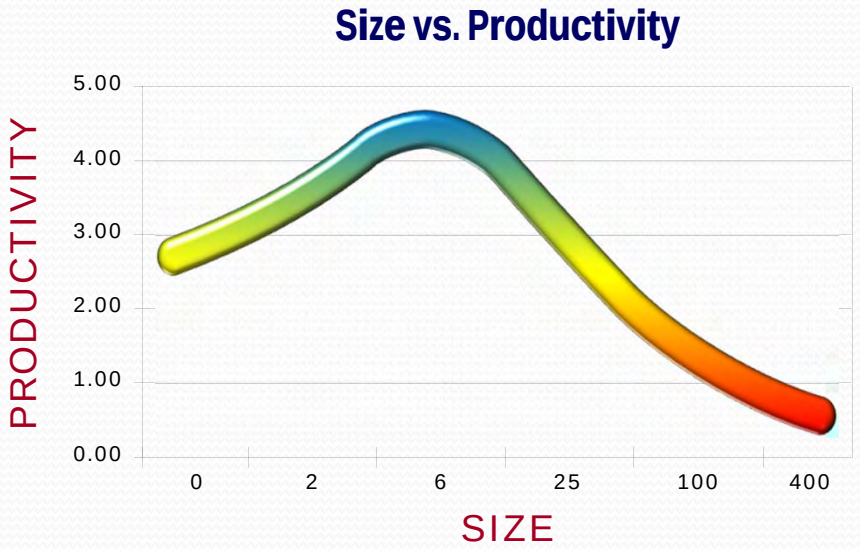


Pine, B. J. (1993). *Mass customization*: *The new frontier in business competition*. Boston, MA: Harvard Business School Press.

Pontius, R. W. (2012). Acquisition of IT: Improving efficiency and effectiveness in IT acquisition in the DoD. *Second Annual AFEI/NDIA Conference on Agile in DoD, Springfield, VA, USA.*

Large TRADITIONAL Projects

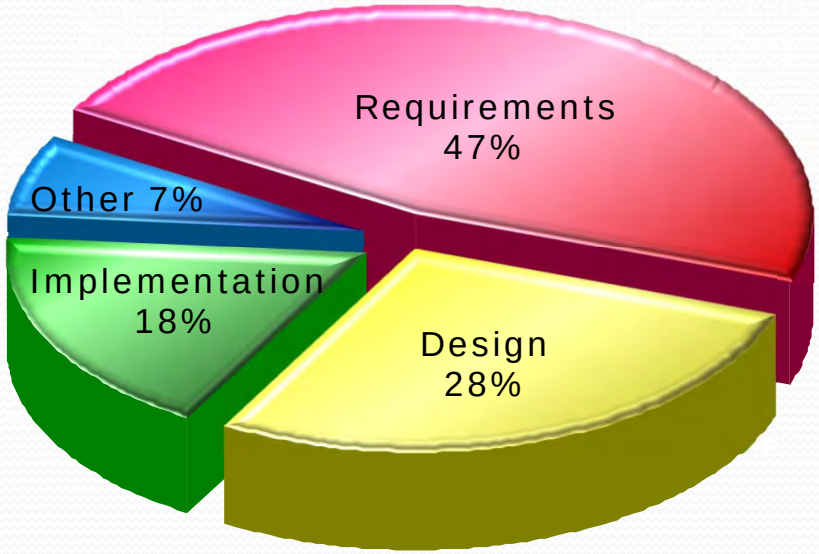




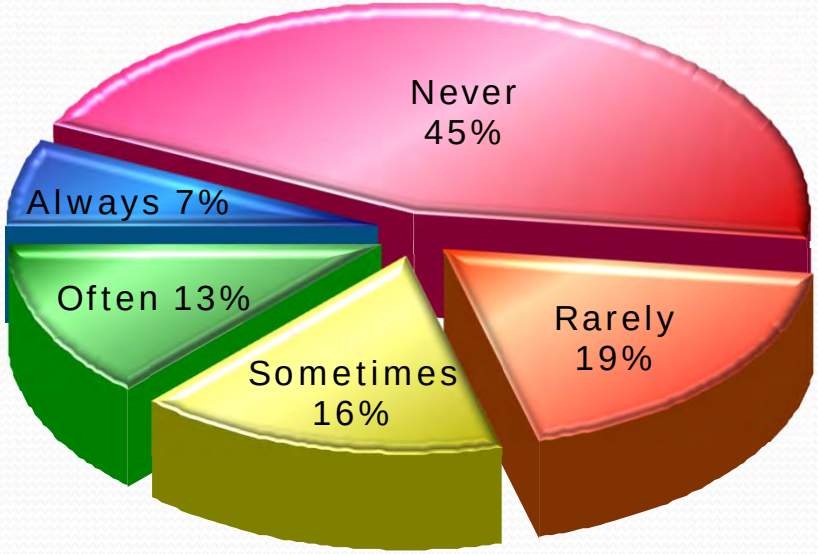
Jones, C. (1991). *Applied software measurement*: *Assuring productivity and quality*. New York, NY: McGraw-Hill.

Large TRADITIONAL Projects—Cont'd

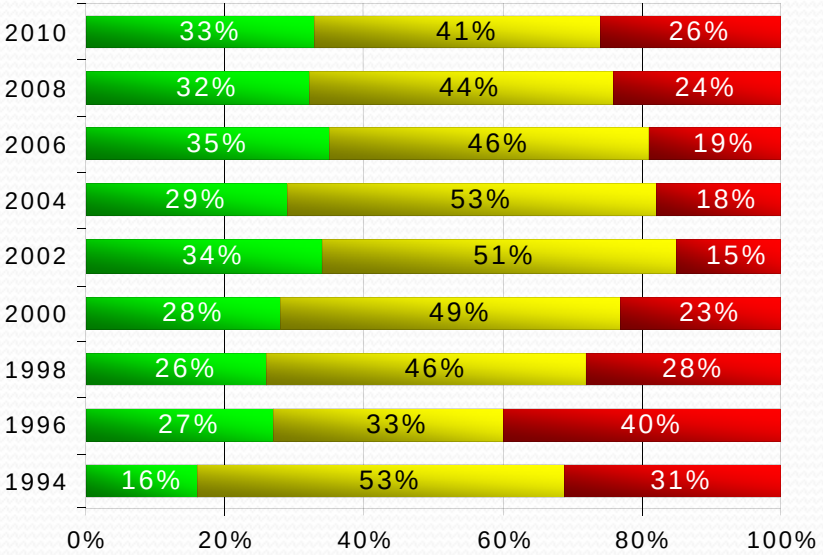
DEFECTS



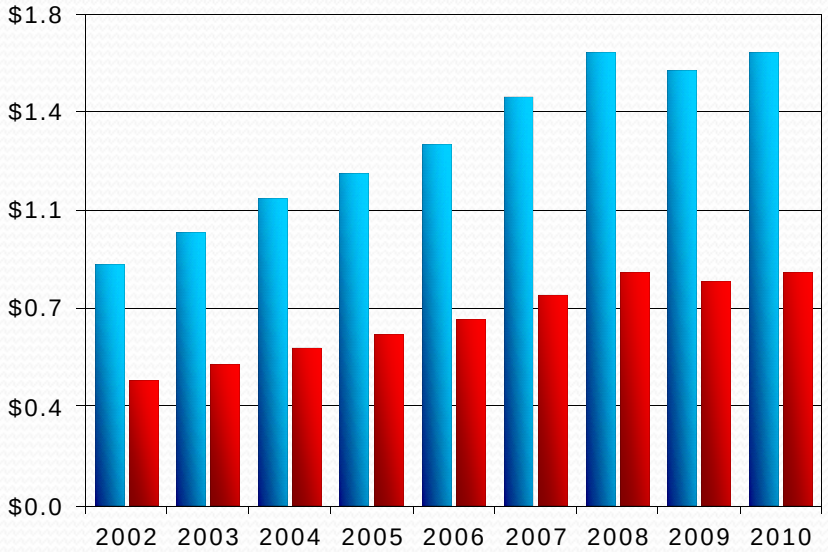
WASTE



IT PROJECT FAILURES



GLOBAL IT PROJECT FAILURES



What is Agility?

- A-gil-i-ty (ə-'ji-lə-tē) Property consisting of quickness, lightness, and ease of movement; To be very nimble
  - *The ability to create and respond to change in order to profit in a turbulent global business environment*
  - *The ability to quickly reprioritize use of resources when requirements, technology, and knowledge shift*
  - *A very fast response to sudden market changes and emerging threats by intensive customer interaction*
  - *Use of evolutionary, incremental, and iterative delivery to converge on an optimal customer solution*
  - *Maximizing* **BUSINESS VALUE** *with right sized, just-enough, and just-in-time processes and documentation*

Highsmith, J. A. (2002). *Agile software development ecosystems*. Boston, MA: Addison-Wesley.

What are Agile Values?

- People-centric way to create innovative solutions
- Product-centric alternative to documents/process
- Market-centric model to maximize business value

CUSTOMER COLLABORATION
vs CONTRACT NEGOTIATION

INDIVIDUALS & INTERACTIONS
vs PROCESSES AND TOOLS

WORKING PRODUCTS
vs COMPREHENSIVE DOCUMENTATION

RESPONDING TO CHANGE
vs FOLLOWING A PLAN

Agile Manifesto. (2001). *Manifesto for agile software development*. Retrieved September 3, 2008, from http://www.agilemanifesto.org

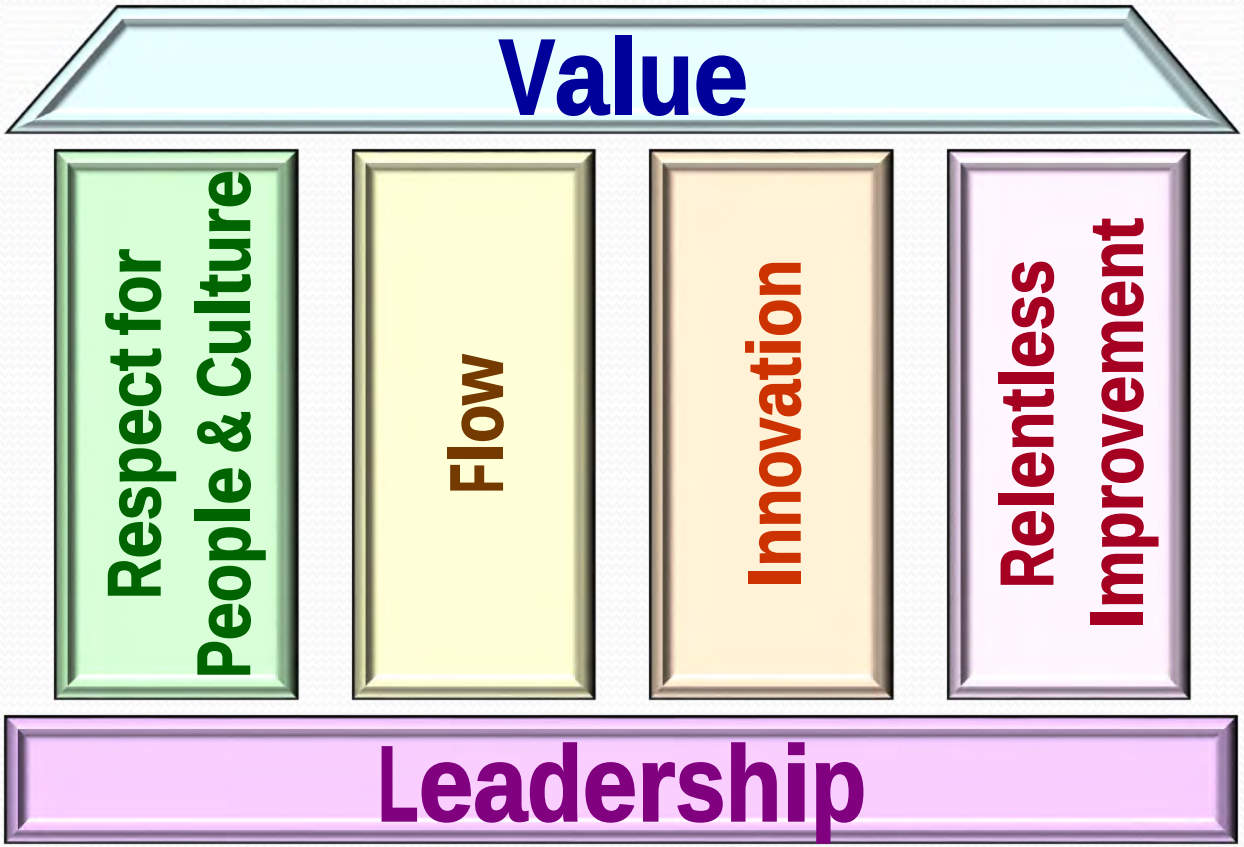
What is Lean?

- Lean (lēn): Property consisting of being thinness, slimness, and skinniness; To be extremely slender
  - *A customer-driven product development process that delivers the maximum amount of business value*
  - *An economical way of planning and managing the development of complex new products and services*
  - *A product development process that is free of excess waste, capacity, and non-value adding activities*
  - *Just-enough, just-in-time, and right-sized product development processes, documentation, and tools*
  - *A product development approach that is* **ADAPTABLE TO CHANGE** *in customer needs and market conditions*

Womack, J. P., & Jones, D. T. (1996). *Lean thinking: Banish waste and create wealth in your corporation*. New York, NY: Free Press.

What are Lean Values?

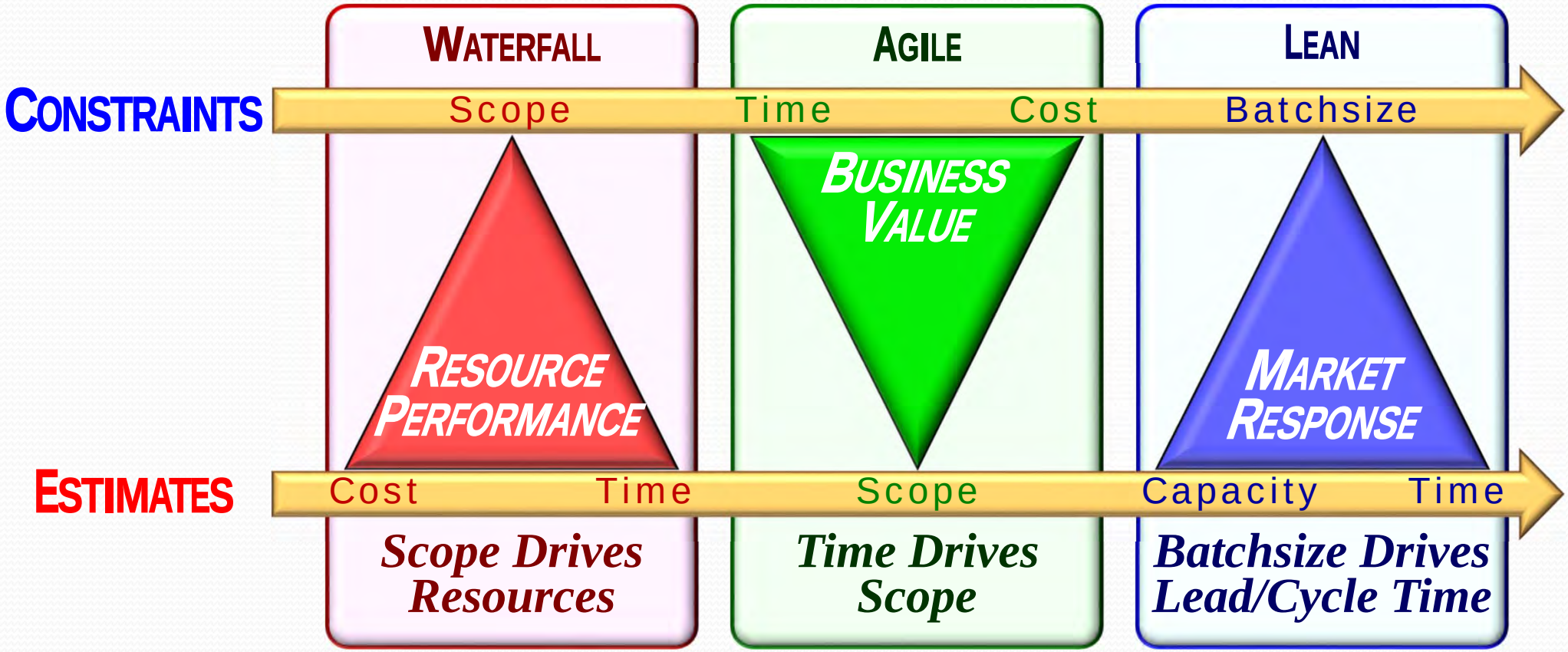
- Time-centric way to compete on speed & time
- Customer-centric model to optimize cost & quality
- Pull-centric alternative to wasteful mass production



Leffingwell, D. (2017). *The SAFe house of lean*. Retrieved February 19, 2018, from http://www.scaledagileframework.com

Lean & Agile GOLDILOCKS Zone

- Traditional project management is scope-based
- Agile project management is primarily time-based
- ☞ Batchsize, capacity, & time key to market response



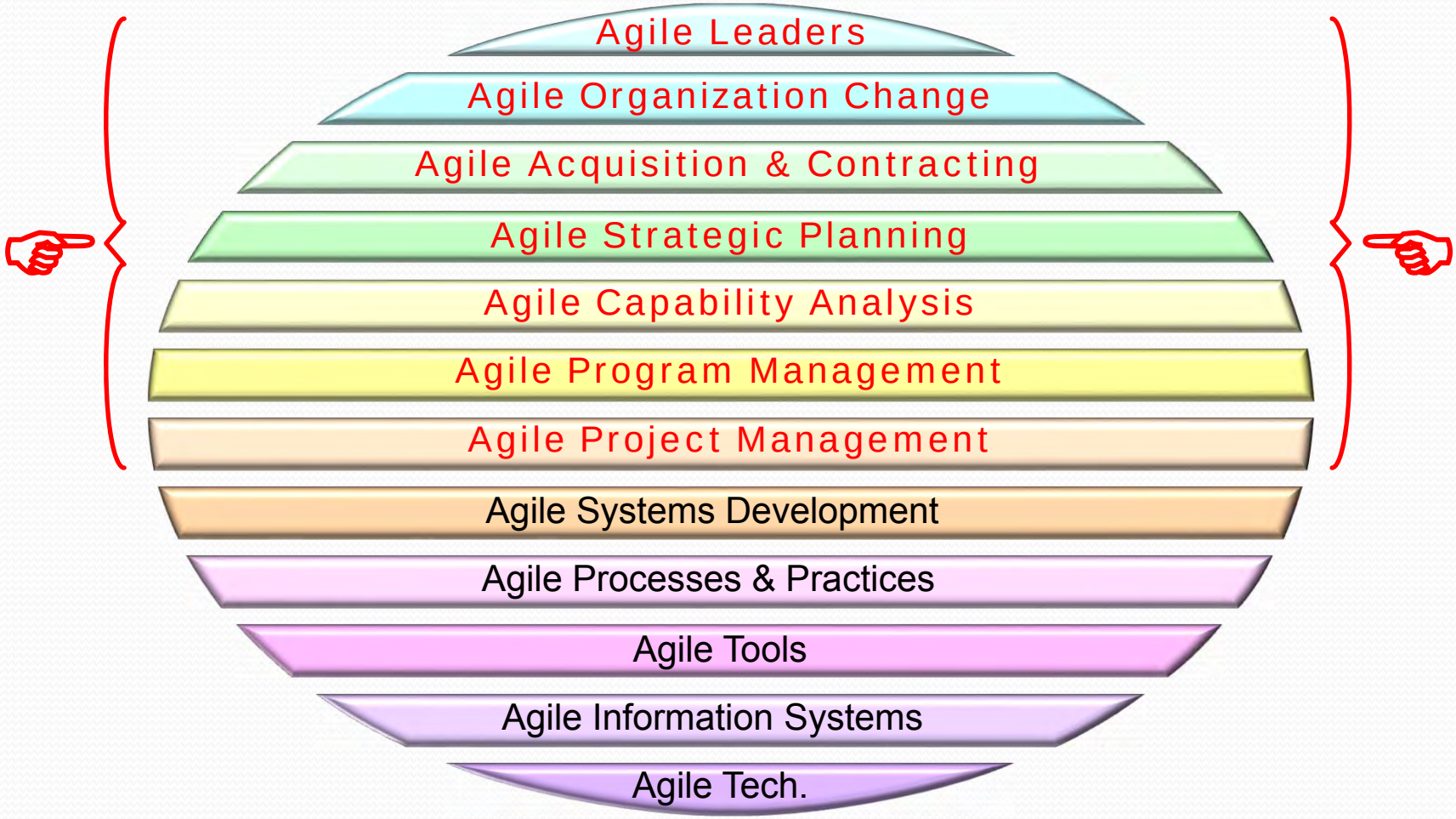
Rico, D. F. (2017). *Lean triangle: Triple constraints*. Retrieved December 17, 2017, from http://davidfrico.com/lean-triangle.pdf

Sylvester, T. (2013). *Waterfall, agile, and the triple constraint*. Retrieved December 16, 2017, from http://tom-sylvester.com/lean-agile/waterfall-agile-the-triple-constraint

Pound, E. S., Bell, J. H., Spearman, M. L. (2014). *Factory physics*: *How leaders improve performance in a post-lean six sigma world*. New York, NY: McGraw-Hill Education.

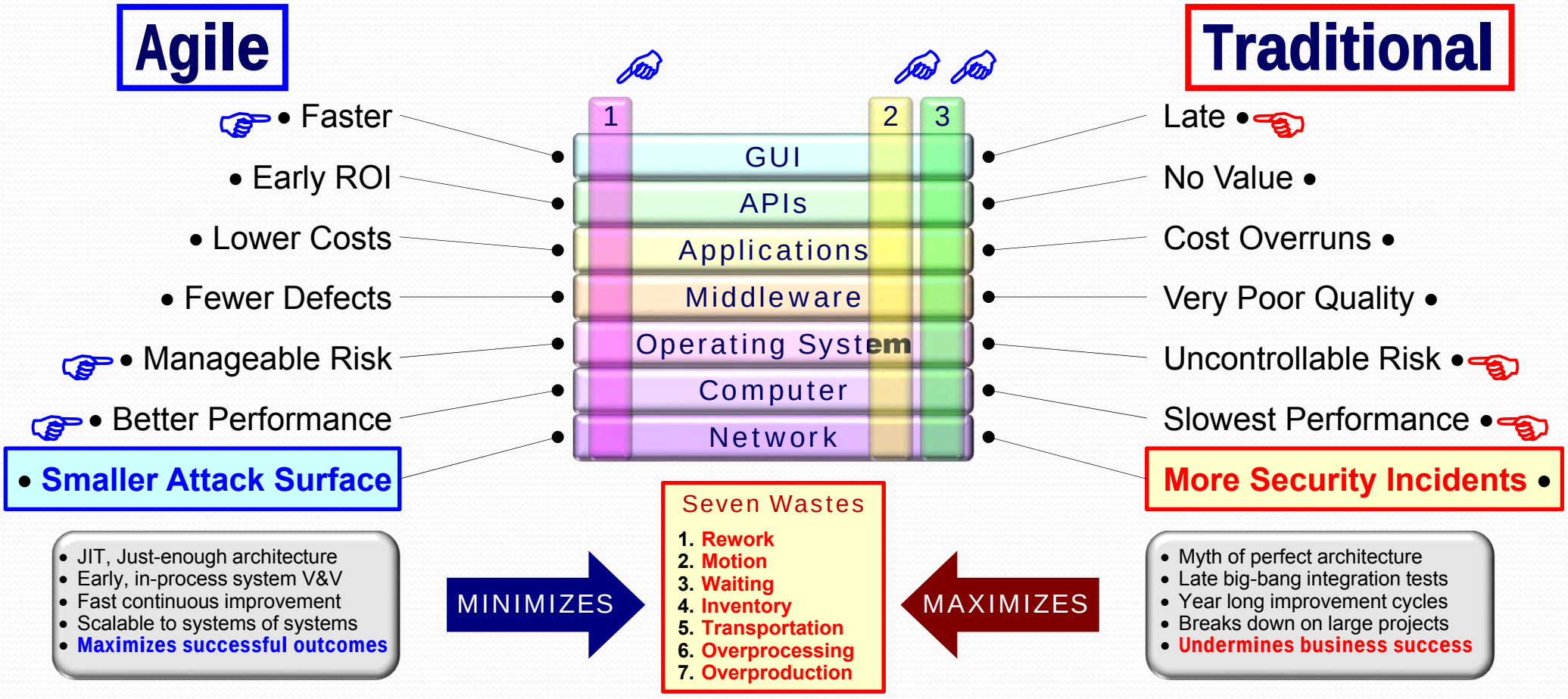
Agile World View

- "Agility" has many dimensions other than IT
- It ranges from leadership to technological agility
- Today's focus is on organizational & enterprise agility



Agile Methods—How they work?

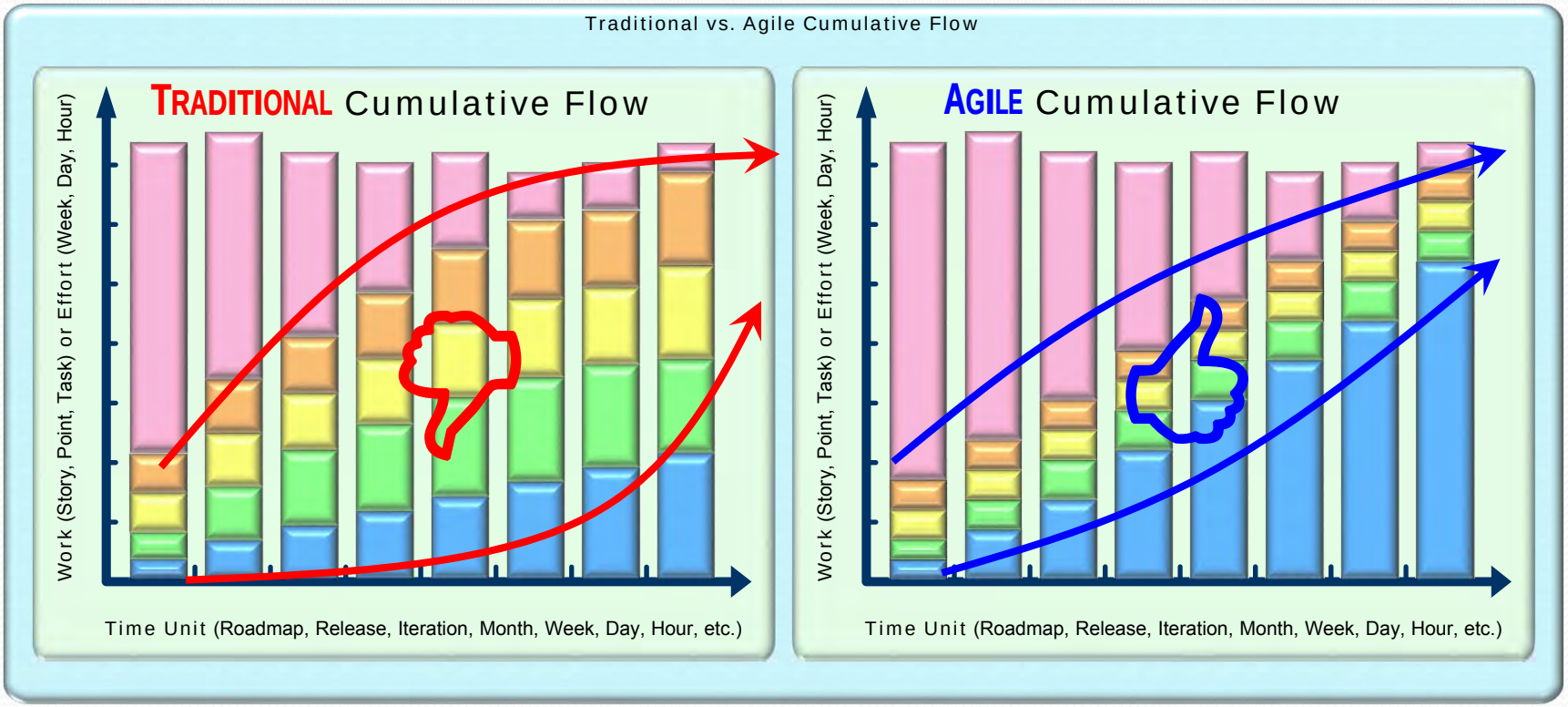
- Agile requirements implemented in slices vs. layers
- User needs with higher business value are done first
- Reduces cost & risk while increasing business success



Shore, J. (2011). Evolutionary design illustrated. *Norwegian Developers Conference, Oslo, Norway*.

Agile Methods—Workflow Results

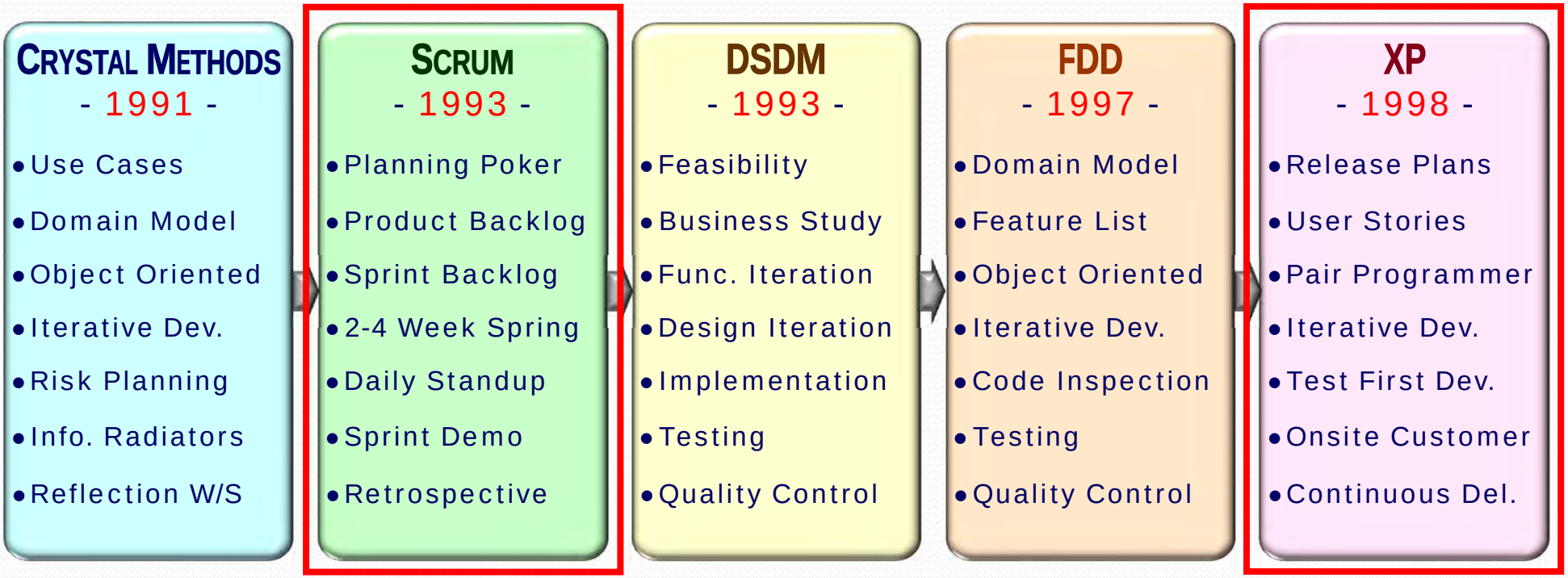
- Late big bang integration increases WIP backlog
- Agile testing early and often reduces WIP backlog
- Improves workflow and reduces WIP & lead times



Anderson, D. J. (2004). *Agile management for software engineering*. Upper Saddle River, NJ: Pearson Education.
Anderson, D. J. (2010). *Kanban*: *Successful evolutionary change for your technology business*. Sequim, WA: Blue Hole Press.

Models of Agile Development

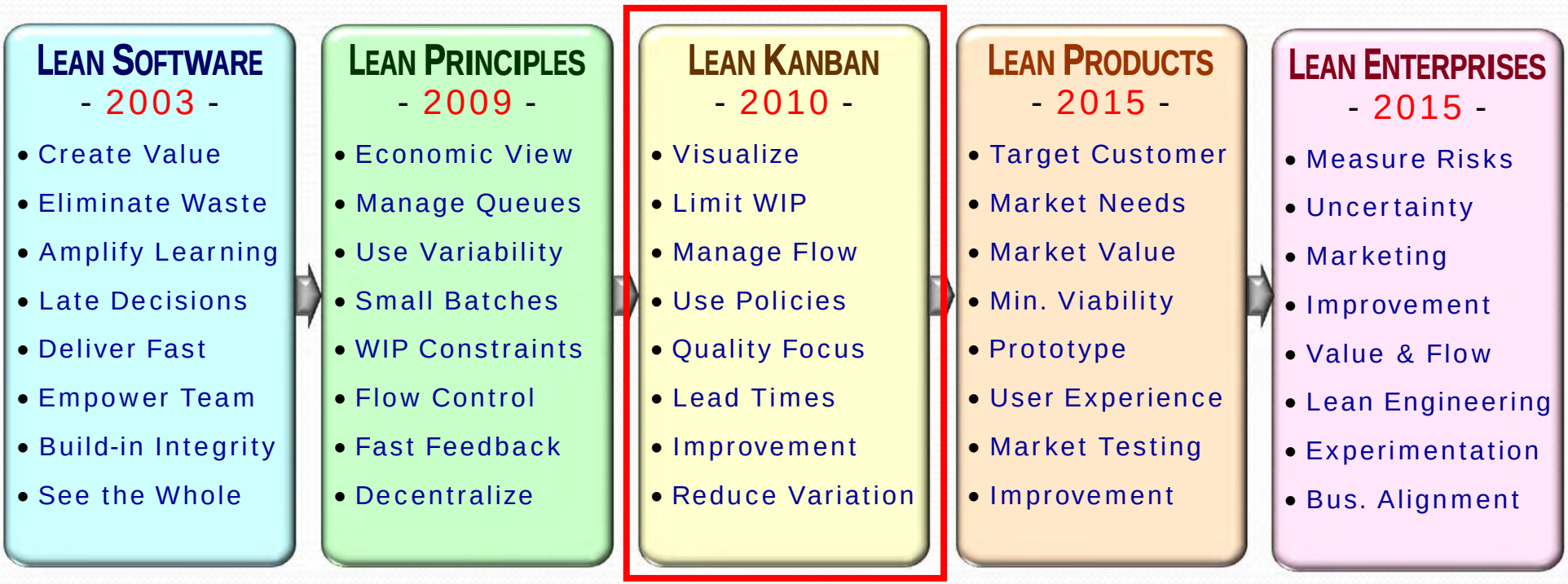
- Agile methods spunoff flexible manufacturing 1990s
- Extreme Programming (XP) swept the globe by 2002
- Today, over 90% of IT projects use Scrum/XP hybrid



Cockburn, A. (2002). *Agile software development*. Boston, MA: Addison-Wesley.
Schwaber, K., & Beedle, M. (2001). *Agile software development with scrum*. Upper Saddle River, NJ: Prentice-Hall.
Stapleton, J. (1997). *DSDM: A framework for business centered development*. Harlow, England: Addison-Wesley.
Palmer, S. R., & Felsing, J. M. (2002). *A practical guide to feature driven development*. Upper Saddle River, NJ: Prentice-Hall.
Beck, K. (2000). *Extreme programming explained: Embrace change*. Reading, MA: Addison-Wesley.

Models of Lean Development

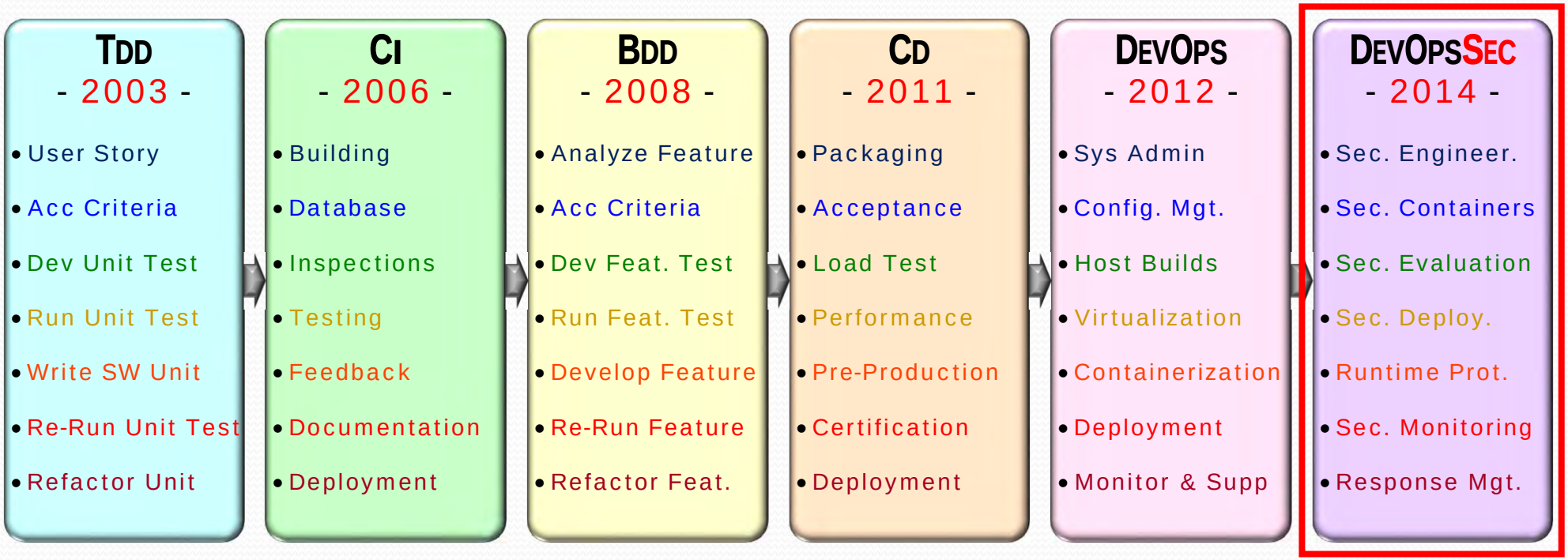
- Numerous models of lean development emerging
- Based on principles of lean thinking & just-in-time
- Include software, project, & product management



Poppendieck, M., & Poppendieck, T. (2003). *Lean software development: An agile toolkit for software development managers*. Boston, MA: Addison Wesley.
Reinertsen, D. G. (2009). *The principles of product development flow: Second generation lean product development*. New York, NY: Celeritas.
Anderson, D. J. (2010). *Kanban: Successful evolutionary change for your technology business*. Sequim, WA: Blue Hole Press.
Olsen, D. (2015). *The lean product playbook: How to innovate with minimum viable products and rapid customer feedback*. Hoboken, NJ: John Wiley & Sons.
Humble, J., Molesky, J., & O'Reilly, B. (2015). *Lean enterprise: How high performance organizations innovate at scale*. Sebastopol, CA: O'Reilly Media.

Models of Agile Delivery

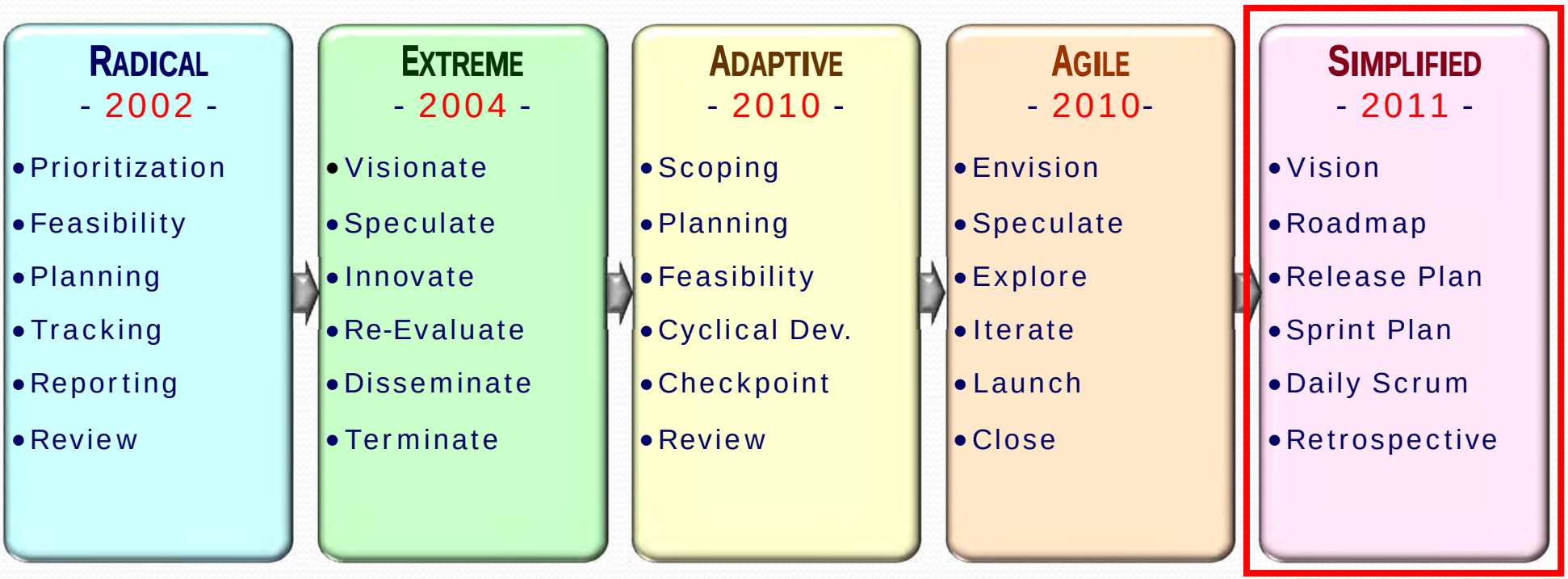
- Numerous models of lean-agile testing emerging
- Based on principles of lean & agile one piece flow
- Include software, hardware, system, & port. testing



Beck, K. (2003). *Test-driven development*: *By example*. Boston, MA: Addison-Wesley.
Duvall, P., Matyas, S., & Glover, A. (2006). *Continuous integration*. Boston, MA: Addison-Wesley.
Barker, K., & Humphries, C. (2008). *Foundations of rspec*: *Behavior driven development with ruby and rails*. New York, NY: Apress.
Humble, J., & Farley, D. (2011). *Continuous delivery*. Boston, MA: Pearson Education.
Huttermann, M. (2012). *Devops for developers*: *Integrate development and operations the agile way*. New York, NY: Apress.
Bird, J. (2016). *Devopssec*: *Delivering secure software through continuous delivery*. Sebastopol, CA: O'Reilly Media.

Models of Agile Project Mgt.

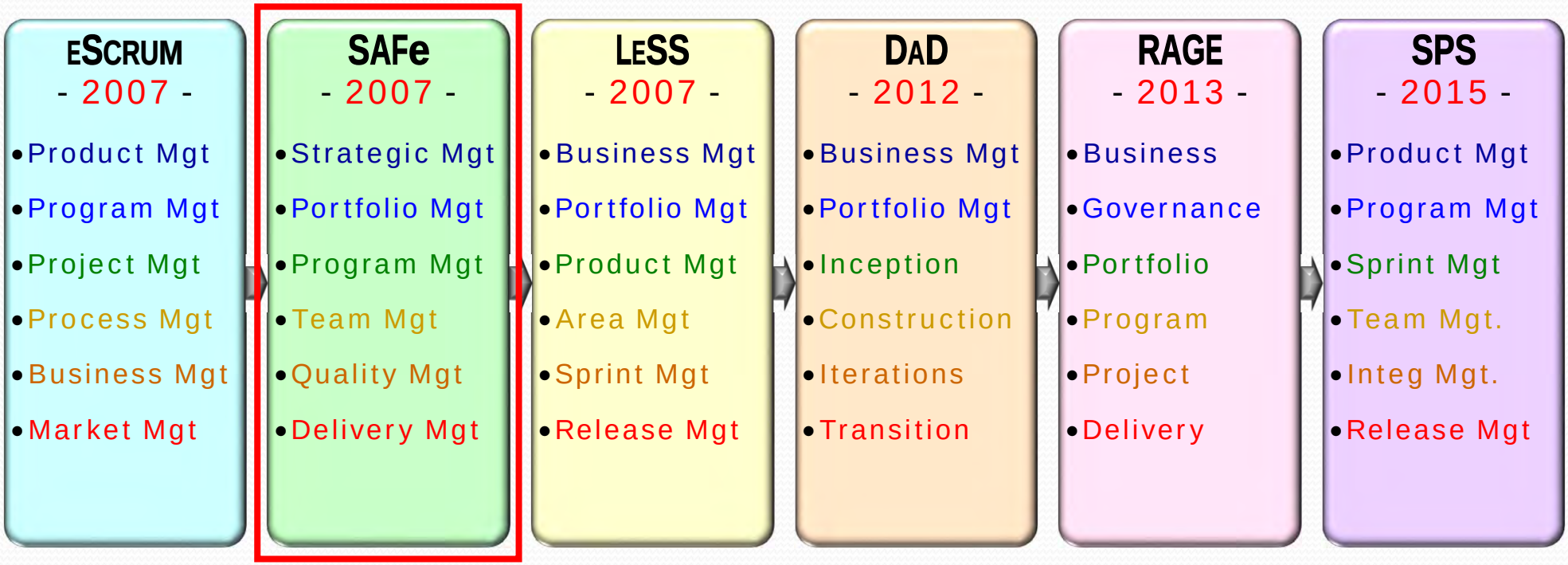
- Dozens of Agile project management models emerged
- Many stem from principles of Extreme Programming
- Vision, releases, & iterative development common



Thomsett, R. (2002). *Radical project management*. Upper Saddle River, NJ: Prentice-Hall.
DeCarlo, D. (2004). *Extreme project management*: *Using leadership, principles, and tools to deliver value in the face of volatility*. San Francisco, CA: Jossey-Bass.
Wysocki, R.F. (2010). *Adaptive project framework*: *Managing complexity in the face of uncertainty*. Boston, MA: Pearson Education.
Highsmith, J. A. (2010). *Agile project management*: *Creating innovative products*. Boston, MA: Pearson Education.
Layton, M. C., & Maurer, R. (2011). *Agile project management for dummies*. Hoboken, NJ: Wiley Publishing.

Models of Agile Portfolio Mgt.

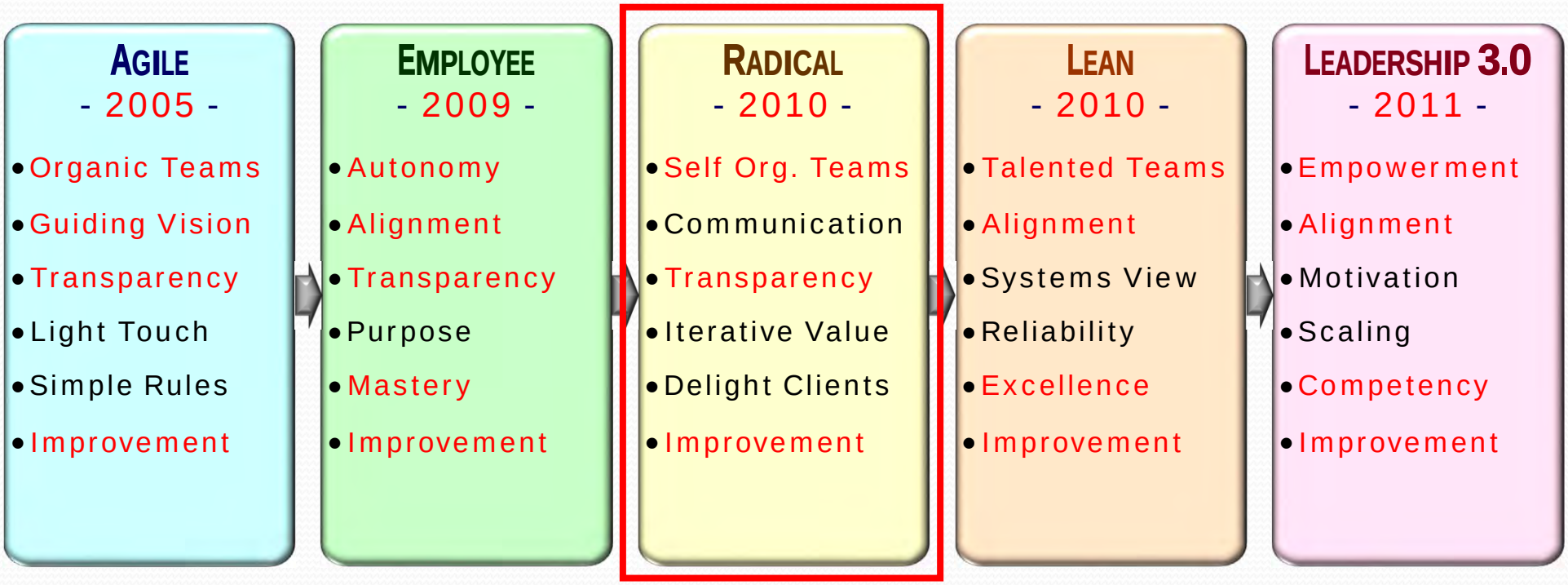
- Numerous models of agile portfolio mgt. emerging
- Based on lean-kanban, release planning, and Scrum
- Include organization, program, & project management



Schwaber, K. (2007). *The enterprise and scrum*. Redmond, WA: Microsoft Press.
Leffingwell, D. (2007). *Scaling software agility*: *Best practices for large enterprises*. Boston, MA: Pearson Education.
Larman, C., & Vodde, B. (2008). *Scaling lean and agile development*: *Thinking and organizational tools for large-scale scrum*. Boston, MA: Addison-Wesley.
Ambler, S. W., & Lines, M. (2012). *Disciplined agile delivery*: *A practitioner's guide to agile software delivery in the enterprise*. Boston, MA: Pearson Education.
Thompson, K. (2013). *cPrime's R.A.G.E. is unleashed*: *Agile leaders rejoice*! Retrieved March 28, 2014, from http://www.cprime.com/tag/agile-governance
Schwaber, K. (2015). *The definitive guide to nexus*: *The exoskeleton of scaled scrum development*. Lexington, MA: Scrum.Org

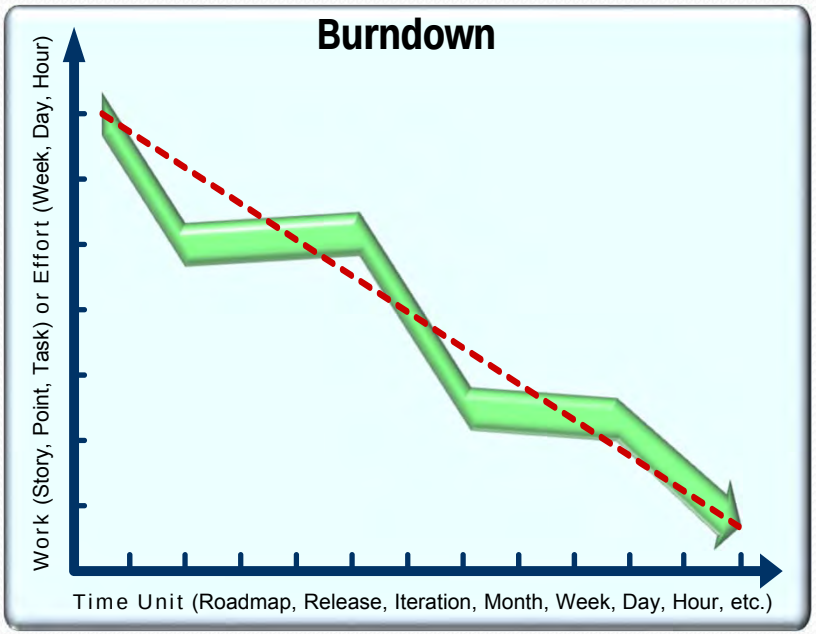
Models of Agile Leadership

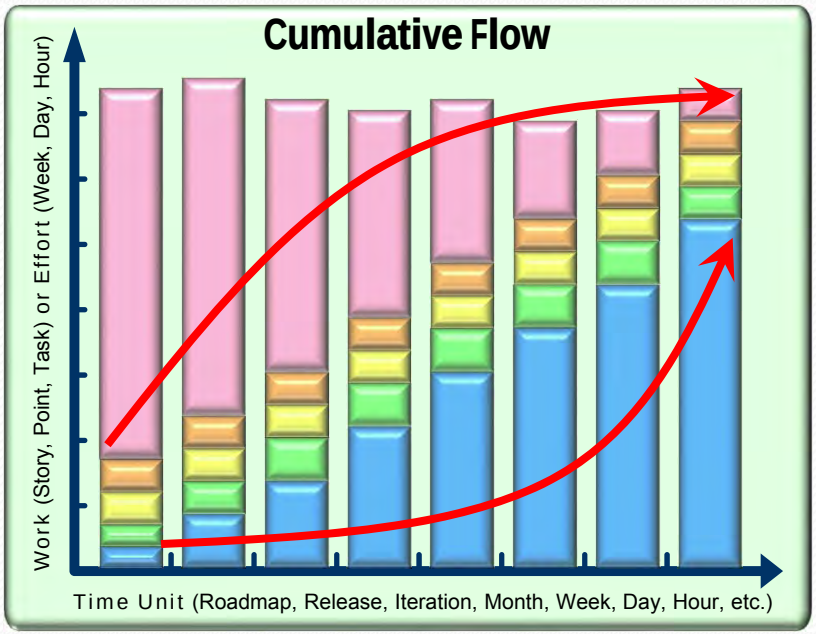
- Numerous theories of agile leadership have emerged
- Many have to do with delegation and empowerment
- Leaders have major roles in visioning and enabling

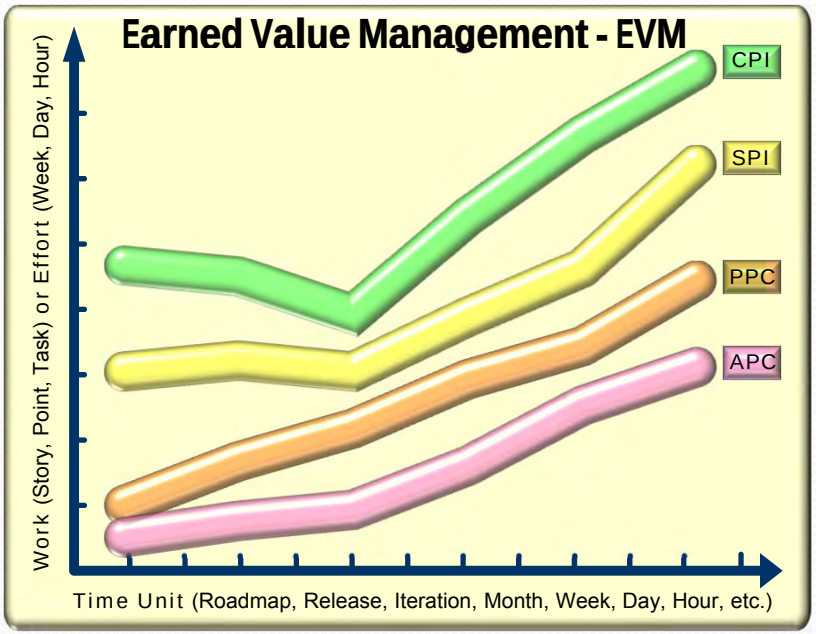


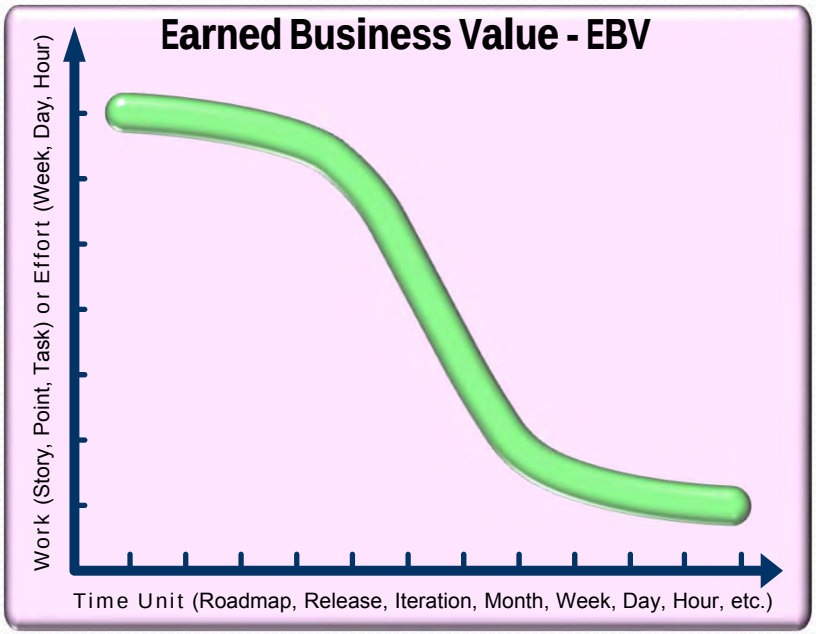
Augustine, S. (2005). *Managing agile projects*. Upper Saddle River, NJ: Pearson Education.
Pink, D. H. (2009). *Drive*: *The surprising truth about what motivates us*. New York, NY: Penguin Books.
Denning, S. (2010). *The leader's guide to radical management*: *Reinventing the workplace for the 21st century*. San Francisco, CA: John Wiley & Sons.
Poppendieck, M, & Poppendieck, T. (2010). *Leading lean software development*: *Results are not the point*. Boston, MA: Pearson Education.
Appelo, J. (2011). *Management 3.0*: *Leading agile developers and developing agile leaders*. Boston, MA: Pearson Education.

Agile Methods—Basic Metrics





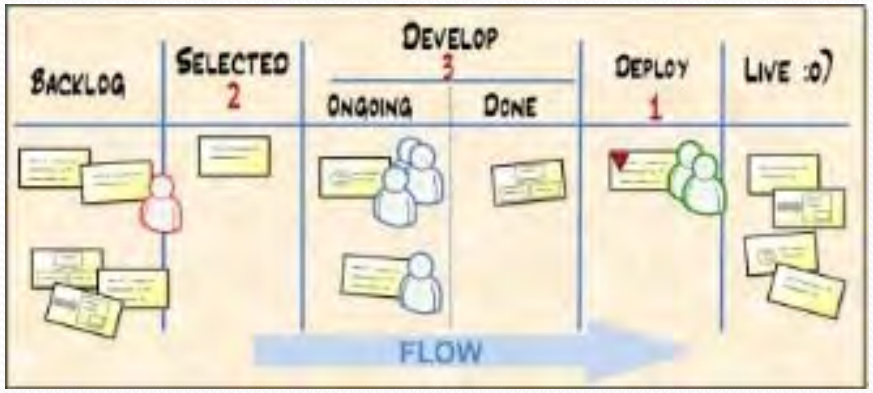




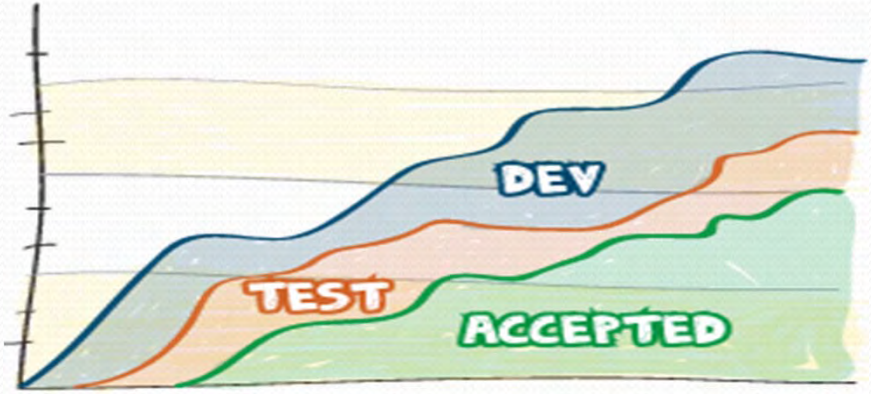
Lean Methods—Basic Metrics

- Late big bang integration increases WIP backlog
- Agile testing early and often reduces WIP backlog
- ☞ CI/CD/DevOps lower WIP, Cycle Time, & Lead Time

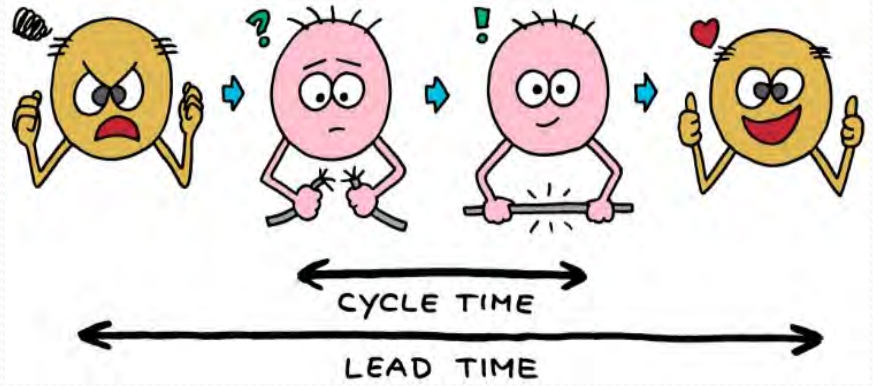
Kanban Board



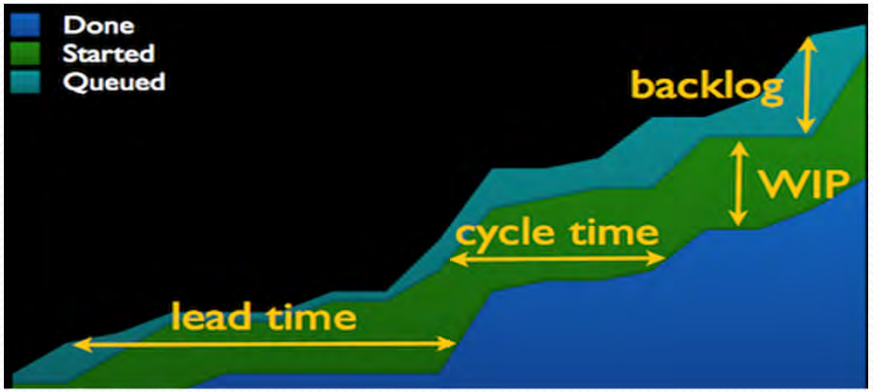
Cumulative Flow Diagram



Lead Time & Cycle Time



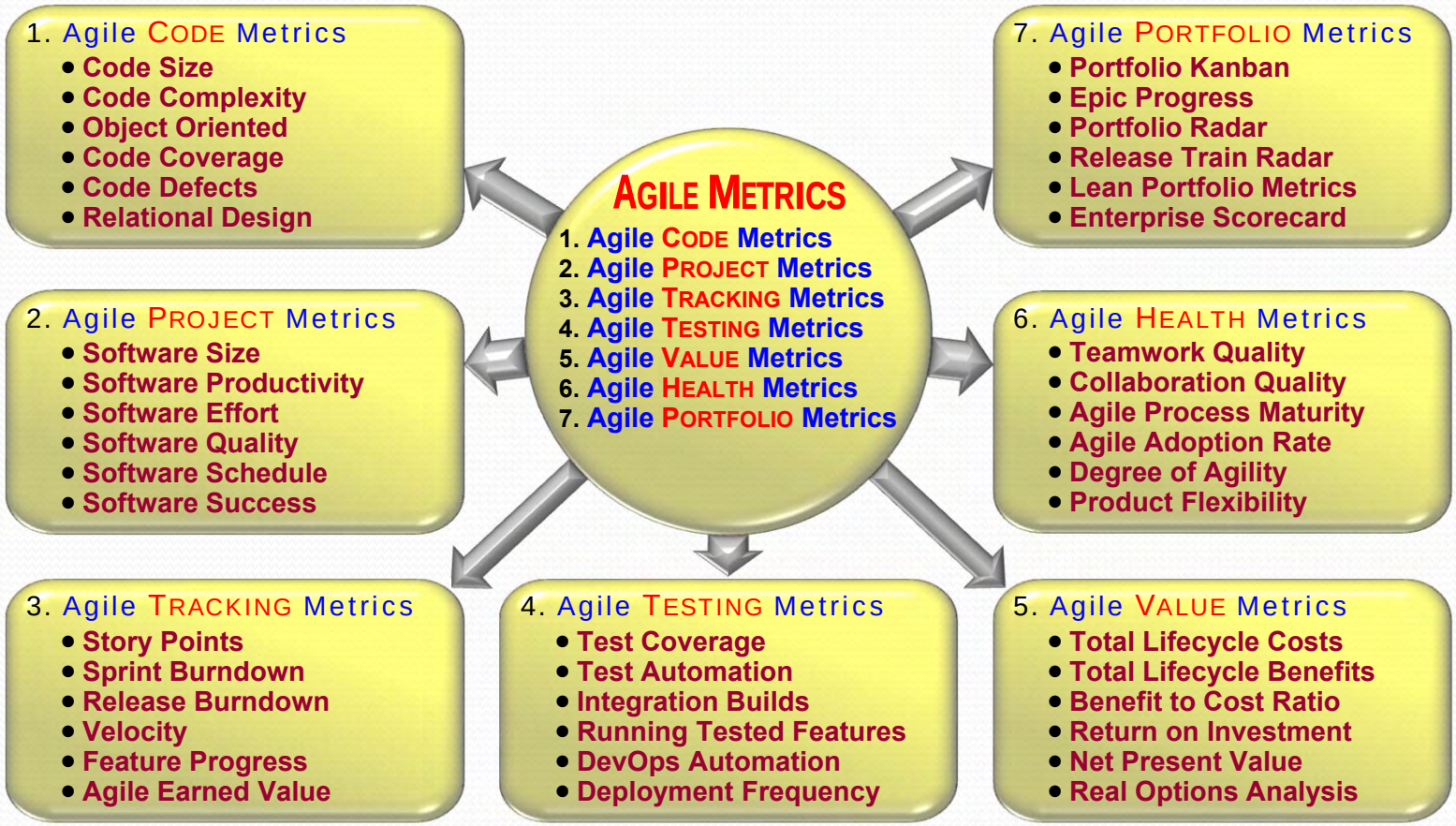
Putting it All Together



Nightingale, C. (2015). *Seven lean metrics to improve flow*. Franklin, TN: LeanKit.

Agile Methods—Metrics Taxonomy

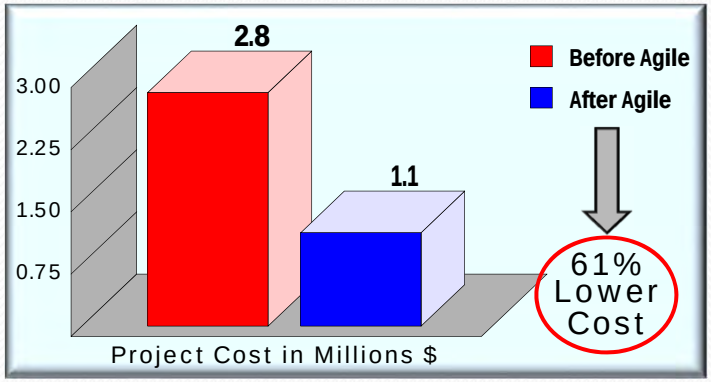
- Agile methods are based on traditional measures
- Story points, velocity, and burndown basic metrics
- Experts use Agile EVM, test, ROI & portfolio metrics

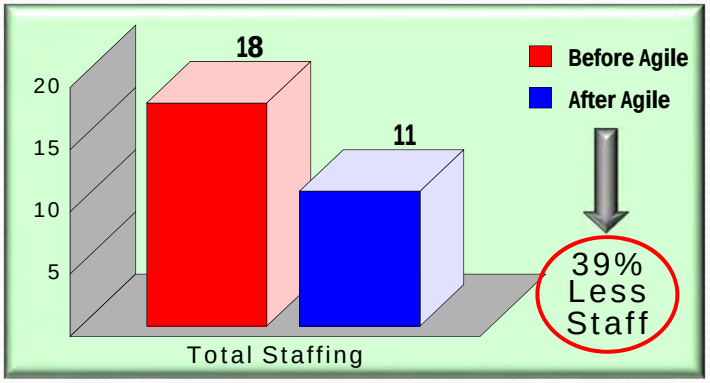


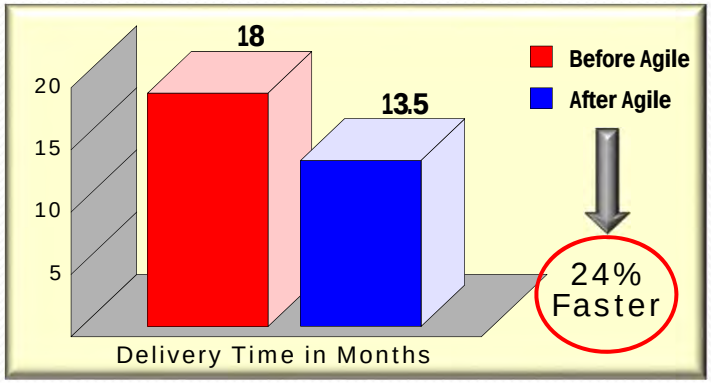
Rico, D. F., Sayani, H. H., & Sone, S. (2009). *The business value of agile software methods*. Ft. Lauderdale, FL: J. Ross Publishing.

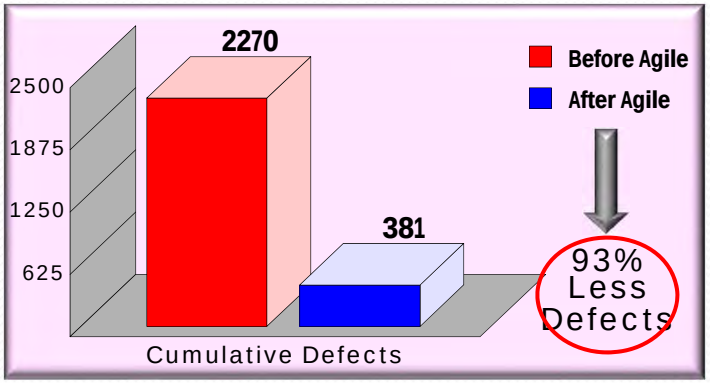
Agile Methods—Costs & Benefits

- Analysis of 23 agile vs. 7,500 traditional projects
- Agile projects are 54% better than traditional ones
- Agile has lower costs (61%) and fewer defects (93%)









Mah, M. (2008). Measuring agile in the enterprise: *Proceedings of the Agile 2008 Conference, Toronto, Canada.*

Agile Methods—Return on Invest.

- Costs based on avg. productivity and quality
- Productivity ranged from 4.7 to 5.9 LOC an hour
- Costs were $588,202 and benefits were $3,930,631

Metric	Formula	Trad. Testing	Agile Testing
Costs	(10,000 ÷ **5.4436** + **3.945** × 10 × 100) × 100	**$588,202**	**$233,152**
Benefits	(10,000 × 10.51 − 6,666.67 × 9) × 100 − **$588,202**	**$3,930,631**	**$4,275,681**
B/CR	**$3,930,631** ÷ **$588,202**	**7:1**	**18:1**
ROI	(**$3,930,631** − **$588,202**) ÷ **$588,202** × 100%	**567%**	**1,734%**
NPV	$(\sum_{i=1}^{5}$ (**$3,930,631** ÷ 5) ÷ 1.05^5) − **$588,202**	$2,806,654	$3,469,140
BEP	**$588,202** ÷ ($4,509,997 ÷ **$588,202** − 1)	$88,220	$12,710
ROA	NORMSDIST(**2.24**) × **$3,930,631** − NORMSDIST(**0.85**) × **$588,202** × EXP(−5% × 5)	$3,504,292	$4,098,159

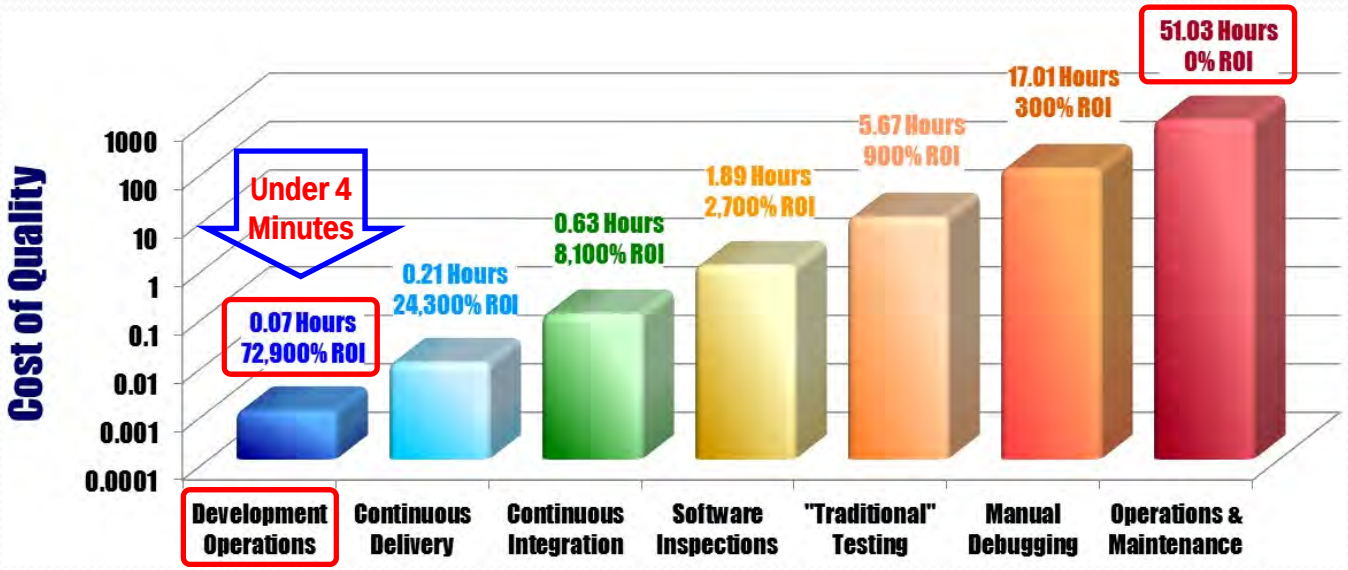
$d1 = [\ln(Benefits \div Costs) + (Rate + 0.5 \times Risk^2) \times Years] \div Risk \times \sqrt{Years}$, $d2 = d1 - Risk \times \sqrt{Years}$

Rico, D. F., Sayani, H. H., & Sone, S. (2009). *The business value of agile software methods: Maximizing ROI with just-in-time processes and documentation*. Ft. Lauderdale, FL: J. Ross Publishing.

Agile Methods—Cost of Quality

- Agile testing is orders-of-magnitude more efficient
- Based on millions of automated tests run in seconds
- One-touch auto-delivery to billions of global end-users

Activity	Def	CoQ	DevOps Economics	Hours	ROI
Development Operations	100	0.001	100 Defects x 70% Efficiency x 0.001 Hours	0.070	72,900%
Continuous Delivery	30	0.01	30 Defects x 70% Efficiency x 0.01 Hours	0.210	24,300%
Continuous Integration	9	0.1	9 Defects x 70% Efficiency x 0.1 Hours	0.630	8,100%
Software Inspections	3	1	2.7 Defects x 70% Efficiency x 1 Hours	1.890	2,700%
"Traditional" Testing	0.81	10	0.81 Defects x 70% Efficiency x 10 Hours	5.670	900%
Manual Debugging	0.243	100	0.243 Defects x 70% Efficiency x 100 Hours	17.010	300%
Operations & Maintenance	0.073	1,000	0.0729 Defects x 70% Efficiency x 1,000 Hours	51.030	n/a



4,500 x Faster than Code Inspections

Rico, D. F. (2016). *Devops cost of quality (CoQ): Phase-based defect removal model*. Retrieved May 10, 2016, from http://davidfrico.com

Agile Methods—HP Case Study

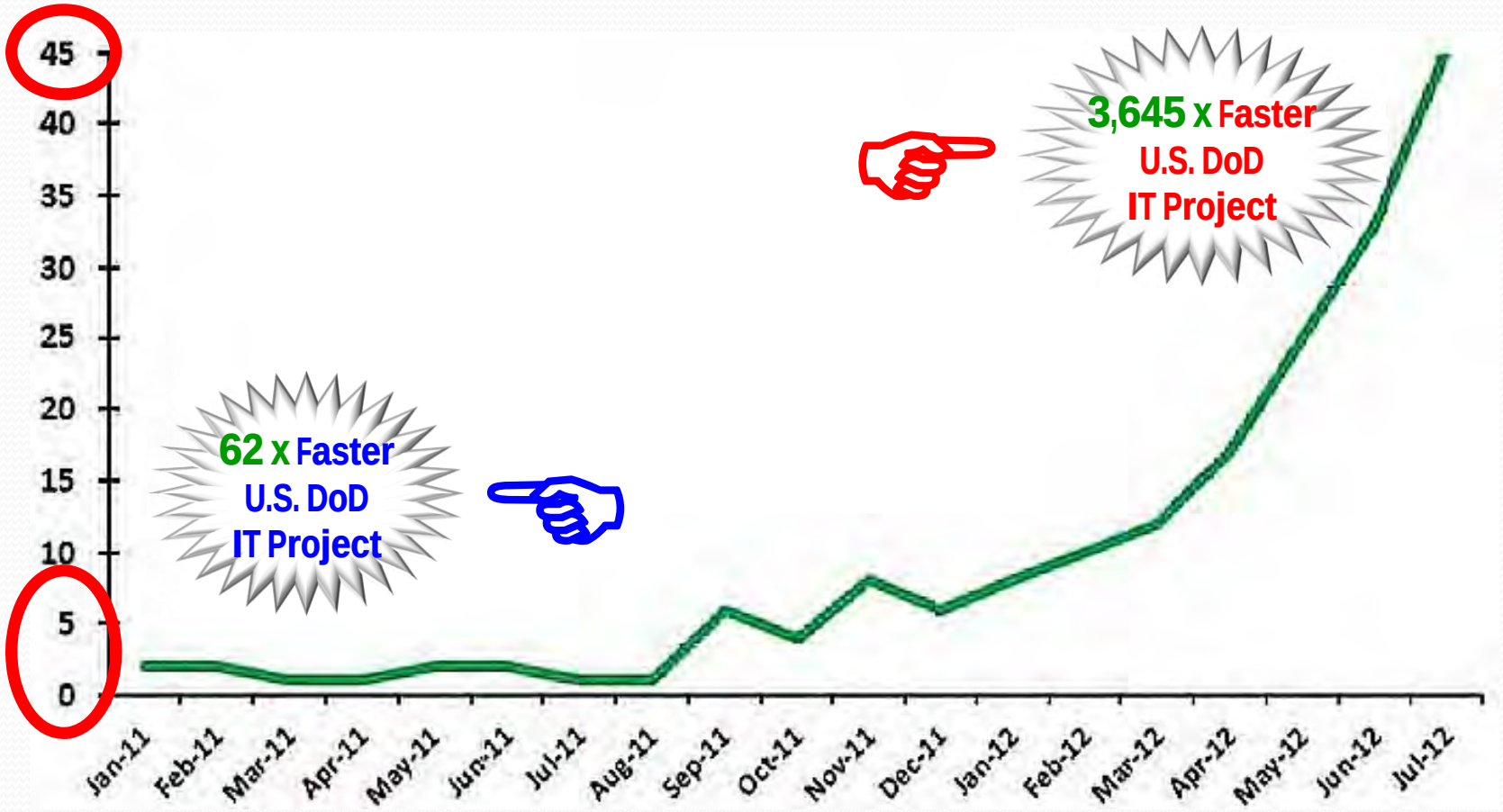
- Hewlett-Packard is a major user of CI, CD, & DevOps
- 400 engineers developed 10 million LOC in 4 years
- Major gains in testing, deployment, & innovation

Type	Metric	Manual	DevOps	Major Gains
Cycle Time Improvements	Build Time	40 Hours	3 Hours	13 x
	No. Builds	1-2 per Day	10-15 per Day	8 x
	Feedback	1 per Day	100 per Day	100 x
	Regression Testing	240 Hours	24 Hours	10 x
Development Cost Effort Distribution	Integration	10%	2%	5 x
	Planning	20%	5%	4 x
	Porting	25%	15%	2 x
	Support	25%	5%	5 x
	Testing	15%	5%	3 x
	Innovation	5%	40%	8 x

Gruver, G., Young, M. & Fulghum, P. (2013). *A practical approach to large-scale agile development*. Upper Saddle River, NJ: Pearson Education.

Agile Methods—Dot Com Cases

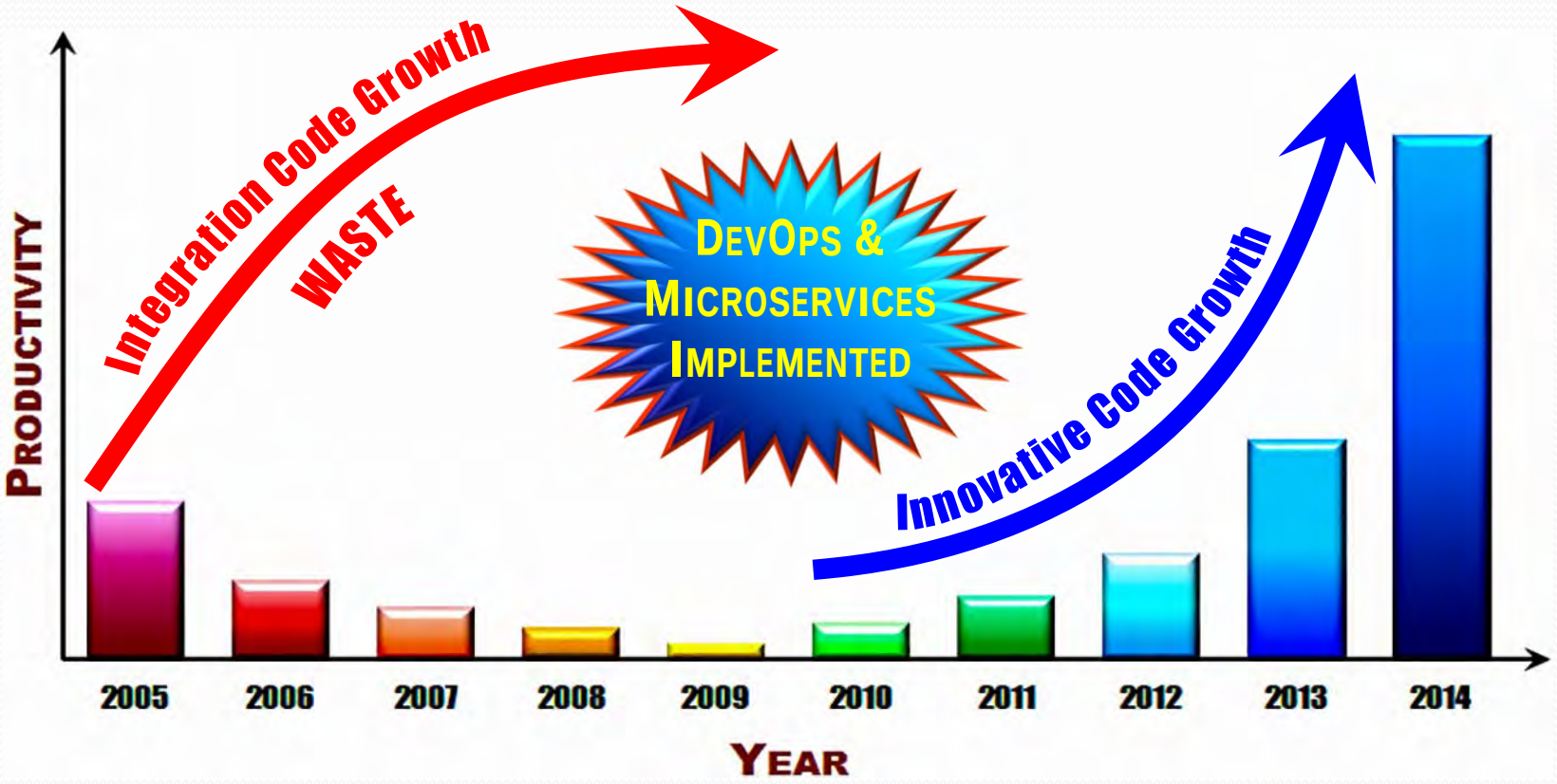
- Assembla went from 2 to 45 releases every month
- 15K Google developers run 120 million tests per day
- 30K+ Amazon developers deliver 136K releases a day



Singleton, A. (2014). *Unblock*: *A guide to the new continuous agile*. Needham, MA: Assembla, Inc.

Agile Methods—Blackboard Case

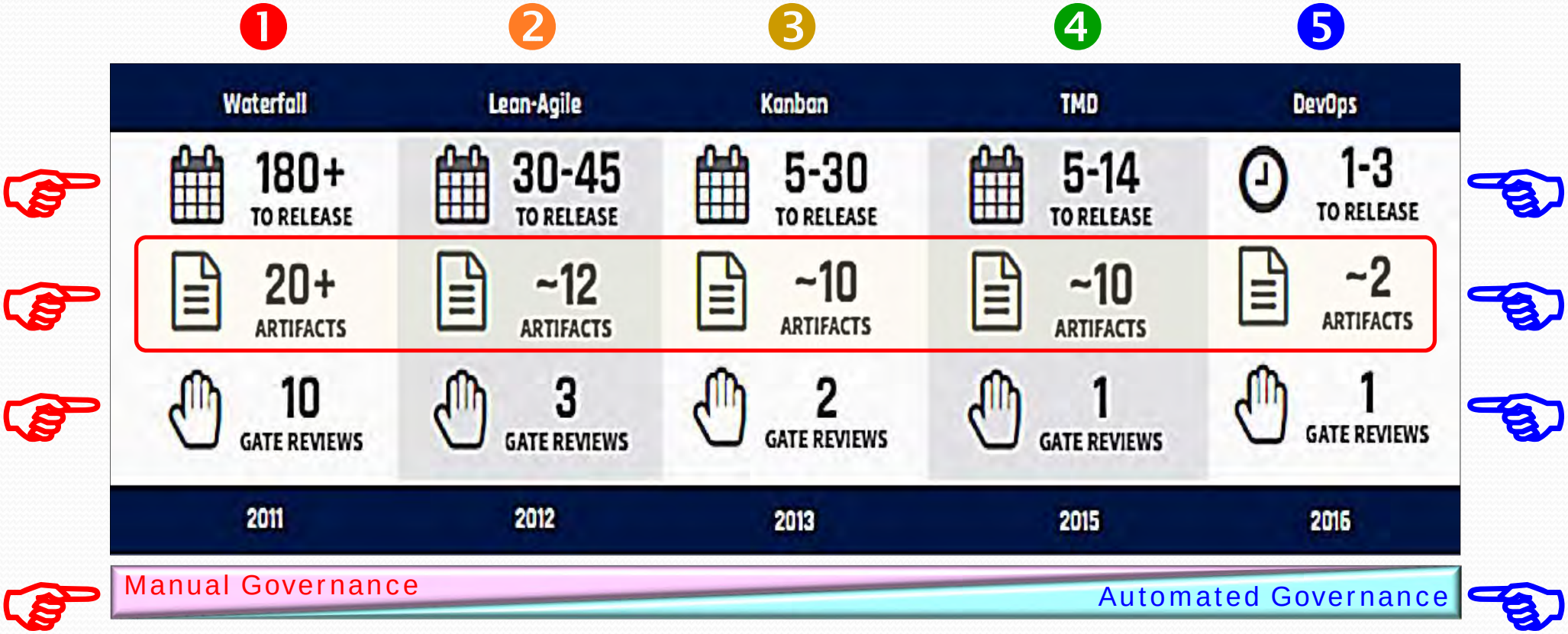
- Productivity **STOPS** due to excessive integration
- Implements DevOps & Microservices around 2010
- Waste elimination, productivity & innovation skyrocket



Ashman, D. (2014). Blackboard: Keep your head in the clouds. *Proceedings of the 2014 Enterprise DevOps Summit, San Francisco, California, USA.*

Agile Methods—U.S. DHS Case

- 1st gen replete with large portfolios & governance
- 2nd-3rd gen yield minor incremental improvements
- 4th-5th gen enables big order-of-magnitude impacts



Denayer, L. (2017). *U.S. DHS citizenship and immigration services*: *USCIS agile development*. Washington, DC. iSDLC Seminar.

Agile Methods—Enterprise ROI

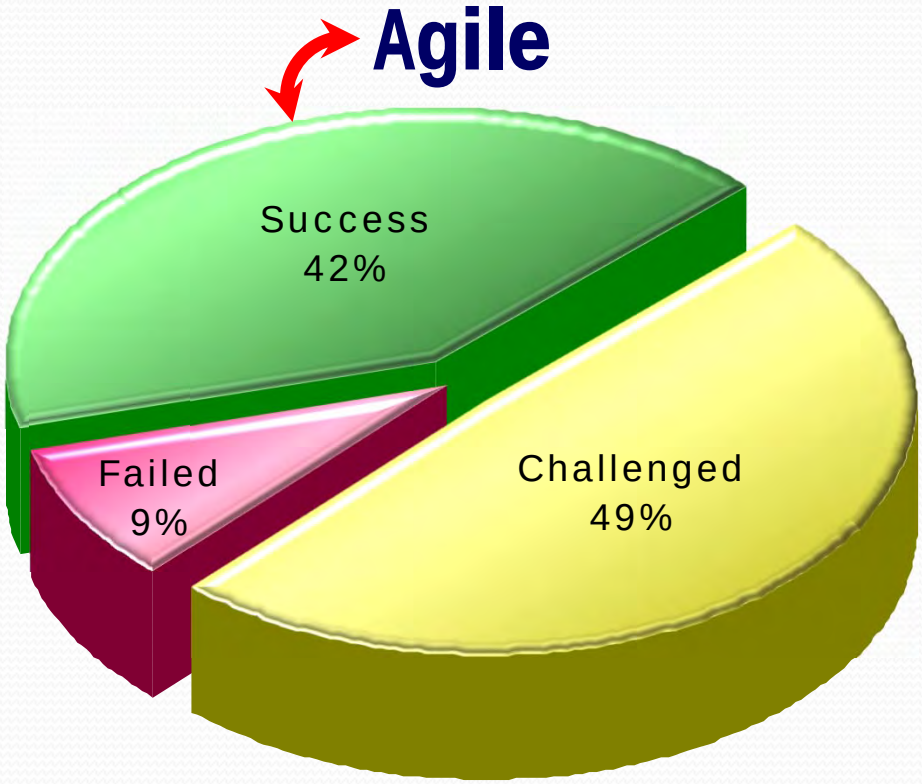
- Detailed DevOps economics starting to emerge
- ROI ranges from $17M to $195M *with minor costs*
- Benefits from cost savings, revenue, and availability

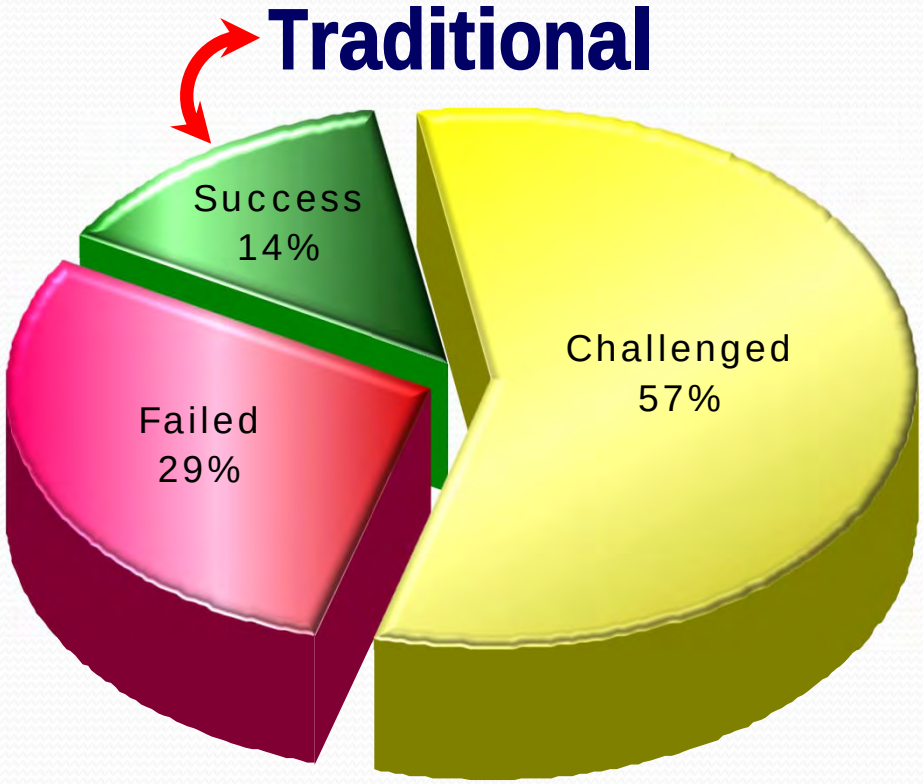
Org	Low Perf	Med Perf	High Perf
Small - 250 -	$23M Benefits	$29M Benefits	$17M Benefits
	$0.2M Costs	$0.2M Costs	$0.2M Costs
	13,589% ROI	**17,799% ROI**	**9,932% ROI**
	3 Day Payback	*2 Day Payback*	*4 Day Payback*
Medium - 2,000 -	$42M Benefits	$66M Benefits	$36M Benefits
	$1.3M Costs	$1.3M Costs	$1.3M Costs
	3,101% ROI	**4,901% ROI**	**2,663% ROI**
	11 Day Payback	*7 Day Payback*	*13 Day Payback*
Large - 8,500 -	$114M Benefits	$195M Benefits	$76M Benefits
	$5.6M Costs	$5.6M Costs	$5.6M Costs
	1,942% ROI	**3,375% ROI**	**1,254% ROI**
	18 Day Payback	*11 Day Payback*	*27 Day Payback*

Forsgren, N., Humble, J., & Kim, G. (2017). *Forecasting the value of devops transformations*: *Measuring roi of devops*. Portland, OR: DevOps Research.
Rico, D. F. (2017). *Devops return on investment (ROI) calculator*. Retrieved August 29, 2017, from http://davidfrico.com/devops-roi.xls

Agile Methods—Success Rate

- Traditional projects succeed at 50% industry avg.
- Traditional projects are challenged 20% more often
- Agile projects succeed 3x more and fail 3x less often

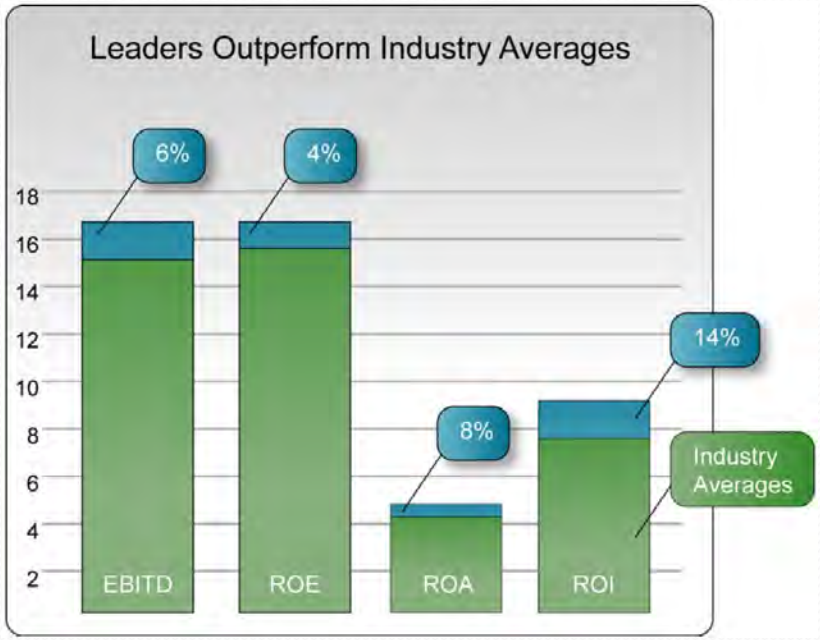




Standish Group. (2012). *Chaos manifesto*. Boston, MA: Author.

Agile Methods—Business Benefits

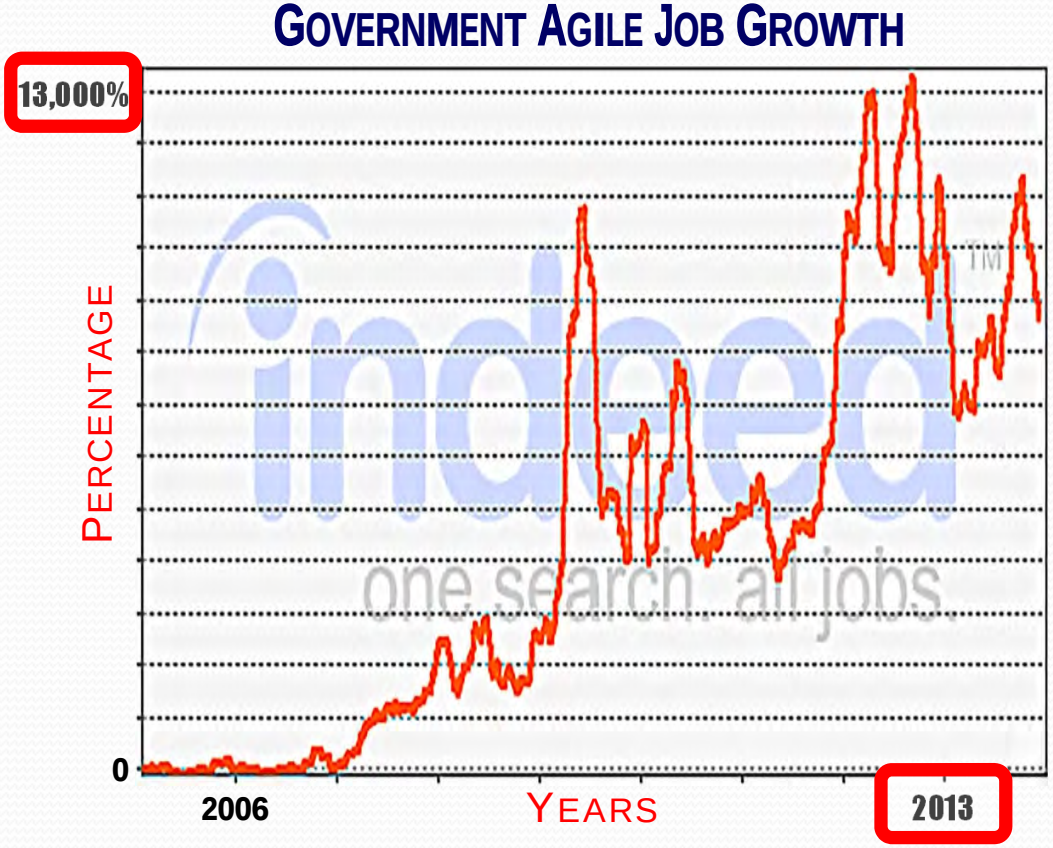
- Study of 15 agile vs. non-agile Fortune 500 firms
- Based on models to measure organizational agility
- ☞ Agile firms out perform non agile firms by up to 36%

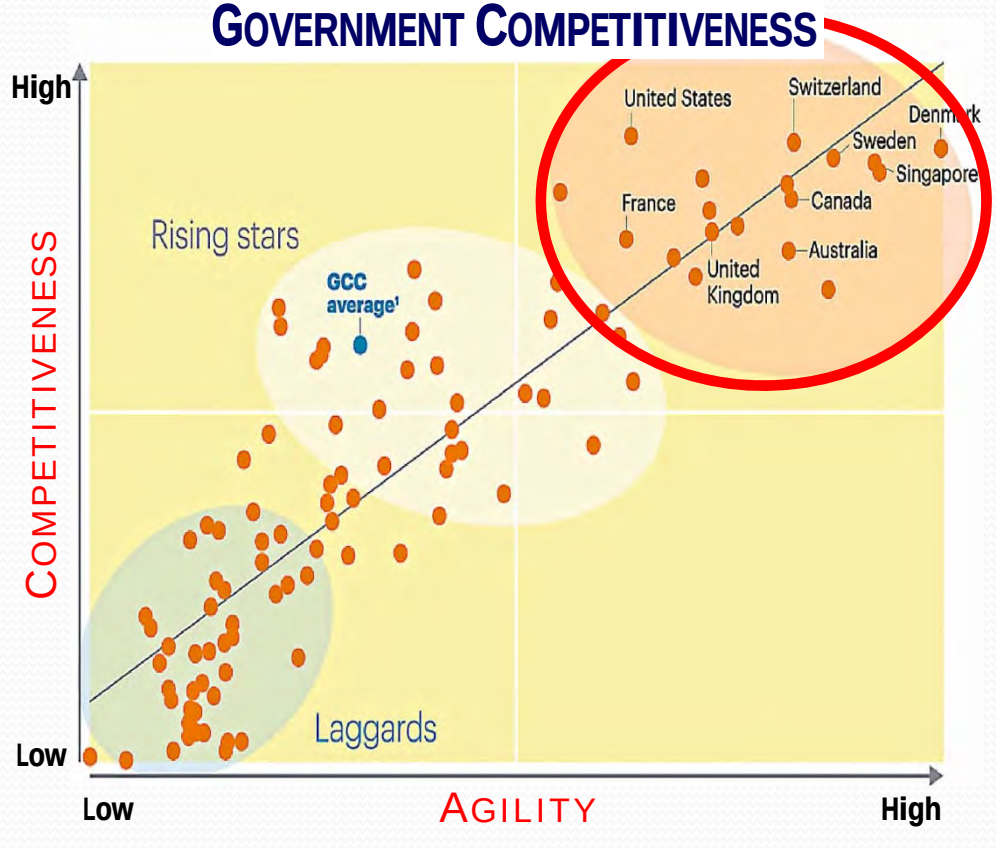


Hoque, F., et al. (2007). *Business technology convergence*. The role of business technology convergence in innovation and adaptability and its effect on financial performance. Stamford, CT: BTM Institute.

Agile Methods—National Benefits

- U.S. gov't agile jobs grew by 13,000% from 2006-2013
- Adoption is higher in U.S. DoD than Civilian Agencies
- GDP of countries with high adoption rates is greater



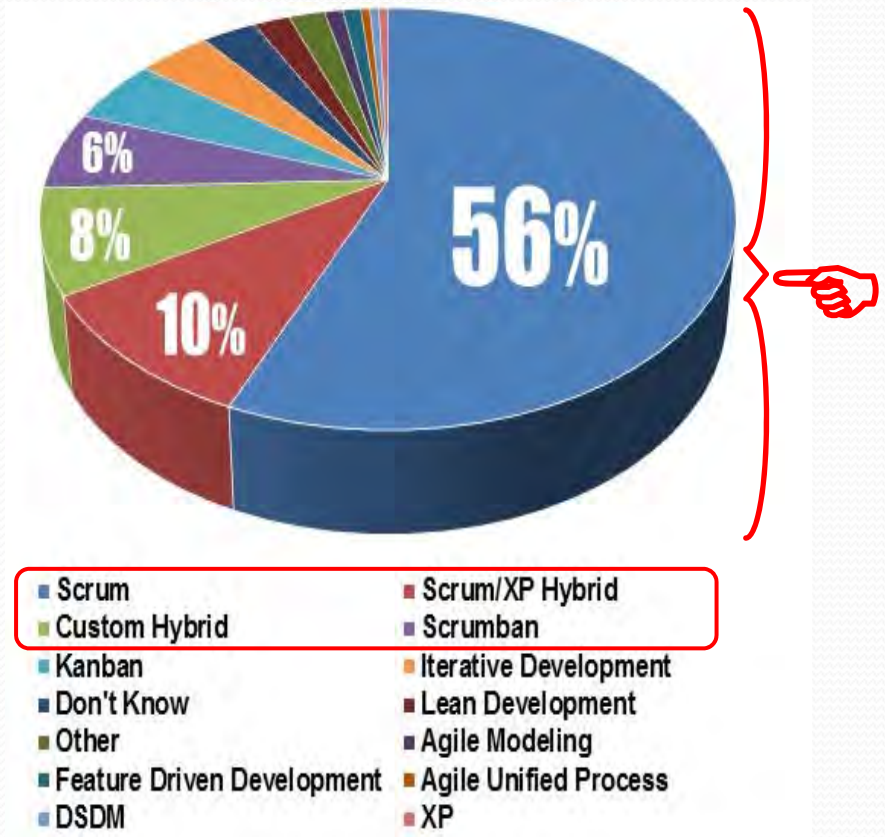


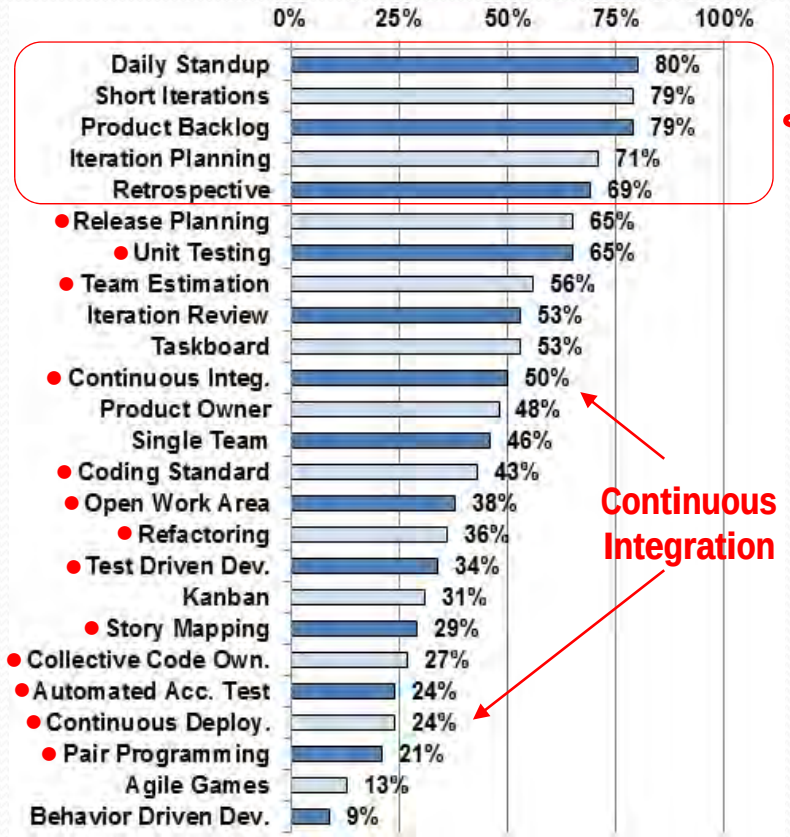
Suhy, S. (2014). *Has the U.S. government moved to agile without telling anyone*? Retrieved April 24, 2015, from http://agileingov.com

Porter, M. E., & Schwab, K. (2008). *The global competitiveness report*: *2008 to 2009*. Geneva, Switzerland: World Economic Forum.

Agile Methods—Adoption Statistics

- VersionOne found 94% using agile methods today
- Most are using Scrum with several key XP practices
- Lean-Kanban is a rising practice with a 31% adoption

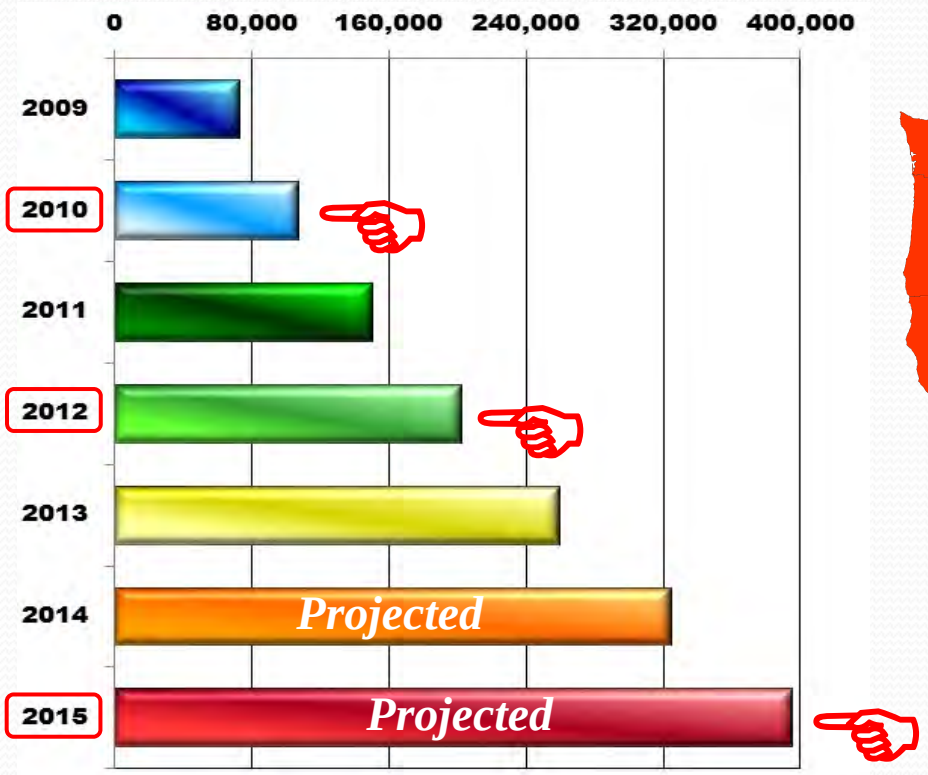


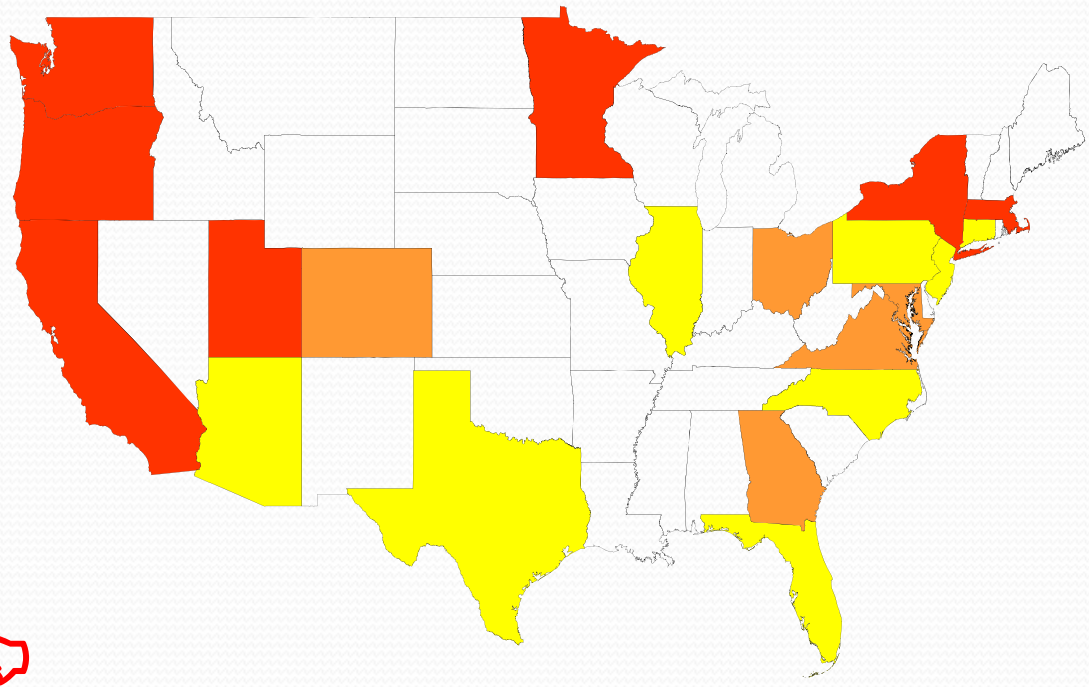


Holler, R. (2015). *Ninth annual state of agile survey*: *State of agile development*. Atlanta, GA: VersionOne.

Agile Methods—National Adoption

- Number of CSMs have doubled to 400,000 in 4 years
- 558,918 agile jobs for only 121,876 qualified people
- 4.59 jobs available for every agile candidate (5:1)





** PMI-PMPs grew from 552,977 to 625,346 in 2014 (i.e., added 72,369)*

Scrum Alliance. (2013). *Scrum certification statistics*. Retrieved April 28, 2015, from http://www.scrumalliance.org

Taft, D. K. (2012). *Agile developers needed*: *Demand outpaces supply*. Foster City, CA: eWeek.

Agile Methods—Summary

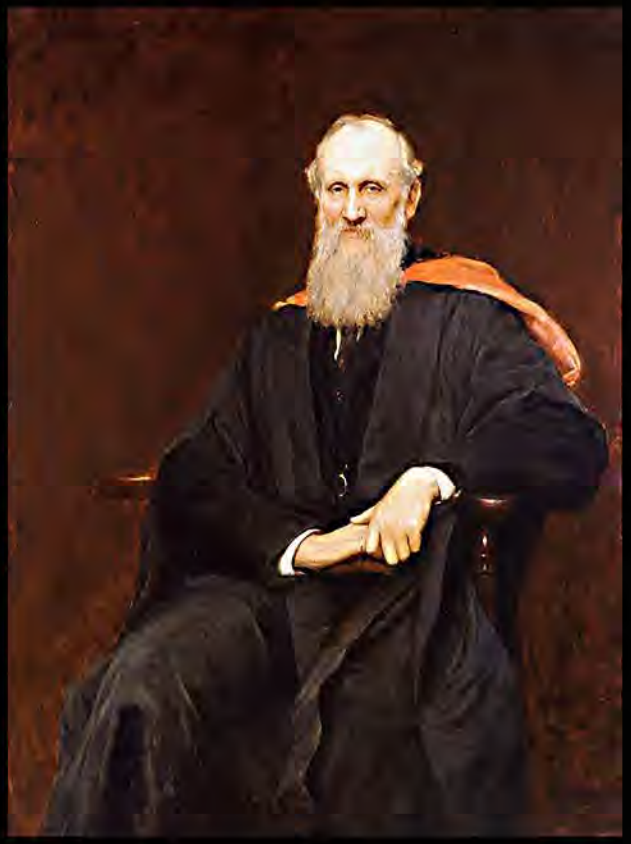
- Agile methods DON'T mean deliver it now & fix it later
- Lightweight, yet disciplined approach to development
- Reduced cost, risk, & waste while improving quality

What	How	Result
Flexibility	Use lightweight, yet disciplined processes and artifacts	Low work-in-process
Customer	Involve customers early and often throughout development	Early feedback
Prioritize	Identify highest-priority, value-adding business needs	Focus resources
Descope	Descope complex programs by an order of magnitude	Simplify problem
Decompose	Divide the remaining scope into smaller batches	Manageable pieces
Iterate	Implement pieces one at a time over long periods of time	Diffuse risk
Leanness	Architect and design the system one iteration at a time	JIT waste-free design
Swarm	Implement each component in small cross-functional teams	Knowledge transfer
Collaborate	Use frequent informal communications as often as possible	Efficient data transfer
Test Early	Incrementally test each component as it is developed	Early verification
Test Often	Perform system-level regression testing every few minutes	Early validation
Adapt	Frequently identify optimal process and product solutions	Improve performance

Rico, D. F. (2012). *What's really happening in agile methods: Its principles revisited*? Retrieved June 6, 2012, from http://davidfrico.com/agile-principles.pdf
Rico, D. F. (2012). *The promises and pitfalls of agile methods*. Retrieved February 6, 2013 from, http://davidfrico.com/agile-pros-cons.pdf
Rico, D. F. (2012). *How do lean & agile intersect*? Retrieved February 6, 2013, from http://davidfrico.com/agile-concept-model-3.pdf

On Measurement—Lord Kelvin

Lord Kelvin on quantification and scientific knowledge

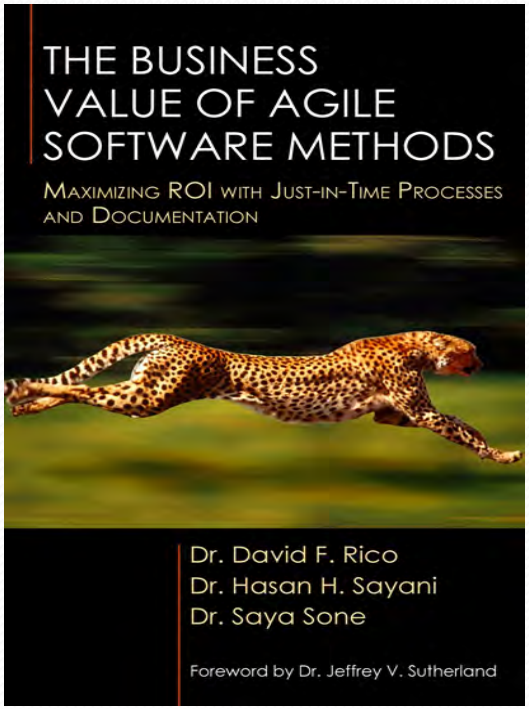


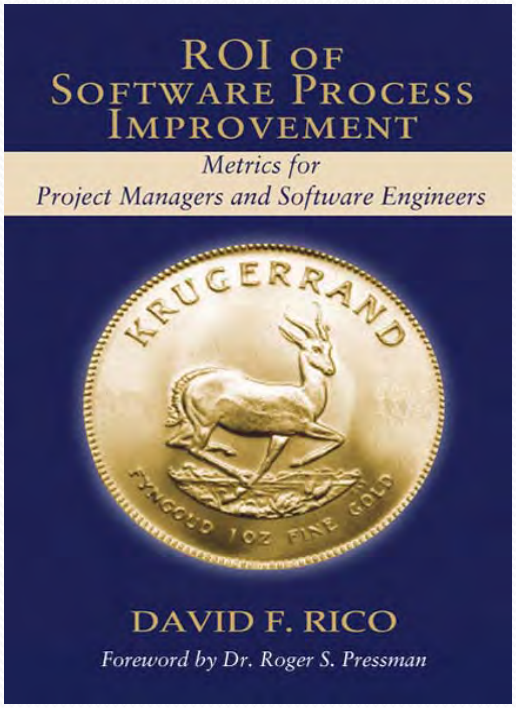
I often say that when you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely, in your thoughts, advanced to the stage of science, whatever the matter may be.

Lecture on "Electrical Units of Measurement" (3 May 1883), published in Popular Lectures

Agile Methods—ROI Resources

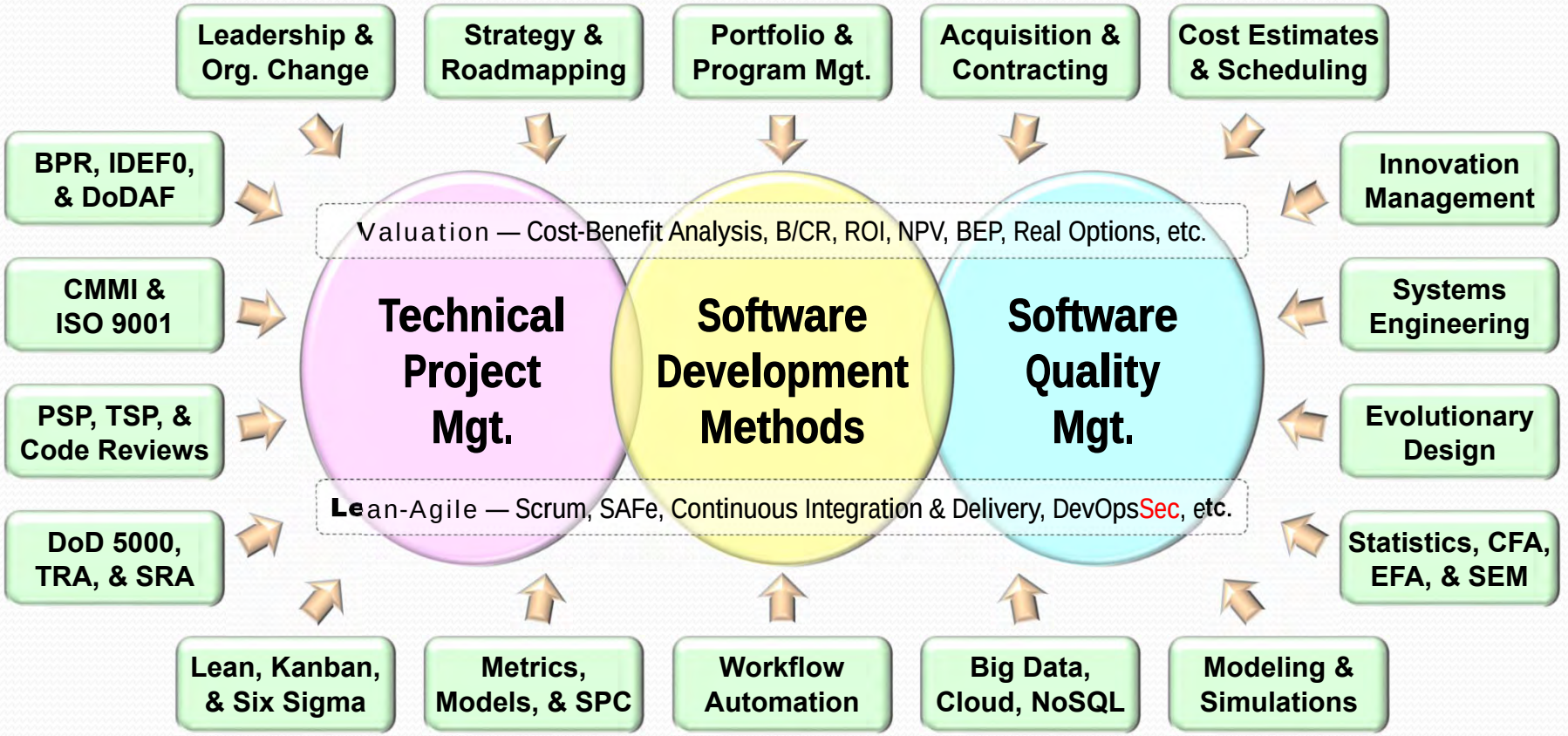
- Guides to software methods for business leaders
- Communicates the business value of IT approaches
- ☞ Rosetta stones to unlocking ROI of software methods





- http://davidfrico.com/agile-book.htm (***Description***)
- http://davidfrico.com/roi-book.htm (***Description***)

Dave's Professional Capabilities



STRENGTHS – Communicating Complex Ideas • Brownbags & Webinars • Datasheets & Whitepapers • Reviews & Audits • Comparisons & Tradeoffs • Brainstorming & Ideation • Data Mining & Business Cases • Metrics & Models • Tiger Teams & Shortfuse Tasks • Strategy, Roadmaps, & Plans • Concept Frameworks & Multi-Attribute Models • Etc.

35+ Years in IT Industry

- Data mining. Metrics, benchmarks, & performance.
- Simplification. Refactoring, refinement, & streamlining.
- Assessments. Audits, reviews, appraisals, & risk analysis.
- Coaching. Diagnosing, debugging, & restarting stalled projects.
- Business cases. Cost, benefit, & return-on-investment (ROI) analysis.
- Communications. Executive summaries, white papers, & lightning talks.
- Strategy & tactics. Program, project, task, & activity scoping, charters, & plans.

PMP, CSEP, FCP, FCT, ACP, CSM, SAFe, & DevOps