R,D&E and Product Development Metrics

John Hauser
and colleagues
Stream of metrics research

- Qualitative interviews *(RTM)*
- R,D&E metrics (by tiers) *(MS)*
- You are what you measure! *(EMJ)*
- Non-monetary compensation *(JMR, MKS)*
- “Engineer” agency theory *(internal notes)*
- Field measures to identify lean metrics
Roadmap for today.

- Qualitative ideas
- R,D & E metrics, measures at Draper
- Some concepts of agency theory
- “Engineered” theory
- Measures at Xerox, Ford
Qualitative ideas:
Metrics have many uses

- Where am I, where am I going?
- In what should I invest?
- You are what you measure!
  - guide the allocation of effort
  - rewards and incentives, possibly non-monetary
Qualitative ideas:
Counterproductive metrics

1. Delaying rewards (people vs. firm)
2. Using risky rewards (market-oriented?)
3. Making metrics hard to control
   (firm’s profit, vehicle-level, car door)
4. Losing sight of the goal (Steelcase)
5. Choosing metrics that are precisely wrong
   (fast, efficient response vs. the right answers)
6. Assuming employees have no options
7. Thinking too narrowly (Intuit)
Seven steps toward lean, effective metrics

- Start by listening to the customer
- Understand the job
- Understand the interrelationships
- Understand the linkages
- Test the correlations and manager, employee reaction
- Involve managers and employees
- Seek new paradigms
Qualitative ideas: Classical agency theory

Actions and Decisions → Metrics are noisy measures → Outcomes

Metrics are noisy measures

Outcomes
Qualitative ideas: You are what you measure!

Actions and Decisions -> Metrics

Metrics -> Outcomes

Outcomes -> Time and Risk
R,D&E metrics: A tier metaphor

Tier 1
Basic Research
Explorations

Tier 2
Development Programs to Match or Create Core Technological Competence

Tier 3
Applied Engineering Projects with or for the Business Units
R,D&E metrics: 
Tier 3, applied engineering

- Firms use output metrics, but subsidize projects from central coffers
- Theory shows that subsidy adjusts for
  - risk
  - time preference
  - concentration of scope
- Option values (e.g., Black-Scholes)
R&D&E metrics: Tier 2, development

- Outcome metrics lead to severe false rejection (selection) of projects \([risk, time]\)

- Once a project is selected, effort metrics (publications, etc.) are important motivators

- Optimal balance is
  - large weight on effort metrics
  - small weight on outcome metrics
R,D&E metrics:
Tier 1, long-term research

- Extant systems emphasize identifying and rewarding idea generators
- “Not-invented-here” is a direct result of the metric system
- Many firms are beginning to reward “research tourism”
### Lean metrics initiative: Draper Laboratories

<table>
<thead>
<tr>
<th>Program</th>
<th>Management Score</th>
<th>Metric Score</th>
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<tbody>
<tr>
<td>Micromech. Sensors</td>
<td>45.0</td>
<td>42.3</td>
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<td>Intelligent Sonobuoys</td>
<td>26.4</td>
<td>29.7</td>
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<tr>
<td>Program 3</td>
<td>24.3</td>
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<tr>
<td>Program 8</td>
<td>32.9</td>
<td>28.2</td>
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</table>

Correlation = 0.934
Draper’s metrics categories

- Personnel capabilities
- Technical capabilities
- Strategic fit
- Project management performance
- Match to customer needs
- Financial outcomes
Tutorial review:
Some concepts of agency theory

- Teams preference functions
  - rewards (risk and time discounts)
  - perceived costs of efforts
  - gaming
- Labor market (participation constraint)
- Incremental efforts, wages, profits
Tutorial review:
Solution methods of agency theory

- Given the reward system, the team maximizes its own well-being.
- Firm chooses the reward system recognizing:
  - how the reward system affects the team
  - subject to labor market constraints
**Tutorial review:**
It ain’t all money!

<table>
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<tr>
<th>Attribute</th>
<th>Raters</th>
<th>Ratees</th>
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<td>$2,900</td>
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<tr>
<td>Expectations</td>
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<td>$ 600</td>
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<tr>
<td>Special skills</td>
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<td>$1,300</td>
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<td>Forego</td>
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<tr>
<td>Assignments</td>
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</tbody>
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**Sample Size**

61 managers 60 employees
Engineering agency theory: Some issues

- PD teams rather than individuals
- Practically, the firm set priorities that apply to classes of projects
- Leverage varies project to project and is a hard-to-observe random variable
- Practical measures are necessary
Field research at Xerox
(data on 20 projects)

Metric categories
- Understanding market and customers (4)
- Product designed for market needs (4)
- Relationship to other products (6)
- Rigor of design process (5)
- Appropriate technology selection (5)
- Coordination and communication (7)
- Relationships with suppliers, partners (7)
- Time to market
- Customer satisfaction

Covariates
- Product fits Xerox (3)
- Size of strategic opportunity (2)
- Size of financial opportunity (5)
- Resources available (3)
- Coordination difficulty of team (4)

Outcomes
- Actual profit in US
- Actual profit in Europe
- Judged overall success
- Profit later (estimates)
Status

- Pilot at Xerox (almost complete)
  - Metrics, covariates, outcomes
  - RDF, precision, judged importance
- Pilots beginning at Ford
- Instrumentation of variables (real challenge)
- Non-monetary compensation (web-based measures, efficient transfers)

1998-1999