Business Value of
Agile Methods

for Systems Development

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Author

- ☐ DoD contractor with 25+ 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

→ *Published six books & numerous journal articles*
→ *Expertise in metrics, models, & cost engineering*
→ *Adjunct at George Washington, UMUC, & Argosy*
→ *Six Sigma, CMMI, ISO 9001, DoDAF & DoD 5000*
→ *Agile Program Management & Lean Development*

Agenda

☞ **OVERVIEW of Briefing**

Intro to Agile Methods

Types of Agile Methods

Studies of Agile Methods

Costs of Traditional Methods

Costs of Agile Methods

Metrics for Agile Methods

Comparison of Agile Methods

Summary of Agile Methods

Purpose of Briefing

- Provide an overview of the <u>business value</u> of Agile Methods using <u>ROI</u> and <u>Real Options</u>:
  - *Provide a brief* introduction *to agile methods*
  - *Illustrate some of the major agile* methods/practices
  - *Summarize the results of major* cost/benefit studies
  - *Talk a little bit about the* cost of quality (CoQ)
  - *Introduce* cost and benefit models *for agile methods*
  - *Describe* metrics *to estimate the ROI of agile methods*
  - Compare *the costs and benefits of agile methods*
  - Summarize *what we've learned about agile methods*

What is Business Value?

- **Val-ue** (văl-'yōō): An amount, quantity, rate, magnitude, or desirability; <u>Economic worth</u>

  - *An economic estimation of the tangible worth of the organizational assets such as buildings and equipment*

  - *An appraisal of intangible assets such as knowledge, experience, skills, patents, processes, and methods*

  - *A technique for evaluating the costs and benefits of investments in a business, operations, or personnel*

  - *The economic impact of deploying a new product development approach such as agile methodologies*

  - *The total life cycle costs of institutionalizing lean and agile project management techniques in an enterprise*

Some of Today's Challenges

- **Chal-lenge** (chăl-'ənj): Contest, competition, fight, defy, confront, or dispute; <u>To question</u>

  - *21st century systems are more* software-intensive *and* highly-complex *with numerous invisible parts*

  - *Technology is evolving at an* exponential rate of change *which severely limits the planning horizon*

  - Global competitiveness *has intensified and* new military threats *are rapidly emerging all of the time*

  - *Customers have* unpredictable needs *and necessitate* decision-making flexibility *throughout the project*

  - *Today's 21st-century post-industrial information age knowledge workers need* agile methods and tools

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Overview of Briefing

☞ **INTRO to Agile Methods**

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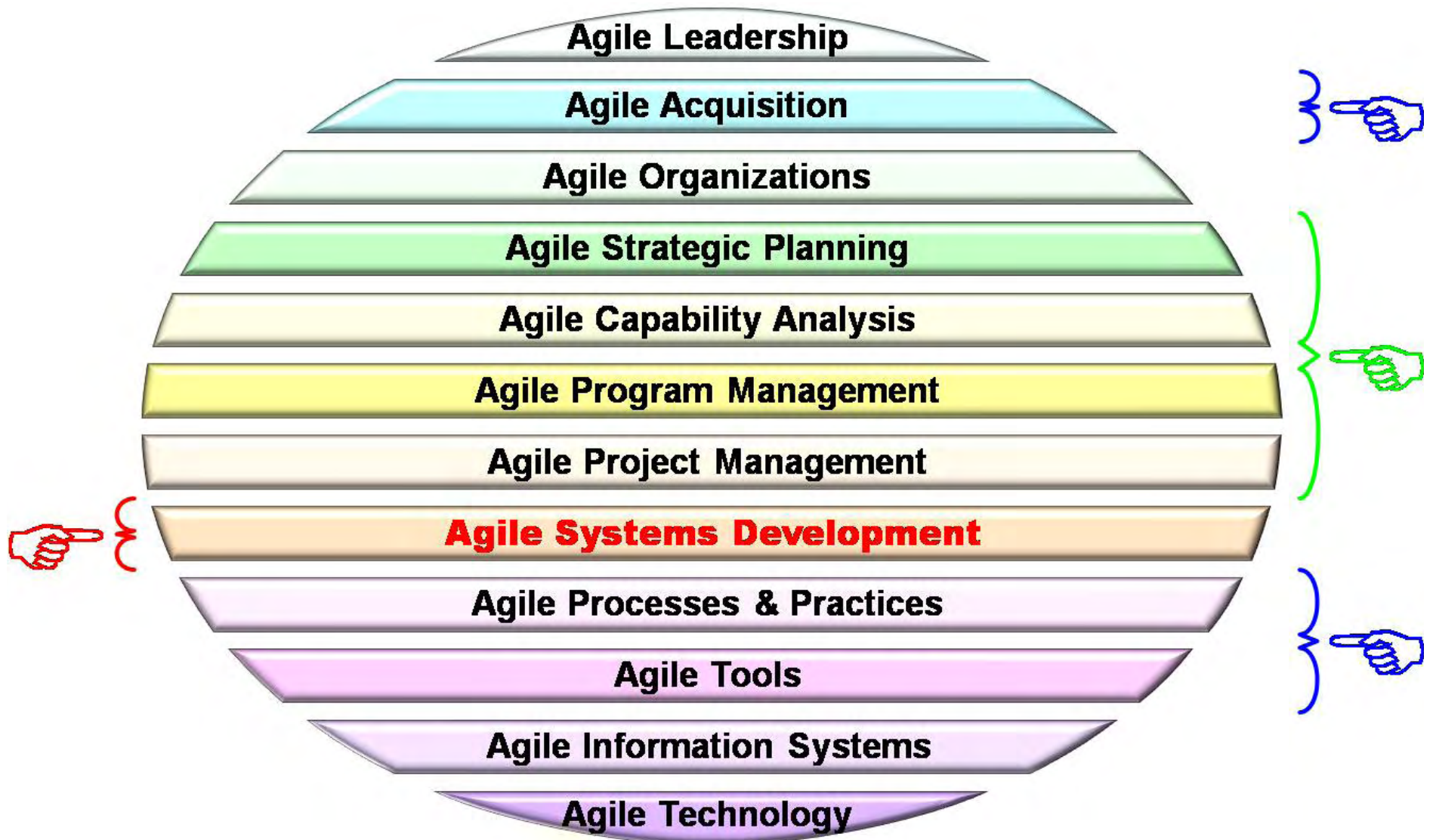**Comparison** of Agile Methods

Summary of Agile Methods

What is Agility?

- **A-gil-i-ty** (ə-ˈji-lə-tē) Quickness, lightness, and ease of movement; <u>To be very nimble</u>
    - *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 the* business value *with right-sized, just-enough, and just-in-time processes and documentation*

Agile Worldview

Agile Leadership

Agile Acquisition

Agile Organizations

Agile Strategic Planning

Agile Capability Analysis

Agile Program Management

Agile Project Management

Agile Systems Development

Agile Processes & Practices
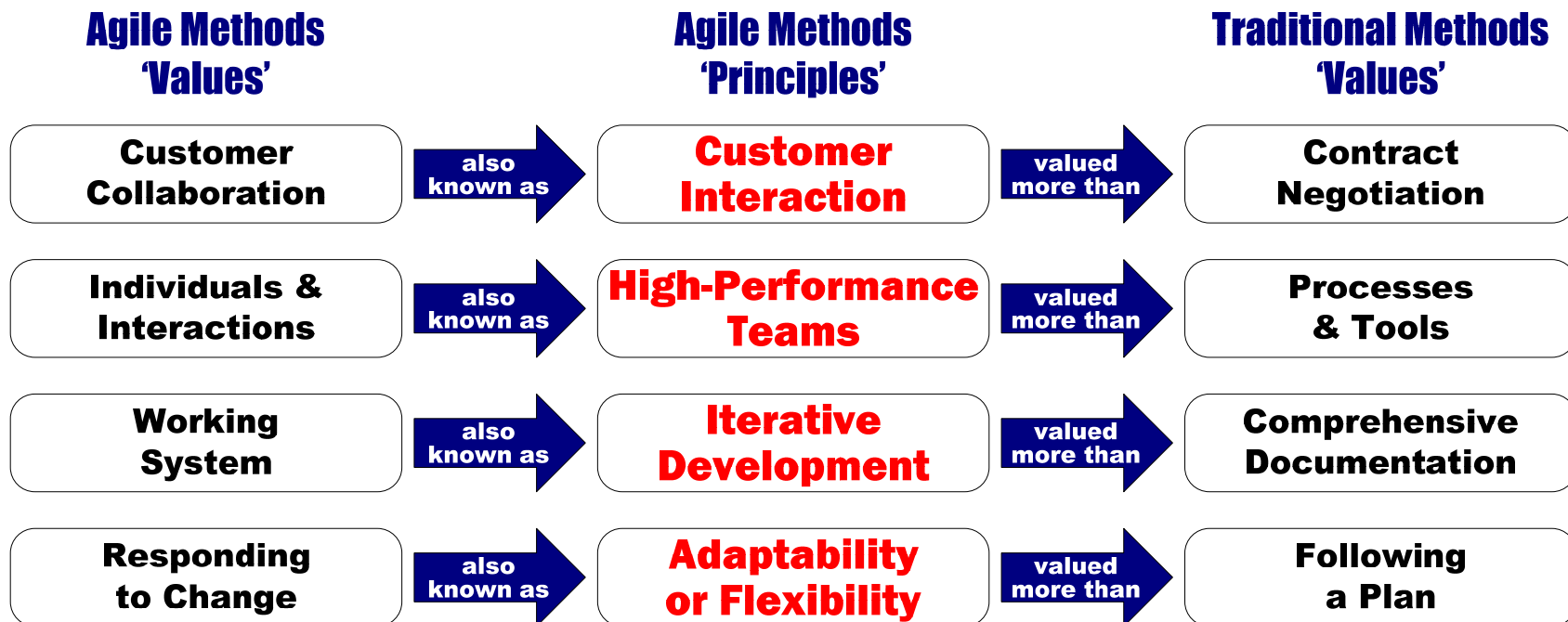
Agile Tools

Agile Information Systems

Agile Technology

What are Agile Methods?

- □ 'Adaptable' system development methodologies
- □ 'Human-centric' method for creating business value
- □ 'Alternative' to large document-based methodologies

Agile Methods 'Values'		Agile Methods 'Principles'		Traditional Methods 'Values'
Customer Collaboration	also known as	Customer Interaction	valued more than	Contract Negotiation
Individuals & Interactions	also known as	High-Performance Teams	valued more than	Processes & Tools
Working System	also known as	Iterative Development	valued more than	Comprehensive Documentation
Responding to Change	also known as	Adaptability or Flexibility	valued more than	Following a Plan

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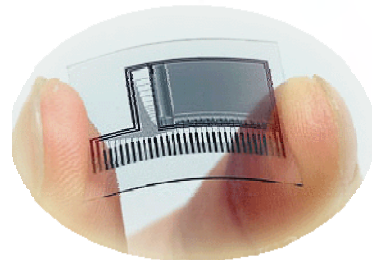
Essence of Agile Methods

- High degree of customer & developer interaction
- Highly-skilled teams producing frequent iterations
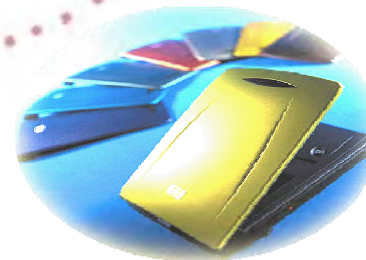- Right-sized, just-enough, and just-in-time process

Customer Interaction

High-Performance Teams

Adaptability or Flexibility

Iterative Development

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

When to use Agile Methods

- On exploratory or research/development projects
- When fast customer responsiveness is paramount
- In organizations that are highly-innovative & creative

Highsmith, J. (2003). *Agile project management*: *Principles and tools*. Arlington, MA: Cutter Consortium.

Myths of Agile Methods

- <u>Common myths</u> still abound, although agile methods have been around for ~20 years:
  - *Agile is only for* software engineering
  - *Agile doesn't scale to* large systems
  - *Agile doesn't use* project management
  - *Agile doesn't have any* requirements
  - *Agile requires a traditional* system architecture
  - *Agile doesn't have any* documentation
  - *Agile isn't* discipline *or* measurable
  - *Agile has low* quality, maintainability, *and* security

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Intro to Agile Methods

☞ **TYPES of Agile Methods**

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Costs of Traditional Methods
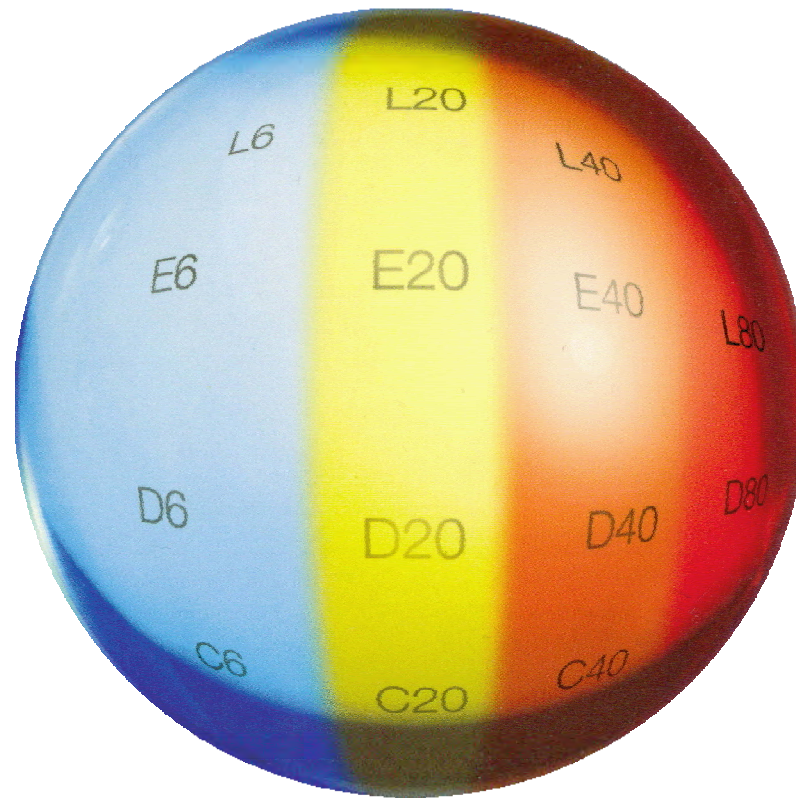
Costs of Agile Methods

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Comparison of Agile Methods

Summary of Business Value

Crystal Methods

- Created by Alistair Cockburn in 1991
- Has 14 practices, 10 roles, and 25 products
- <u>Scalable family of techniques for critical systems</u>

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

Scrum

- Created by Jeff Sutherland at Easel in 1993
- Has 5 practices, 3 roles, 5 products, rules, etc.
- <u>Uses EVM to burn down backlog in 30-day iterations</u>

Schwaber, K., & Beedle, M. (2001). *Agile software development with scrum.* Upper Saddle River, NJ: Prentice-Hall.
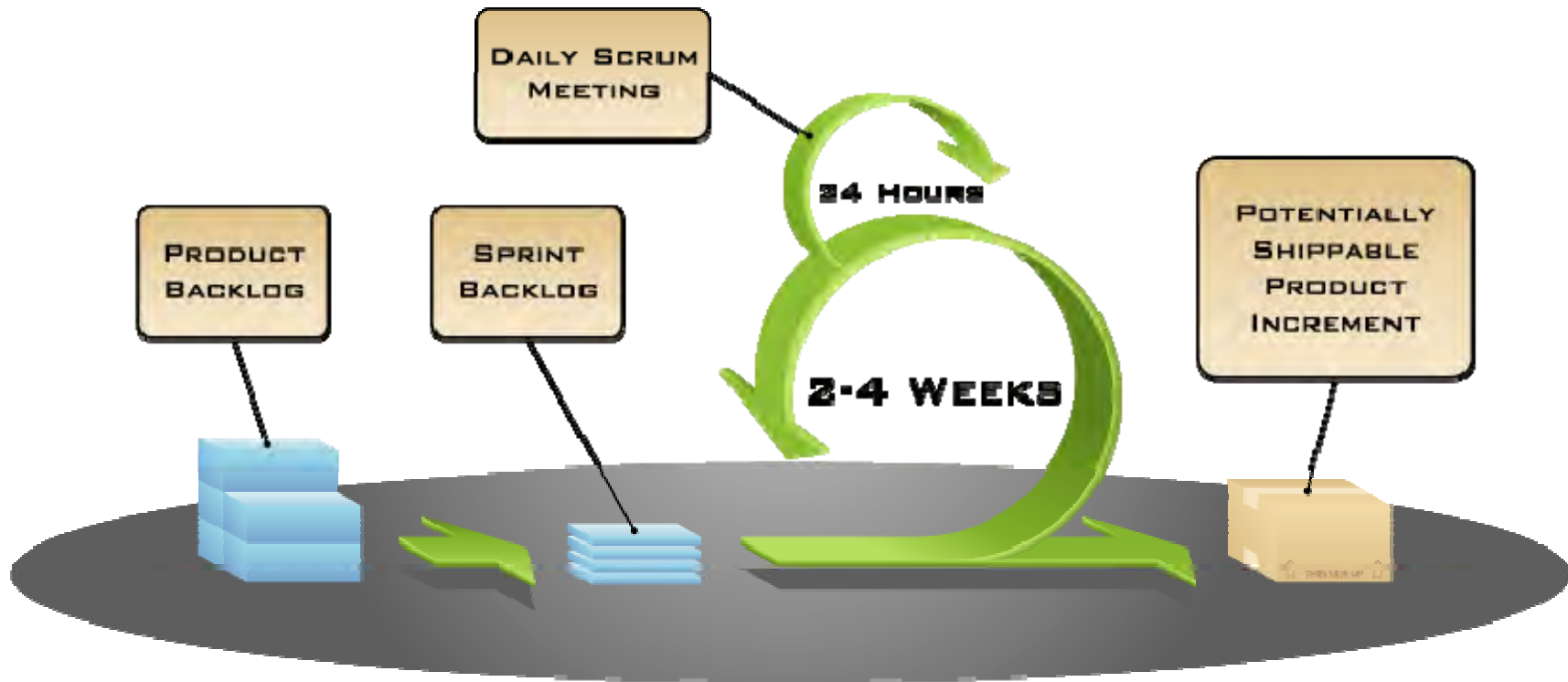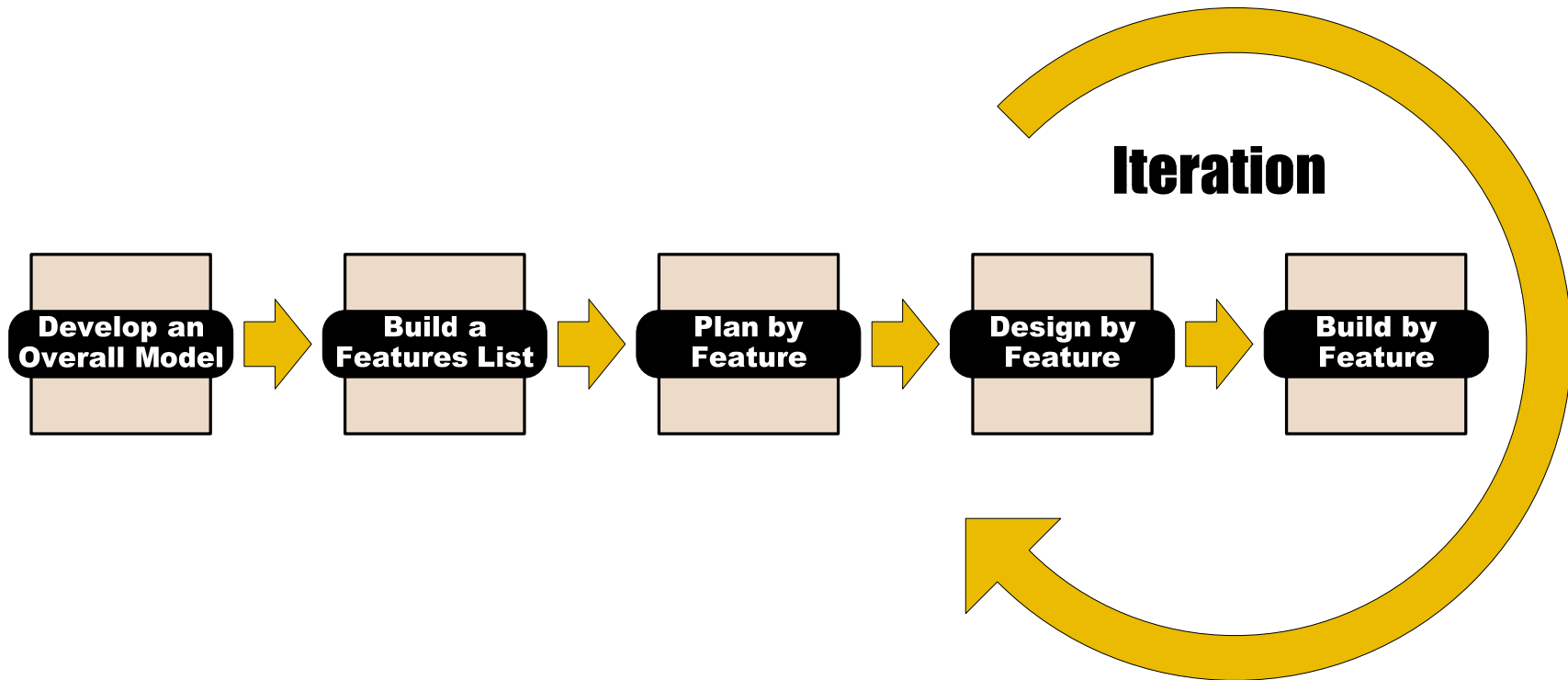
Dynamic Systems Develop.

- ☐ Created by group of British firms in 1993
- ☐ 15 practices, 12 roles, and 23 work products
- ☐ <u>Non-proprietary RAD approach from early 1990s</u>
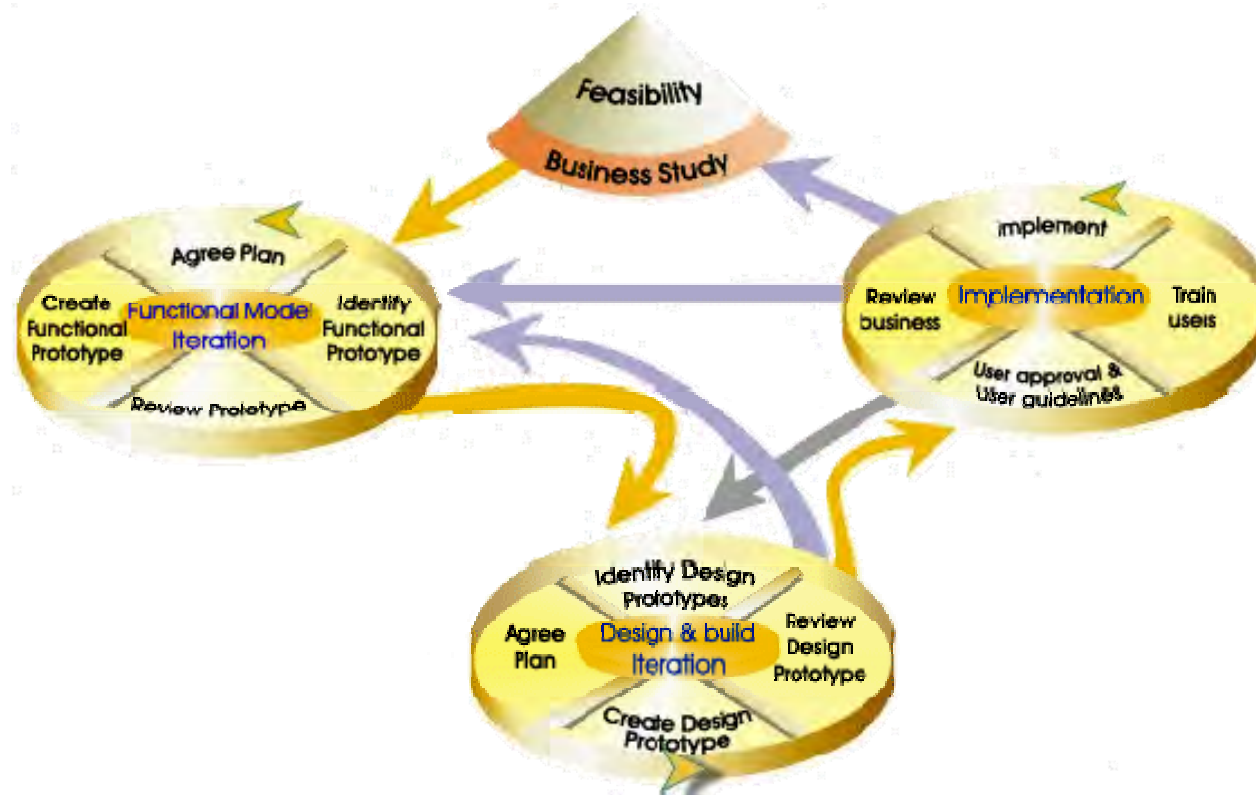
Stapleton, J. (1997). *DSDM: A framework for business centered development*. Harlow, England: Addison-Wesley.

Feature Driven Development

- Created by Jeff De Luca at Nebulon in 1997
- Has 8 practices, 14 roles, and 16 work products
- <u>Uses object-oriented design and code inspections</u>

Iteration

Develop an Overall Model	→	Build a Features List	→	Plan by Feature	→	Design by Feature	→	Build by Feature

Palmer, S. R., & Felsing, J. M. (2002). *A practical guide to feature driven development.* Upper Saddle River, NJ: Prentice-Hall.

Extreme Programming

- Created by Kent Beck at Chrysler in 1998
- Has 28 practices, 7 roles, and 7 work products
- <u>Popularized pair programming and test-driven dev.</u>
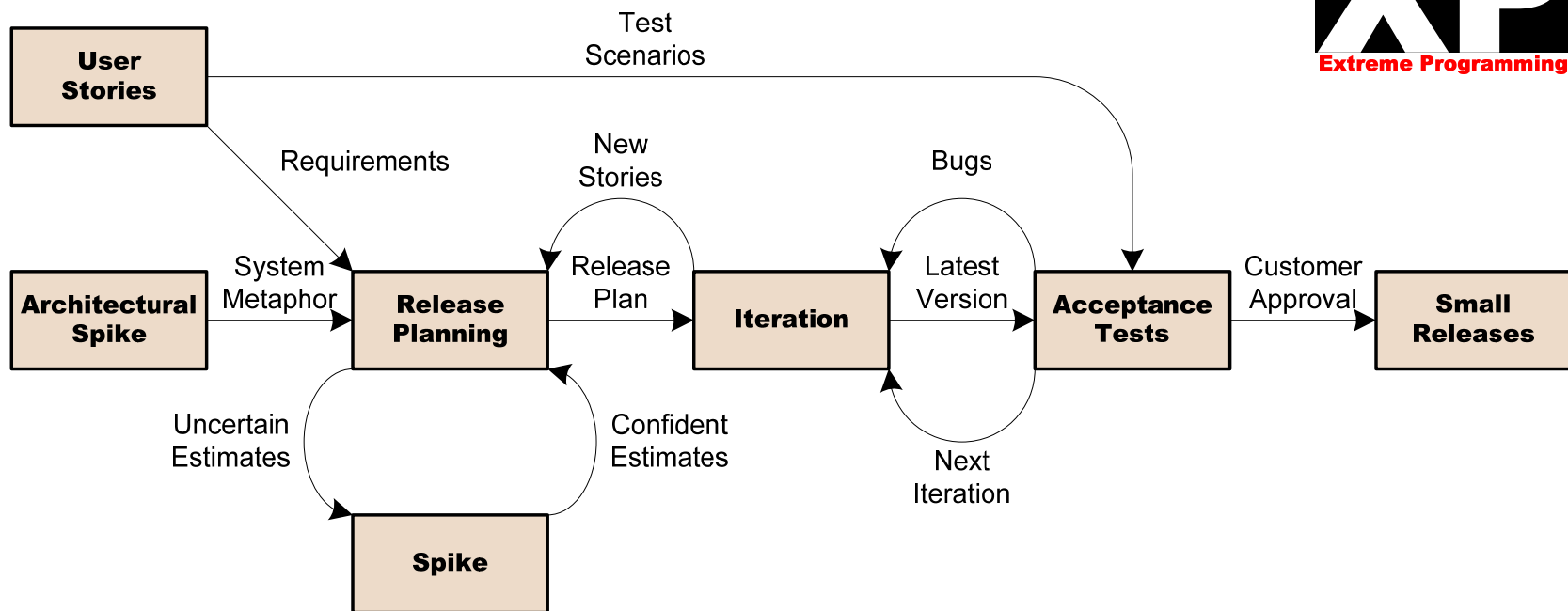
Beck, K. (2000). *Extreme programming explained*: *Embrace change*. Reading, MA: Addison-Wesley.

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☞ **STUDIES of Agile Methods**

Costs of Traditional Methods

Costs of Agile Methods

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Summary of Agile Methods

Surveys of Agile Methods

- ☐ Numerous surveys of Agile Methods since 2003
- ☐ AmbySoft and Version One collect annual data
- ☐ Generally include both hard and soft benefits

Year	Organization	Author	Size	Productivity	Quality	Cost
2003	Shine	Johnson	131	93%	88%	49%
2006	Agile Journal	Barnett	400	45%	43%	23%
2007	Microsoft	Begel, et al.	492	14%	32%	16%
2007	UMUC	Rico, et al.	250	81%	80%	75%
2008	AmbySoft	Ambler	642	82%	72%	72%
2008	IT Agile	Wolf, et al.	207	78%	74%	72%
2008	Version One	Hanscom	3,061	74%	68%	38%
Average				67%	65%	49%

Rico, D. F. (2008). *What is the return-on-investment of agile methods*? Retrieved February 3, 2009, from http://davidfrico.com/rico08a.pdf

Studies of Agile Methods

- Agile (138 pt.) and traditional methods (99 pt.)
- Agile methods fare better in all benefits categories
- Agile methods 359% better than traditional methods

Agile Methods

Category	Low	Median	High
Cost	10%	26%	70%
Schedule	11%	71%	700%
Productivity	14%	122%	712%
Quality	10%	70%	1,000%
Satisfaction	70%	70%	70%
ROI	240%	2,633%	8,852%

Traditional Methods

Category	Low	Median	High
Cost	3%	20%	87%
Schedule	2%	37%	90%
Productivity	9%	62%	255%
Quality	7%	50%	132%
Satisfaction	-4%	14%	55%
ROI	200%	470%	2,770%

Rico, D. F. (2008). What is the ROI of agile vs. traditional methods? *TickIT International*, *10*(4), 9-18.

Projects Using Agile Methods

- ☐ Analysis of 23 agile vs. 7,500 traditional projects
- ☐ Agile projects are 41% better than traditional ones
- ☐ XP (56%) and Scrum (26%) better than trad. projects

Agile vs. Traditional Benefits

Category	XP	Scrum	Agile
Time-to-Market	62%	138%	100%
Quality	100%	12%	56%
People	40%	-57%	-8%
Cost	21%	30%	26%
Productivity	59%	6%	32%

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

Projects Using Agile PM Tools

- Analysis of 29 agile vs. 7,500 traditional projects
- Agile projects are 33% better than traditional ones
- Rally projects are 28% better than traditional ones

Agile vs. Traditional Benefits

Category	Agile	Rally	Total No.
Time-to-Market	37%	50%	80%
Productivity	16%	25%	33%
Quality	33%	8.3%	40%

Rally Software. (2009). *The agile impact report*. Boulder, CO: Author.

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☞ COSTS of Traditional Methods
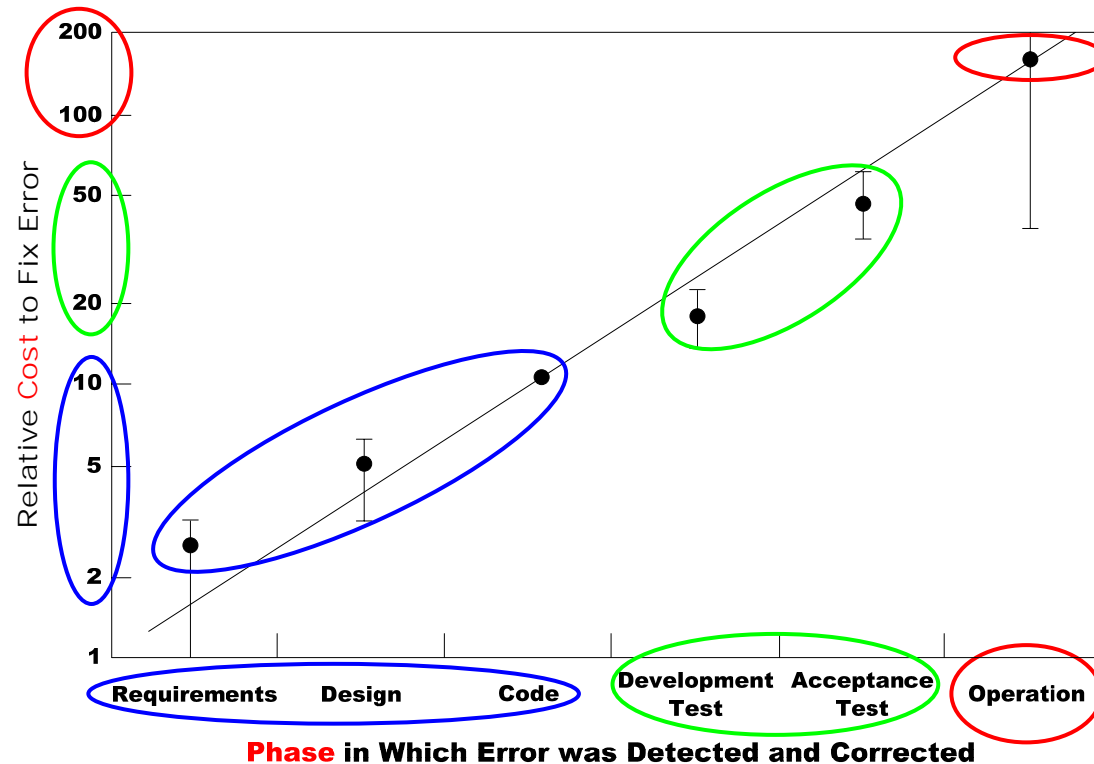
Costs of Agile Methods

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Summary of Agile Methods

Cost of Quality (CoQ)

- □ **1:10:100** ratio forms a basic model to estimate ROI
- □ Defects have negative multiplicative effect on cost
- □ Agile methods leave fewer defects (higher ROI)

Boehm, B. W. (1981). *Software engineering economics*. Englewood Cliffs, NJ: Prentice-Hall.

Traditional Cost Models

- □ Cost estimation models still in use today
- □ Used to estimate effort of Traditional Methods
- □ Adjusted average of **5,088** used for ROI estimation

Source	Model	LOC	Months	Hours	Years
COCOMO-O	$\text{Months} = 2.4 \times \text{KLOC}^{1.05}$	10,000	26.93	4,667.60	2.24
COCOMO-S	$\text{Months} = 3.0 \times \text{KLOC}^{1.12}$	10,000	39.55	**6,854.94**	3.30
COCOMO-E	$\text{Months} = 3.6 \times \text{KLOC}^{1.20}$	10,000	57.06	9,889.73	4.75
COCOMO-II	$\text{Months} = 2.9 \times \text{KLOC}^{1.10}$	10,000	36.51	6,328.20	3.04
Walston-Felix	$\text{Months} = 5.2 \times \text{KLOC}^{0.91}$	10,000	42.27	**7,326.31**	3.52
Bailey-Basili	$\text{Months} = 5.5 + 0.73 \times \text{KLOC}^{1.15}$	10,000	15.81	**2,740.66**	1.32
Doty	$\text{Months} = 5.288 \times \text{KLOC}^{1.047}$	10,000	58.92	**10,213.48**	4.91
Average			**39.58**	**6,860.13**	**3.30**

$^{*}(\textbf{6,854.94} + \textbf{7,326.31} + \textbf{2,740.66} + \textbf{10,213.48}) \div 4 \times 0.75 = \textbf{5,087.89}$

Benediktsson, O., & Dalcher, D. (2005). Estimating size in incremental software development projects. *Journal of Engineering Manufacture, 152*(6), 253-259.

Total Lifecycle Costs

- **0.51 hours/line of code** for Traditional Methods
- 10% defect inject rate (1,000 defects/10 KLOC)
- 67% of defects in test (33% in maintenance)

Step	Total Lifecycle Cost Model
1.	$0.51 \times Size + 100 \times IR \times Size - 100 \times IH - 10 \times TH + IH + TH$
2.	$0.51 \times Size + 100 \times 10\% \times Size - 100 \times IH - 10 \times TH + IH + TH$
3.	$0.51 \times Size + 10 \times Size - 100 \times IH - 10 \times TH + IH + TH$
4.	$0.51 \times Size + 10 \times Size - 99 \times IH - 9 \times TH$
5.	$10.51 \times Size - 99 \times IH - 9 \times TH$
6.	$10.51 \times 10{,}000 - 0 - 9 \times 6{,}666.67$
7.	**45,099.97**[*] *hours* or **$4,509,997**

[*] *5,087.89 Development Hours + 6,666.67 Test Hours + 33,345.41 Maintenance Hours*

Rico, D. F. (2004). *ROI of software process improvement: Metrics for project managers and software engineers*. Boca Raton, FL: J. Ross Publishing.
In, H. P., et al. (2006). A quality-based cost estimation model for the product line life cycle. *Communications of the ACM, 49*(12), 85-88.
McCann, B. (2007). The relative cost of interchanging, adding, or dropping quality practices. *Crosstalk, 20*(6), 25-28.

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☞ **COSTS of Agile Methods**

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Agile Lifecycle Cost Models

- **Costs** based on **productivity** and **quality** models
- Development costs based on $LOC \div productivity$ rate
- Maintenance costs based on $defects \times KLOC \times MH$

No.	Method	Agile Lifecycle Cost Models	Costs
1.	XP	$(10,000 \div 16.1575 + 0.7466 \times 10 \times 100) \times 100$	$136,548
2.	TDD	$(10,000 \div 29.2800 + 2.1550 \times 10 \times 100) \times 100$	$249,653
3.	PP	$(10,000 \div 33.4044 + 2.3550 \times 10 \times 100) \times 100$	$265,437
4.	Scrum	$(10,000 \div 05.4436 + 3.9450 \times 10 \times 100) \times 100$	$578,202
5.	Agile	$(10,000 \div 21.2374 + 1.7972 \times 10 \times 100) \times 100$	$226,805

Rico, D. F. (2008). What is the ROI of agile vs. traditional methods? *TickIT International*, *10*(4), 9-18.

Agile Lifecycle Benefit Models

- **Benefits** based on total traditional less agile **costs**
- Traditional costs based $LOC \times dev. + maint.$ effort
- Traditional costs credited with testing effort

No.	Method	Agile Lifecycle Benefit Models	Benefits
1.	XP	$(10,000 \times 10.51 - 6,666.67 \times 9) \times 100 -$ **$136,548**	**$4,373,449**
2.	TDD	$(10,000 \times 10.51 - 6,666.67 \times 9) \times 100 -$ **$249,653**	**$4,260,344**
3.	PP	$(10,000 \times 10.51 - 6,666.67 \times 9) \times 100 -$ **$265,437**	**$4,244,560**
4.	Scrum	$(10,000 \times 10.51 - 6,666.67 \times 9) \times 100 -$ **$578,202**	**$3,931,795**
5.	Agile	$(10,000 \times 10.51 - 6,666.67 \times 9) \times 100 -$ **$226,805**	**$4,283,192**

Rico, D. F. (2008). What is the ROI of agile vs. traditional methods? *TickIT International*, *10*(4), 9-18.

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Costs of Agile Methods

☞ METRICS for Agile Methods

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Measures of Business Value

- ☐ A major principle of Agile Methods is creating value
- ☐ ROI is the measure of value within Agile Methods
- ☐ There are seven closely related ROI measures

Metric	Definition	Formula
Costs **Sum of Costs**	Total amount of money spent	$\sum_{i=1}^{n} Cost_i$
Benefits **Sum of Benefits**	Total amount of money gained	$\sum_{i=1}^{n} Benefit_i$
B/CR **Benefit to Cost Ratio**	Ratio of benefits to costs	$\dfrac{Benefits}{Costs}$
ROI **Return on Investment**	Ratio of adjusted benefits to costs	$\dfrac{Benefits - Costs}{Costs} \times 100\%$
NPV **Net Present Value**	Discounted cash flows	$\sum_{i=1}^{Years} \dfrac{Benefits_i}{(1 + Discount\ Rate)^{Years}} - Costs_0$
BEP **Breakeven Point**	Point when benefits exceed costs	$\dfrac{New\ Costs}{Old\ Costs / New\ Costs - 1}$
ROA **Real Options Analysis**	Value gained from strategic delay	$N(d_1) \times Benefits - N(d_2) \times Costs \times e^{-Rate \times Years}$

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

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

Data for Agile Methods

- Agile Methods were ranked based on ROI
- Agile Methods with high quality had higher ROI
- Agile Methods with high productivity had lower ROI

Method	Costs	Benefits	B/CR	ROI	NPV	BEP	ROA
XP	$136,548	$4,373,449	32:1	3,102%	$3,649,388	$4,263	$4,265,936
TDD	$249,653	$4,260,344	17:1	1,606%	$3,438,351	$14,629	$4,066,678
PP	$265,437	$4,244,560	16:1	1,499%	$3,408,902	$16,599	$4,040,377
Scrum	$578,202	$3,931,795	7:1	580%	$2,825,313	$85,029	$3,608,772
Average	$226,805	$4,283,192	19:1	1,788%	$3,480,979	$12,010	$4,105,884

Rico, D. F. (2008). *What is the ROI of agile vs. traditional methods*? Retrieved September 3, 2008, from http://davidfrico.com/agile-benefits.xls

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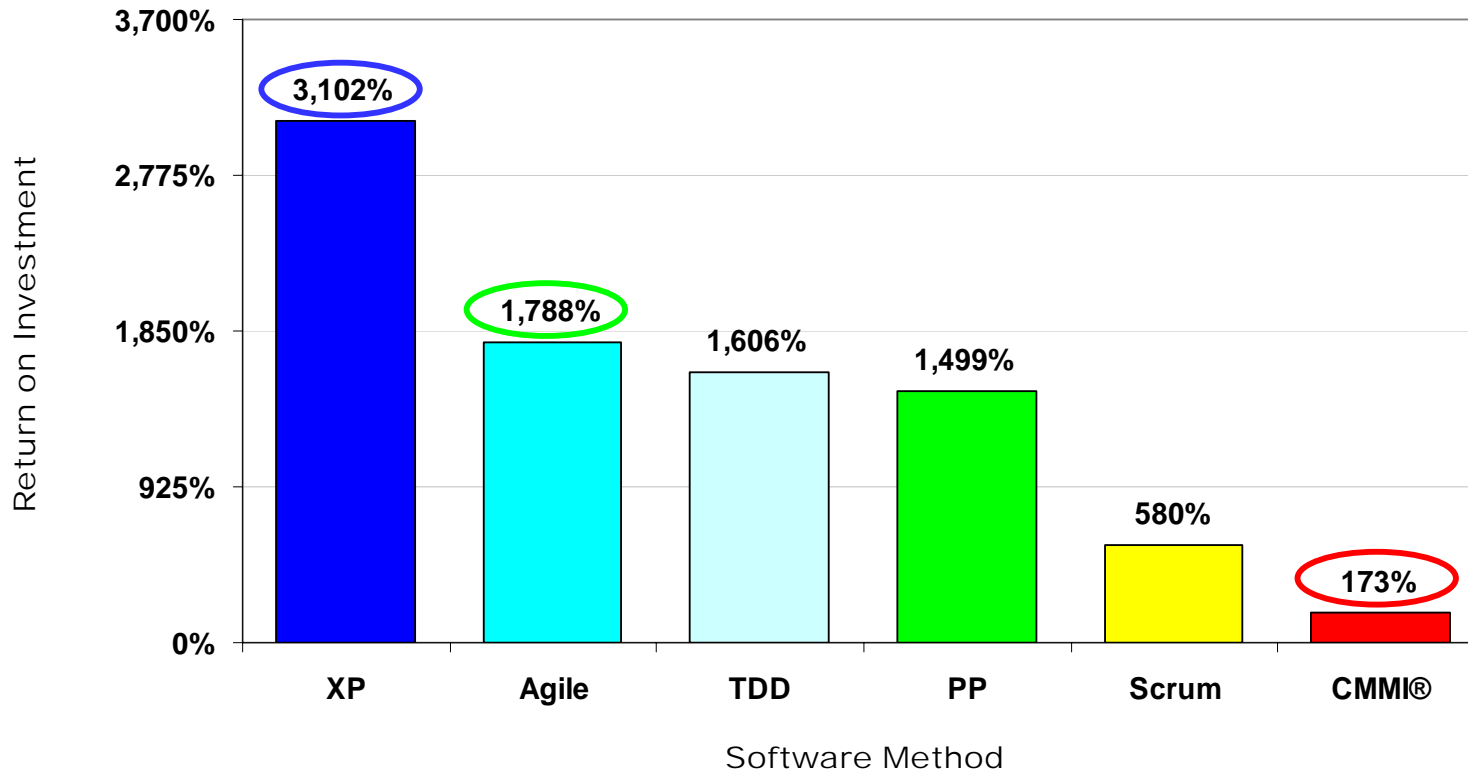
Costs of Agile Methods

Metrics for Agile Methods

☞ **COMPARISON of Agile Methods**

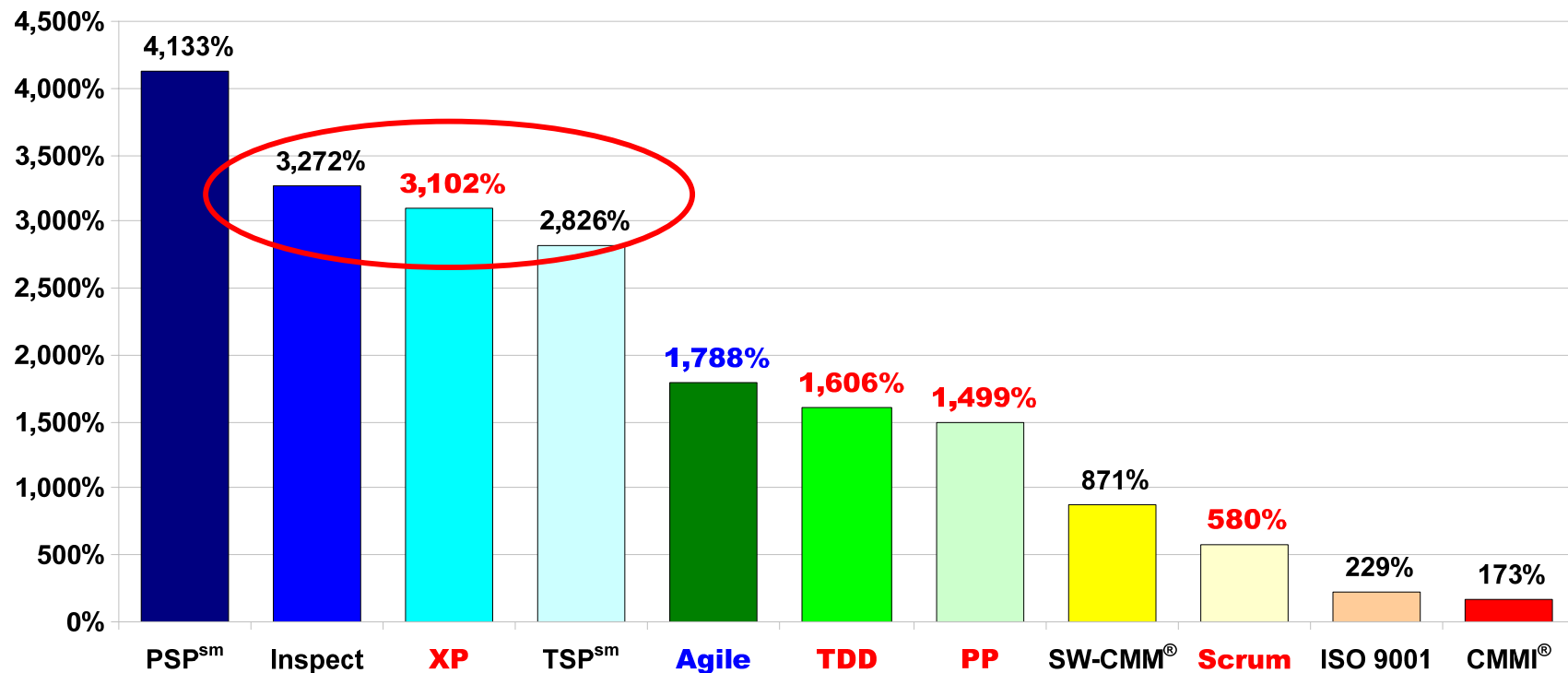**Summary** of Agile Methods

ROI of Agile Methods

- XP ROI 18X more than traditional methods
- Scrum ROI 3.4X more than traditional methods
- Agile methods ROI 10X more than trad. methods

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

Agile vs. Traditional Methods

- All of the methods were ordered by ROI
- Agile Methods had a high ROI value of 3,102%
- Traditional Methods had a high ROI value of 4,133%

Rico, D. F. (2008). *What is the ROI of agile vs. traditional methods*? Retrieved September 3, 2008, from http://davidfrico.com/agile-benefits.xls

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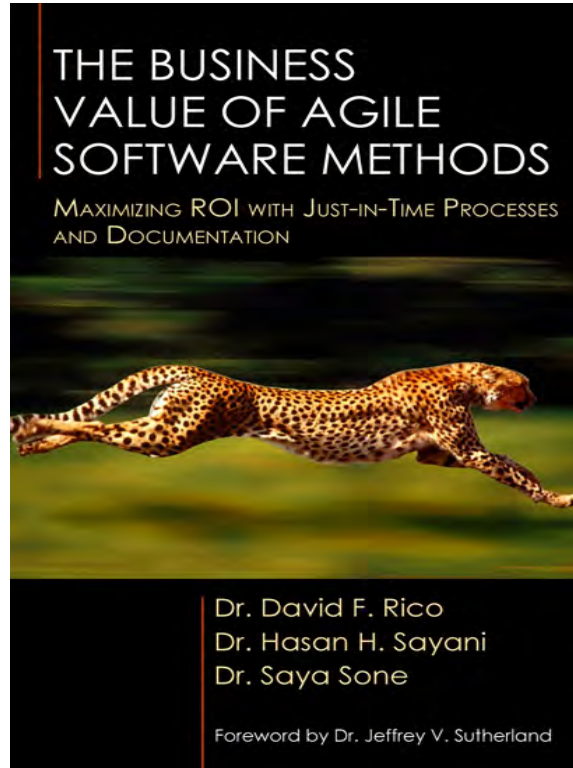
☞ **SUMMARY of Agile Methods**

Summary

- ☐ Agility is the evolution of management thought
- ☐ Confluence of traditional and non-traditional ideas
- ☐ Improve performance by over an order-of-magnitude

Agile methods and practices are ...

- ☑ Systems development approaches

- ☑ New product development approaches

- ☑ Expertly designed to be fast and efficient

- ☑ Intentionally lean and free of waste (muda)

- ☑ Systematic highly-disciplined approaches

- ☑ Capable of producing high quality systems

- ☑ Right-sized, just-enough, and just-in-time tools

- ☑ Intended to maximize business value for customers

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.

New Book on Agile Methods

☐ Guide to Agile Methods for business leaders
☐ Communicates business value of Agile Methods
☐ Rosetta stone to Agile Methods for traditional folks

THE BUSINESS VALUE OF AGILE SOFTWARE METHODS

MAXIMIZING ROI WITH JUST-IN-TIME PROCESSES AND DOCUMENTATION

Dr. David F. Rico
Dr. Hasan H. Sayani
Dr. Saya Sone

Foreword by Dr. Jeffrey V. Sutherland

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NEW!   NEW!

■ http://davidfrico.com/agile-book.htm (*Description*)
■ http://www.amazon.com/dp/1604270314 (*Amazon*)