The Effectiveness Formula

A Quantitative measure of Organization Capability

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Software Problems

- Unreliable
- Late delivery
- Modification costs prohibitive
- Impossible to maintain
- Inadequate performance
- Product exceeds budget costs

1968 NATO CS Conference, Munich, Germany
1970 Development Environment

- Stable process
- Intelligent, experienced, dedicated programmers
  - Ethic of workaholism
  - Sacrificed personal lives
  - Gulled into hopeless schedules
- Stable environment
- Advanced technologies
- 2010 Environment identical except for technologies
Traditional Capability Rating

- Programming ability
  - Education
  - IQ
  - Problem solving skills
- Efficiency
- Communication ability
- Cooperation

Traditional data does not work for agile development environments
Productivity Gains -- Technology

*1.5 SLOC/PM/Year productivity gain
Chaos 2013 Software Project Survey

Success Rate

- Success: 43
- Failed: 18
- Challenged: 39
1975 Pair Programming Pilot Study

- Real time system executive
- 30,000 Fortran source lines
- 6 software components
- 5 two-person teams plus manager
- Average productivity prior to study = 77 LPPM
- Pilot study productivity = 175 LPPM
- Error rate <0.1% of norm
Effective Capability Rating

- Motivation
- Management style
- Use of team methods
  - Communication ability
  - Cooperation
- Hawthorne Effect
- Working environment
  - Noise level
  - Individual working (thinking) space
  - Proximity of team members
- Problem solving skills
- Programming ability

C & M

CS
Software engineering is:
(1) the systematic design and development of software products
(2) the management of the software process.
Effectiveness Formula

\[ E = C[M(CS)] \]

where

- \( E \) = Effectiveness
- \( C \) = Communication skills (0 – 1)
- \( M \) = Management concept awareness (0 – 1)
- \( CS \) = Computer science technical ability (0 – 1)


*Initial Goal: Development environment model*
Effectiveness Formula Evolution

1975 Team Experiment

EF (1979+)

EF = Effectiveness Formula

Traditional Software Project Data
(1960 – 1985)

Seer
1980 - 1995

Seer II (Sage)
(1995+)

Agile Software Project Data
(1995 – present)
# Capability Score Calculation

<table>
<thead>
<tr>
<th>Ctb Calculation</th>
<th></th>
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<tbody>
<tr>
<td><strong>ACAP</strong></td>
<td>1.00</td>
</tr>
<tr>
<td><strong>AEXP</strong></td>
<td>1.00</td>
</tr>
<tr>
<td><strong>MODP</strong></td>
<td>1.00</td>
</tr>
<tr>
<td><strong>PCAP</strong></td>
<td>1.00</td>
</tr>
<tr>
<td><strong>RESP</strong></td>
<td>1.00</td>
</tr>
<tr>
<td><strong>TOOL</strong></td>
<td>1.00</td>
</tr>
<tr>
<td><strong>TURN</strong></td>
<td>1.00</td>
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</table>

- **Capability Score**: 0.23
- **Percentile Rating**: 50%
- **Ctb**: 5,707
Components of Communication

How Much Communication Here?

(0 – 1) scale

= 0.07!
Poor management can increase software costs more rapidly than any other factor…

Despite this cost variation, COCOMO does not include a factor for management quality, but instead provides estimates which assume that the project will be well managed…

Weinberg’s Analysis of COCOMO Drivers

3 TOOLS
11 PEOPLE
17 SYSTEMS
64 MANAGEMENT

Management Research Highlights

- General management concepts, 1911
  Management philosophy: Plan, Organize, Command, Coordinate, Control
- Hawthorne experiment (1924-1932)
- People impacts, Mayo, 1933
- Lockheed Skunk Works, 1940s
- Theory X/ Theory Y, McGregor, 1960
- CMM, Humphrey, 1989
### Theory X / Theory Y Management

<table>
<thead>
<tr>
<th>Theory X</th>
<th>Theory Y</th>
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<tbody>
<tr>
<td>1. Work is inherently distasteful to most people.</td>
<td>1. Work is as natural as play, if conditions are favorable.</td>
</tr>
<tr>
<td>2. Most people are not ambitious, have little desire for responsibility, and prefer to be directed.</td>
<td>2. Self-control is often indispensable in achieving organizational goals.</td>
</tr>
<tr>
<td>3. Most people have little capacity for creativity in solving organizational problems.</td>
<td>3. The capacity for creativity in solving organizational problems is widely distributed in the population.</td>
</tr>
<tr>
<td>4. Motivation occurs only at the physiological and safety levels.</td>
<td>4. Motivation occurs at the social, esteem, and self-actualization levels, as well as physiological and security levels.</td>
</tr>
<tr>
<td>5. <strong>Management philosophy:</strong> Plan, Organize, Command, Coordinate, Control</td>
<td></td>
</tr>
</tbody>
</table>
Motivation Impact on Productivity

EMPLOYEE

Percent of Ability

Area affected by motivation

80 to 90 percent

20 to 30 percent
While there are many unique characteristics to software, they all require more management discipline, not less. Managers should thus demand detailed plans, tracking systems, and periodic technical and management reviews. **Software management should be entirely traditional, only more so.** Unfortunately, many managers who insist on these items for hardware let their software teams get by without them.

Effectiveness Formula Redux

\[ E = CM(CS) \]

where

\( E \) = Effectiveness
\( CM \) = Communications/Management ability (0 – 1)
\( CS \) = Software Engineering technical ability (0 – 1)

- Forty five years of validation data !!
- Data does not permit communication – management split
Effective Formula Distribution

<table>
<thead>
<tr>
<th>EF Value</th>
<th>Percentile</th>
<th>Ctb</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.11</td>
<td>10</td>
<td>2000</td>
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<tr>
<td>0.25</td>
<td>50</td>
<td>6500</td>
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<tr>
<td>0.38</td>
<td>70</td>
<td>8192</td>
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<tr>
<td>0.40</td>
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<td>8630</td>
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<tr>
<td>0.50</td>
<td>88</td>
<td>12,500</td>
</tr>
</tbody>
</table>
Conclusions

- Low productivity improvement over the last 3 decades has been primarily driven by technology.

- Productivity/Effectiveness is a function of 3 attributes: communications, management, and technology.

- Communications and management are **KEY** productivity drivers.

- Estimates for non-classic environments must account for all 3 effectiveness attributes for application to agile development.

- Effectiveness Formula applies to almost all development environments.
Our job is to escape the cave, look around, then come back and tell others what we have seen . . . Of course, they won’t believe us.

Plato, Republic Book 7