Quantitative Software Management

Using Metrics to Develop a Software Project Strategy

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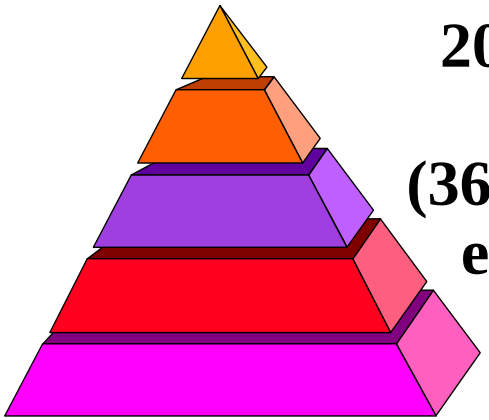
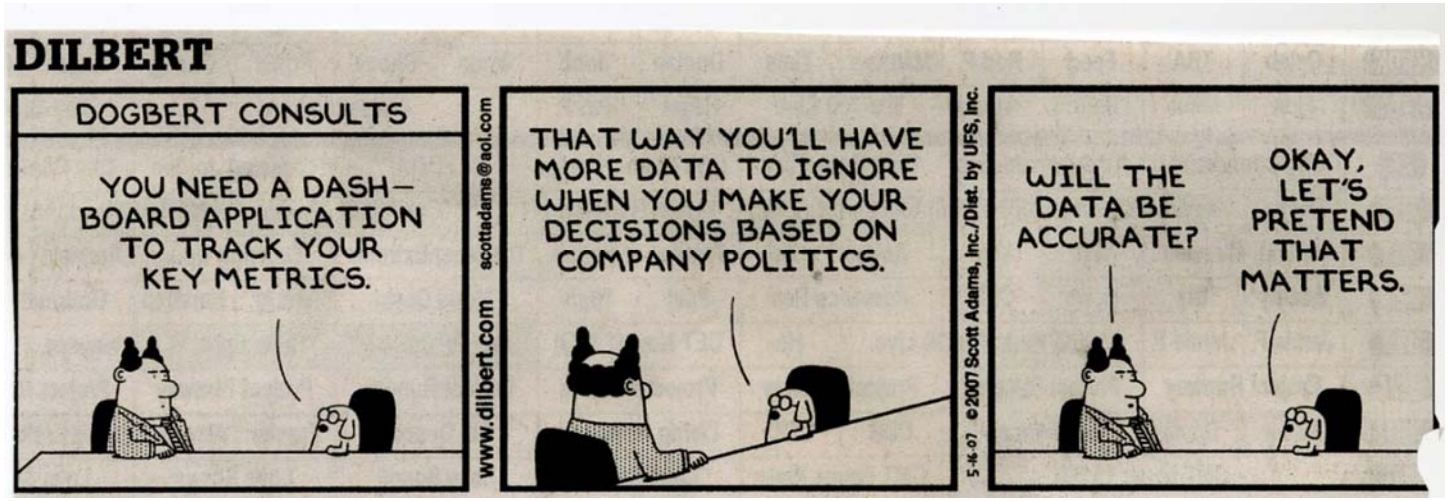


QSM The Intelligence behind Successful Software Projects

Outline

- Overview
- Measurement, Expense or Investment
- State of the Industry: Project Estimation
- Staffing and Schedule
- Understanding Trade-offs
- Conclusion
- Questions?

Overview



Does this sound familiar?

Measurement: Expense or Investment

- **Software measurement (and process improvement) are viewed as expenses: Overhead**
  - **Lean, agile organizations want to reduce overhead**
  - **But, how do organizations become "lean & agile"?**
  - **Measurement activities not directly related to revenue generation**
- **Part of cost of doing business**
  - **3 – 5% on average**
  - **Project management averages 14%**

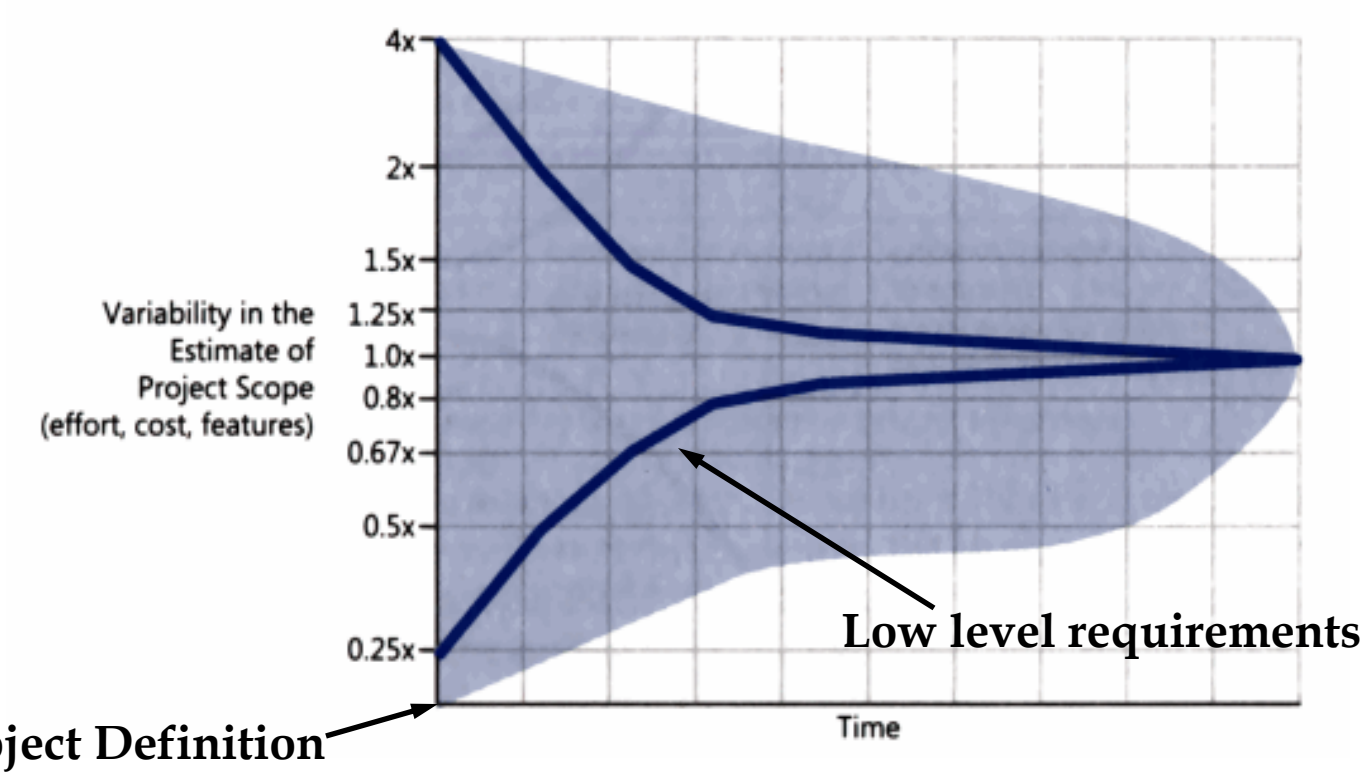
Measurement: Expense or Investment

- **What does software measurement provide?**
  1. **Knowledge of an organization's capabilities**
  2. **Identifies patterns and trends (Strengths to leverage and weaknesses to correct)**
  3. **Insight into projects in time to make effective mid-stream corrections**
  4. **Ability to benchmark against competition or "the industry" in quality, productivity, and time to market**
  5. **Quantitative basis for evaluating project and organizational performance**
- **Improves ability to meet commitments, avoid pitfalls, and evaluate trade-offs**

State of the Industry: Project Estimation

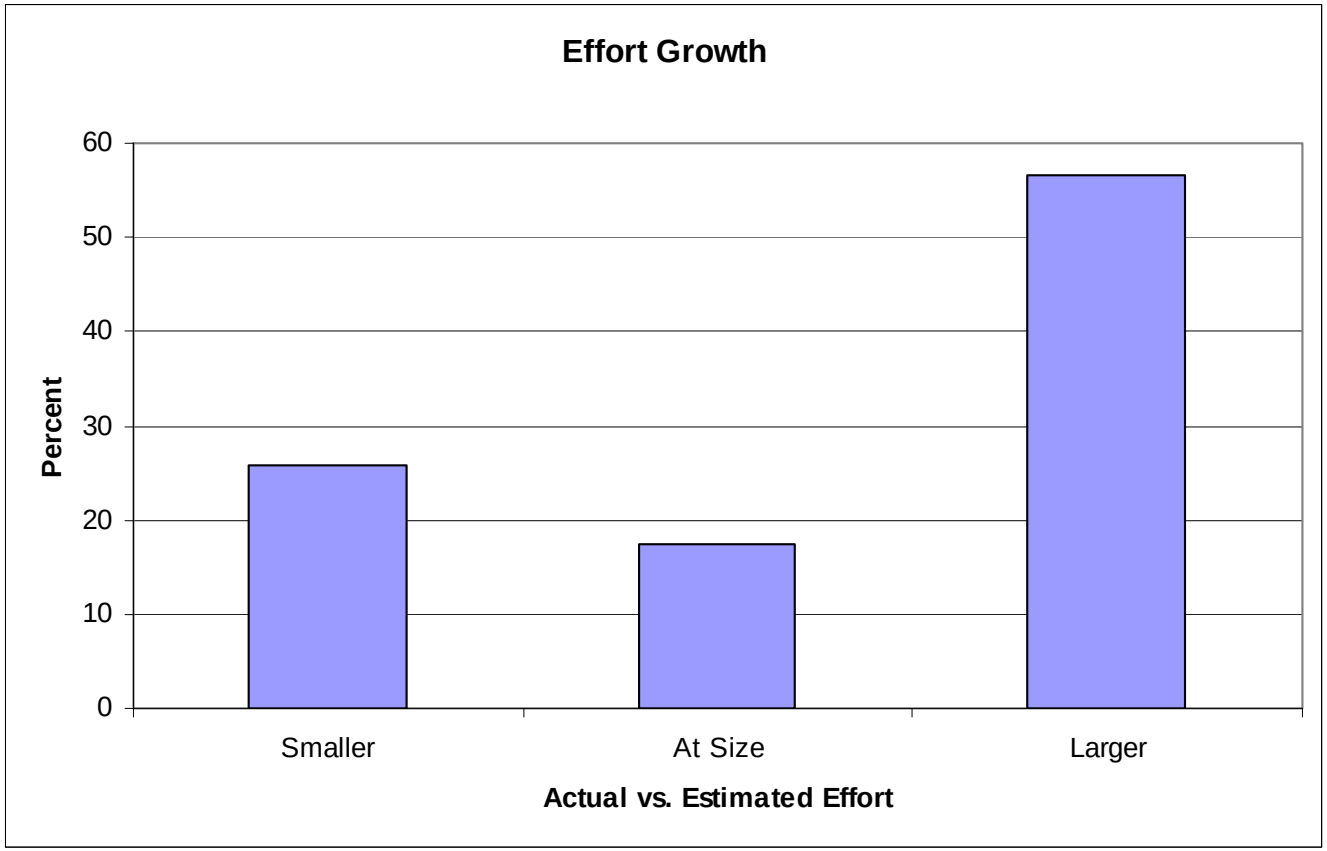
- Software estimates are not project plans
- Estimates contain uncertainty about two key components:
  - Scope of the requirements (project size)
  - Team productivity
- Estimates define a range of possible outcomes
  - Trade-offs can be examined
  - Impossible solutions identified

The Cone of Uncertainty

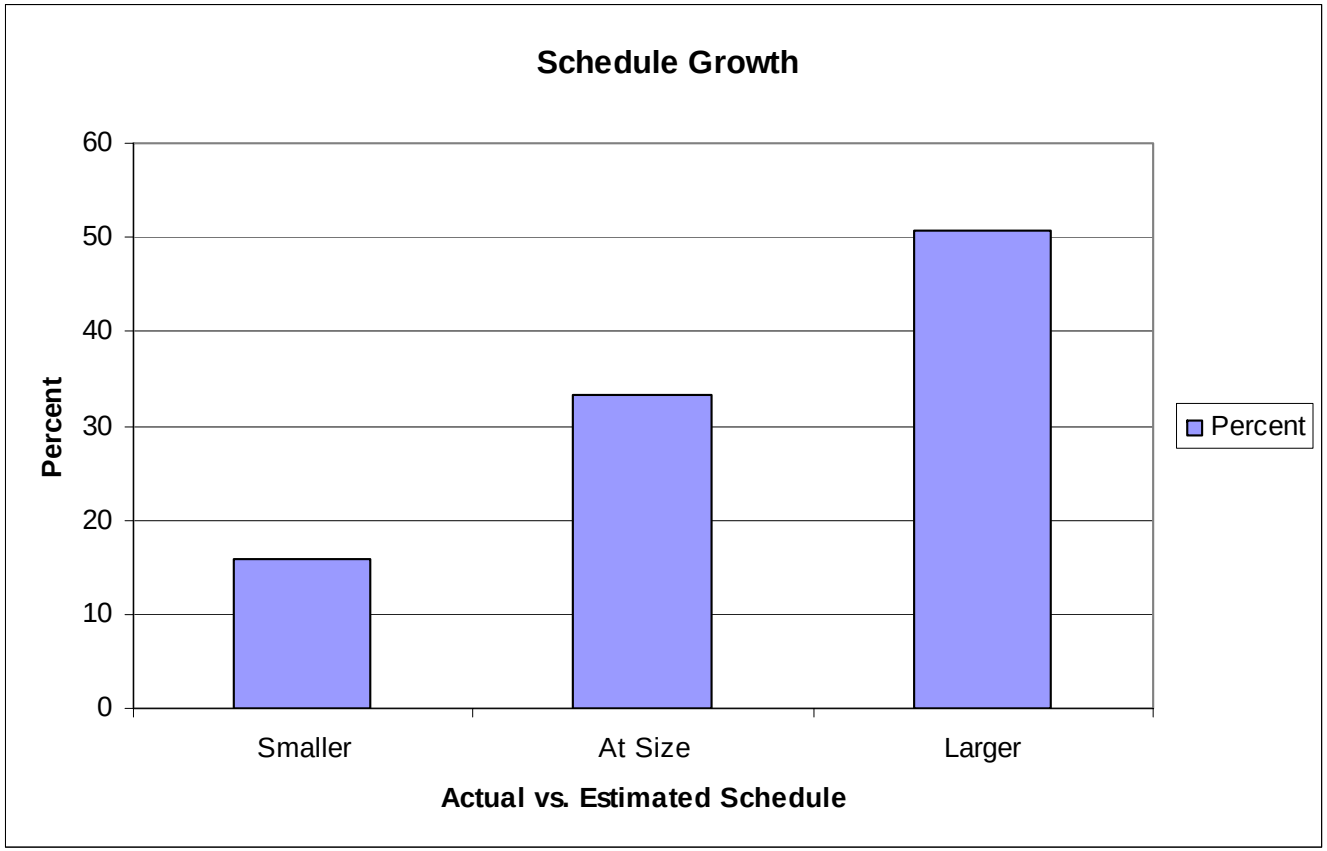


- Not enough information is available early in the development lifecycle to make accurate estimates
- Precision is not accuracy

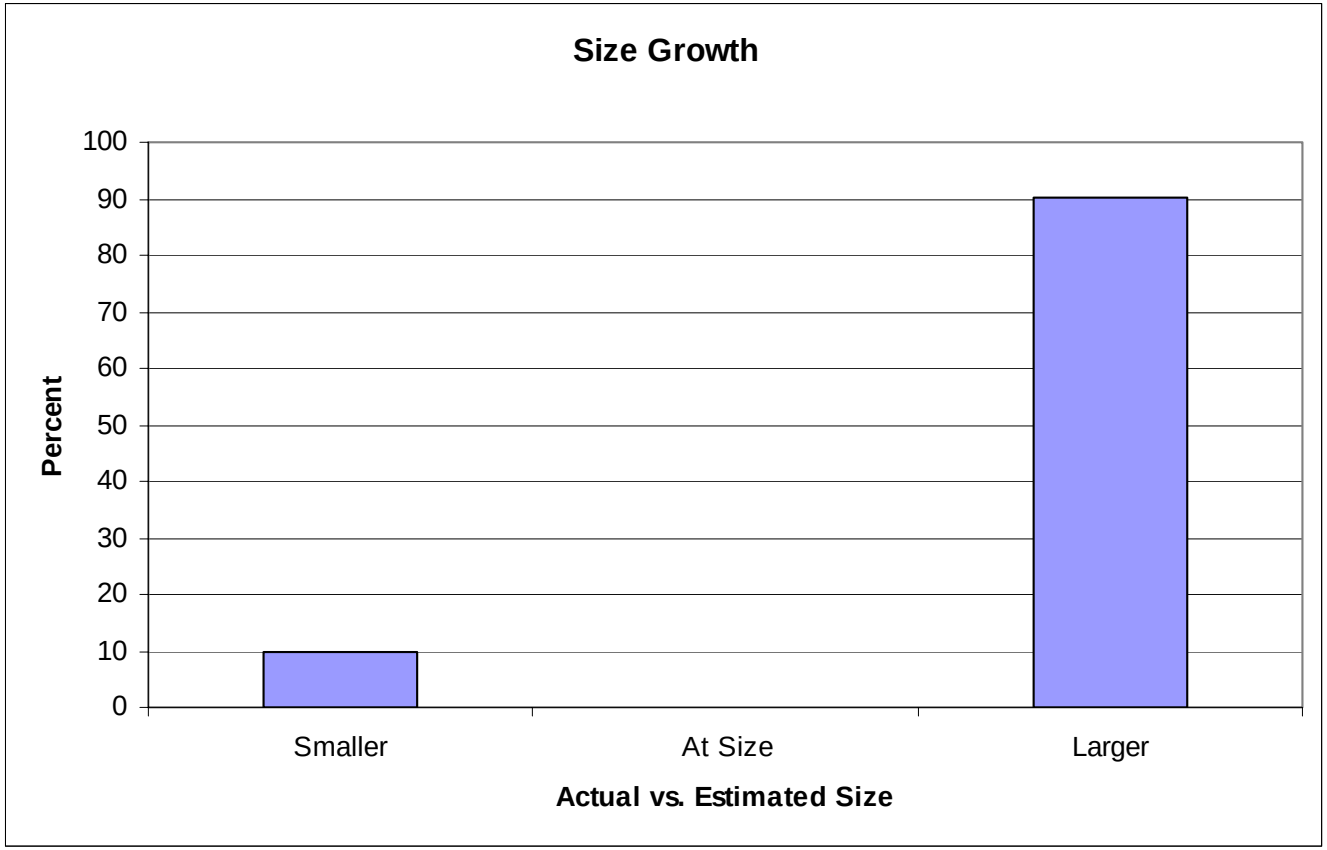
Actual vs. Estimated Effort



Actual vs. Estimated Schedule



Actual vs. Estimated Size



Change Happens

- Software development is more of a discovery process than a manufacturing one
- Software projects tend to grow as the implications of requirements are better defined
- Change must be
  - Managed (Change control process)
  - Anticipated
  - Its implications quantified

In Summary

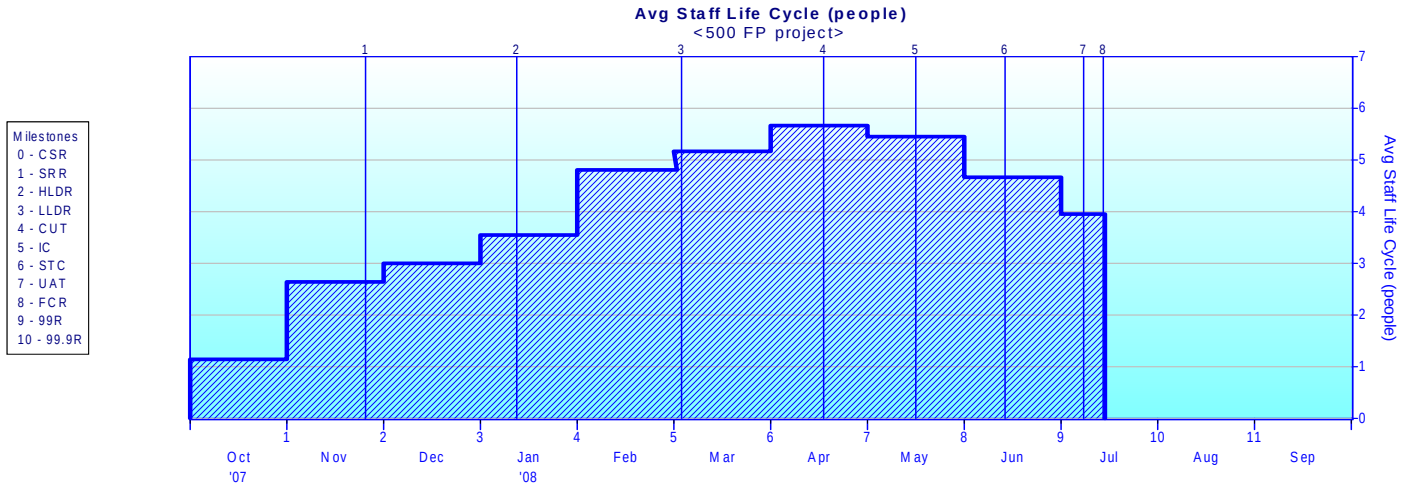
- **Average schedule growth is 8%**
- **Average cost/effort growth is 16%**
- **Average size growth is 15%**
- **So how can we use this information to create more accurate estimates?**

Modeling Increased Size

- **Create best project estimate based on proposed size**
  - **Use historically based productivity**
  - **Account for project constraints (staff, effort, schedule)**
- **Create estimate based on 15% size growth**
  - **Does this account for projected schedule & effort growth?**

500 FP Project

Staffing & Probability Analysis



SOLUTION PANEL - <500 FP project>

	C&T	Life Cycle	
Duration	6.7	9.4	Months
Effort	29	37	PM
Cost	493.4	643.6	$ (K)
Peak Staff	5.7	5.7	people
MTTD	1.823	1.823	Days
Start Date	12/23/2007	10/1/2007	

PI=16.5 MBI=3.6 Eff FP=500

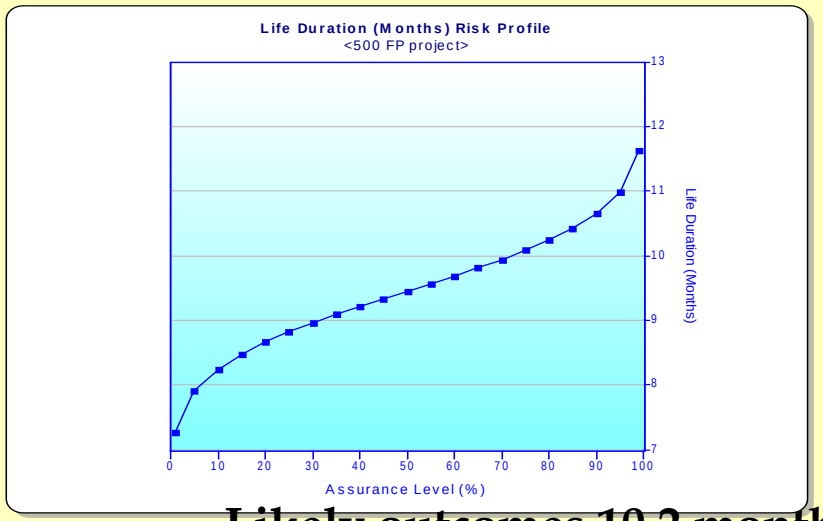
9.4 months duration

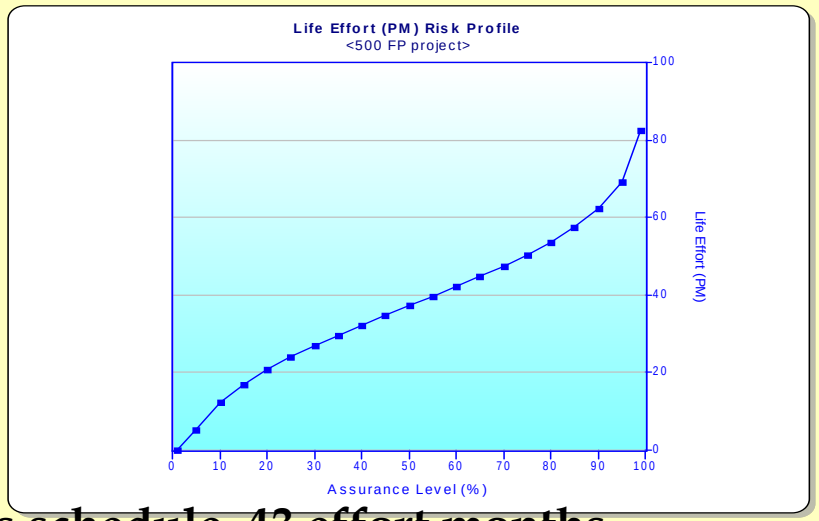
37 person months effort

50% probability

500 FP Project

Evaluate Probability of Current Estimate





Likely outcomes 10.2 months schedule, 43 effort months

Life Duration (Months) Risk Profile - Probability demo
<500 FP project>

Assurance Level (%)	Life Duration (Months)
1	7.26
5	7.90
10	8.25
15	8.48
20	8.66
25	8.82
30	8.96
35	9.09
40	9.21
45	9.33
50	9.45
55	9.57
60	9.69
65	9.81
70	9.94
75	10.08
80	10.24
85	10.42

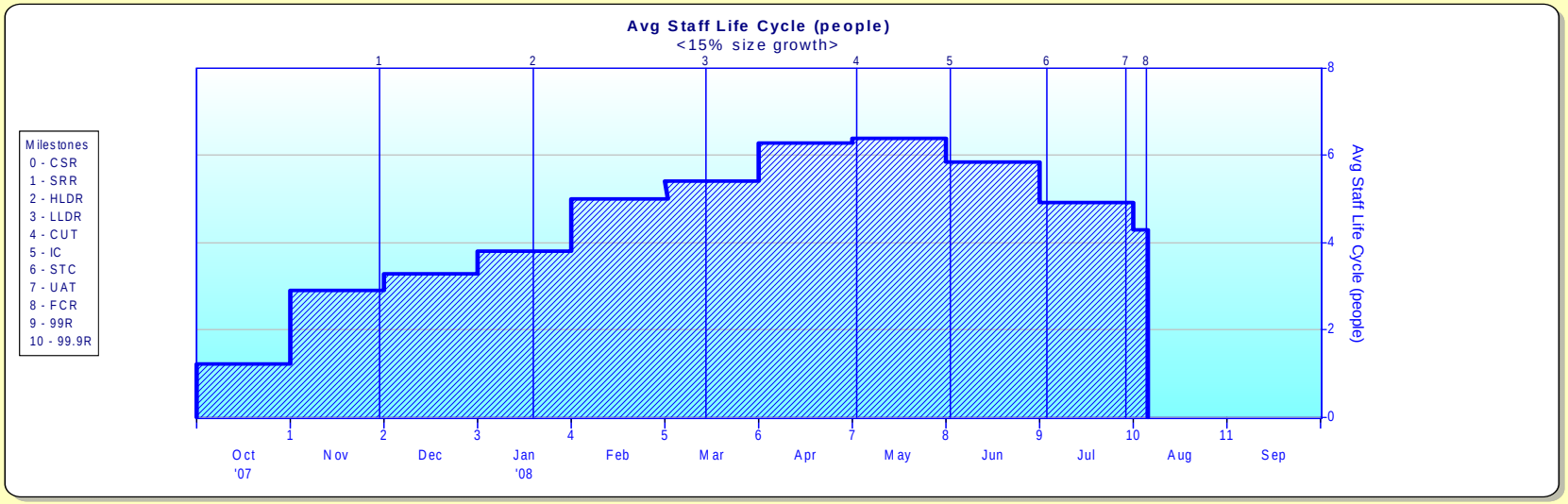
Life Effort (PM) Risk Profile - Probability demo
<500 FP project>

Assurance Level (%)	Life Effort (PM)
1	0.00
5	5.11
10	12.20
15	16.99
20	20.79
25	24.05
30	26.98
35	29.69
40	32.27
45	34.75
50	37.20
55	39.65
60	42.13
65	44.71
70	47.42
75	50.35
80	53.61
85	57.41

Project: Probability demo

15% Growth (575 FP)

Staffing & Probability Analysis



SOLUTION PANEL - <15% size growth>

	C&T	Life Cycle	
Duration	7.3	10.2	Months
Effort	35	46	PM
Cost	603.7	787.5	$ (K)
Peak Staff	6.5	6.5	people
MTTD	1.681	1.681	Days
Start Date	12/28/2007	10/1/2007	

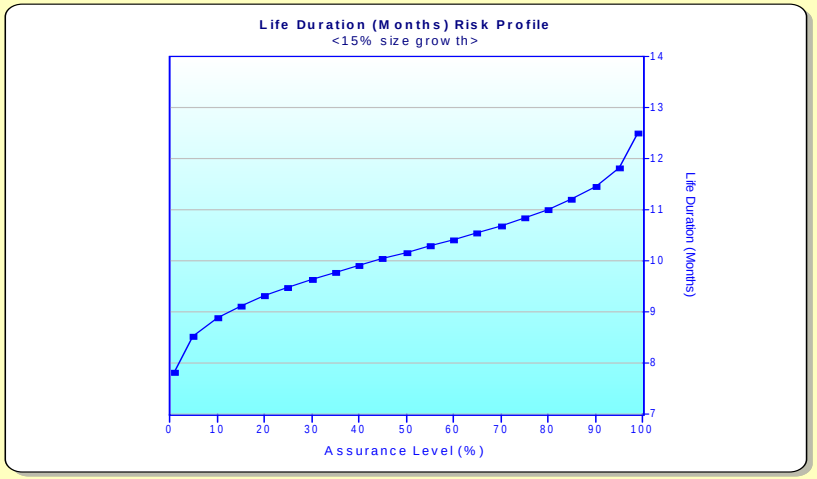
PI=16.5 MBI=3.4 Eff FP=575

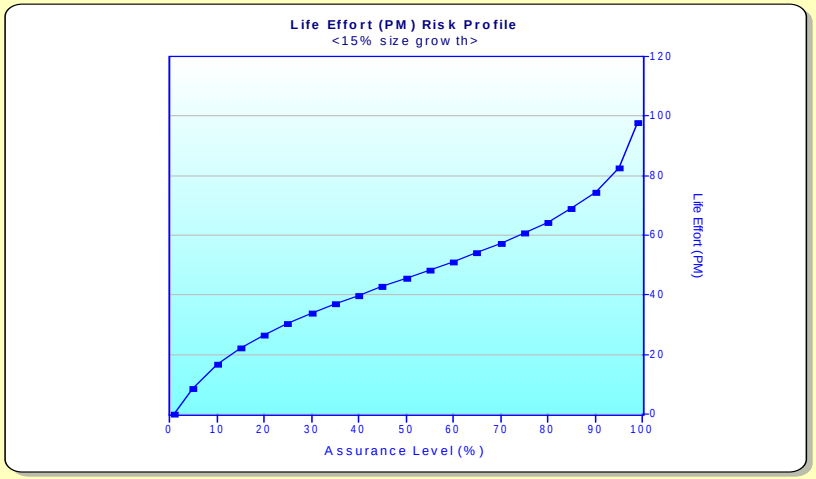
10.2 months duration

46 person months effort

15% Growth (575 FP)

Evaluate Probability of Current Estimate





Life Duration (Months) Risk Profile - Probability demo
<15% size growth>

Assurance Level (%)	Life Duration (Months)
1	7.83
5	8.51
10	8.88
15	9.12
20	9.32
25	9.48
30	9.63
35	9.77
40	9.91
45	10.03
50	10.16
55	10.2
60	10.41
65	10.55
70	10.69
75	10.84
80	11.00
85	11.20

Life Effort (PM) Risk Profile - Probability demo
<15% size growth>

Assurance Level (%)	Life Effort (PM)
1	0.00
5	8.61
10	16.76
15	22.27
20	26.64
25	30.39
30	33.76
35	36.89
40	39.85
45	42.71
50	45.52
55	48.33
60	51.19
65	54.15
70	57.28
75	60.65
80	64.40
85	68.77

Project Probability Demo

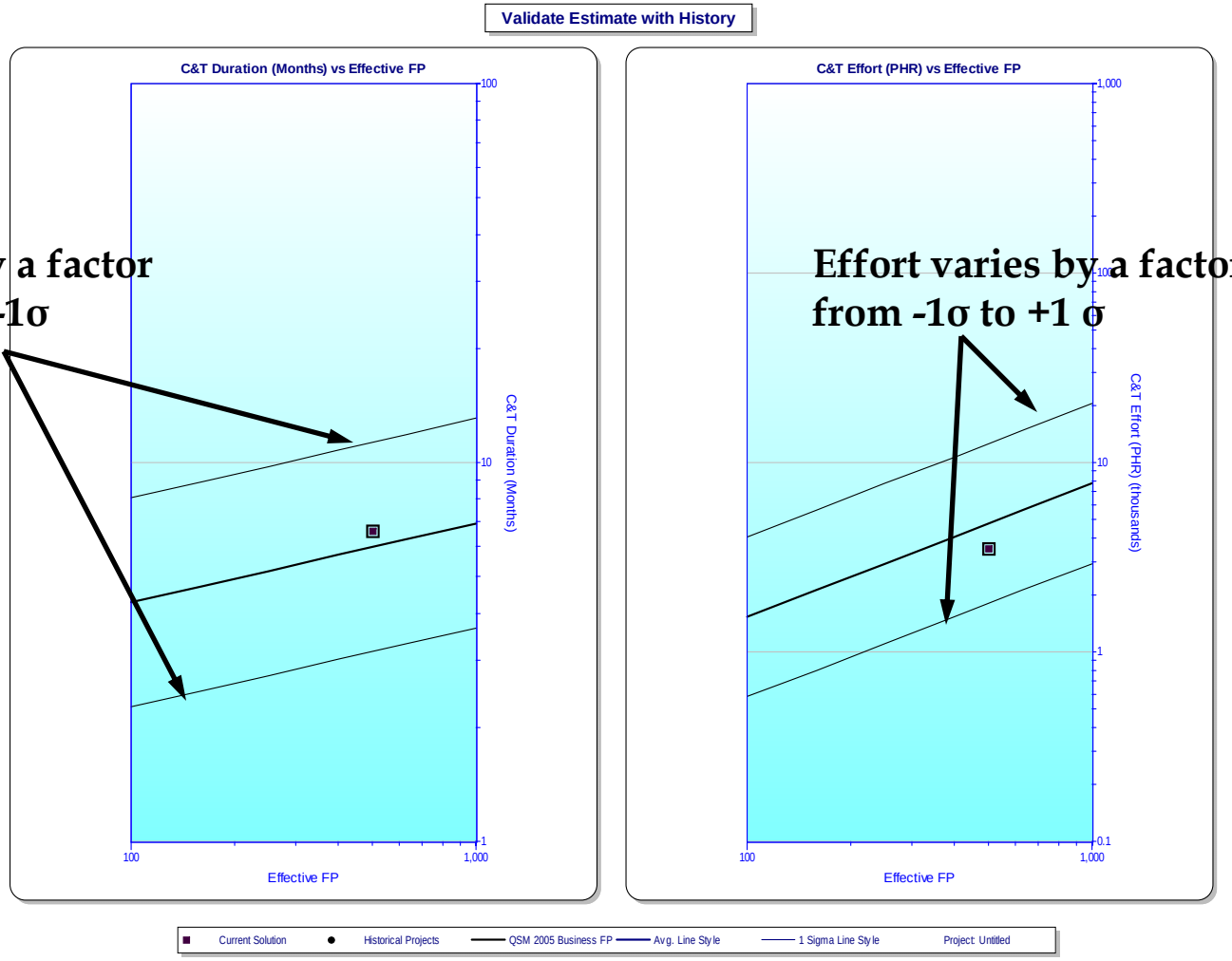
Averages close to numbers predicted for effort and schedule growth (10.2 duration and 43 staff months of effort)

QSM The Intelligence behind Successful Software Projects

Staffing & Schedule

Schedule varies by a factor of 3.5 from +1σ to -1σ

Effort varies by a factor of 8 from -1σ to +1 σ



What is "normal" variability?

How Should Project Effort Be Expended A Case Study

- 838 projects that had data reported for Analysis/Design as well as Construction and Test phases
- Average Effort applied to Analysis/Design = 20%
- 474 projects in the sample used <= 20% analysis/design effort
  - Average Analysis/Design Effort = 11%
- 364 projects in the sample used > 20% analysis/design effort
  - Average Analysis/Design Effort = 33%
- Size profiles of samples very similar

Observations

- **Projects with <20% effort in Requirements and Design**
  - **Took 12% longer to complete**
  - **Averaged 5.6% more effort (median 24.4% greater)**
  - **Had an average staff 14.6% higher**
- **But these projects did excel at one thing:**
  - **Found 63.7% more defects in systems test**
  - **Had 127% more defects in the first 12 months after delivery**

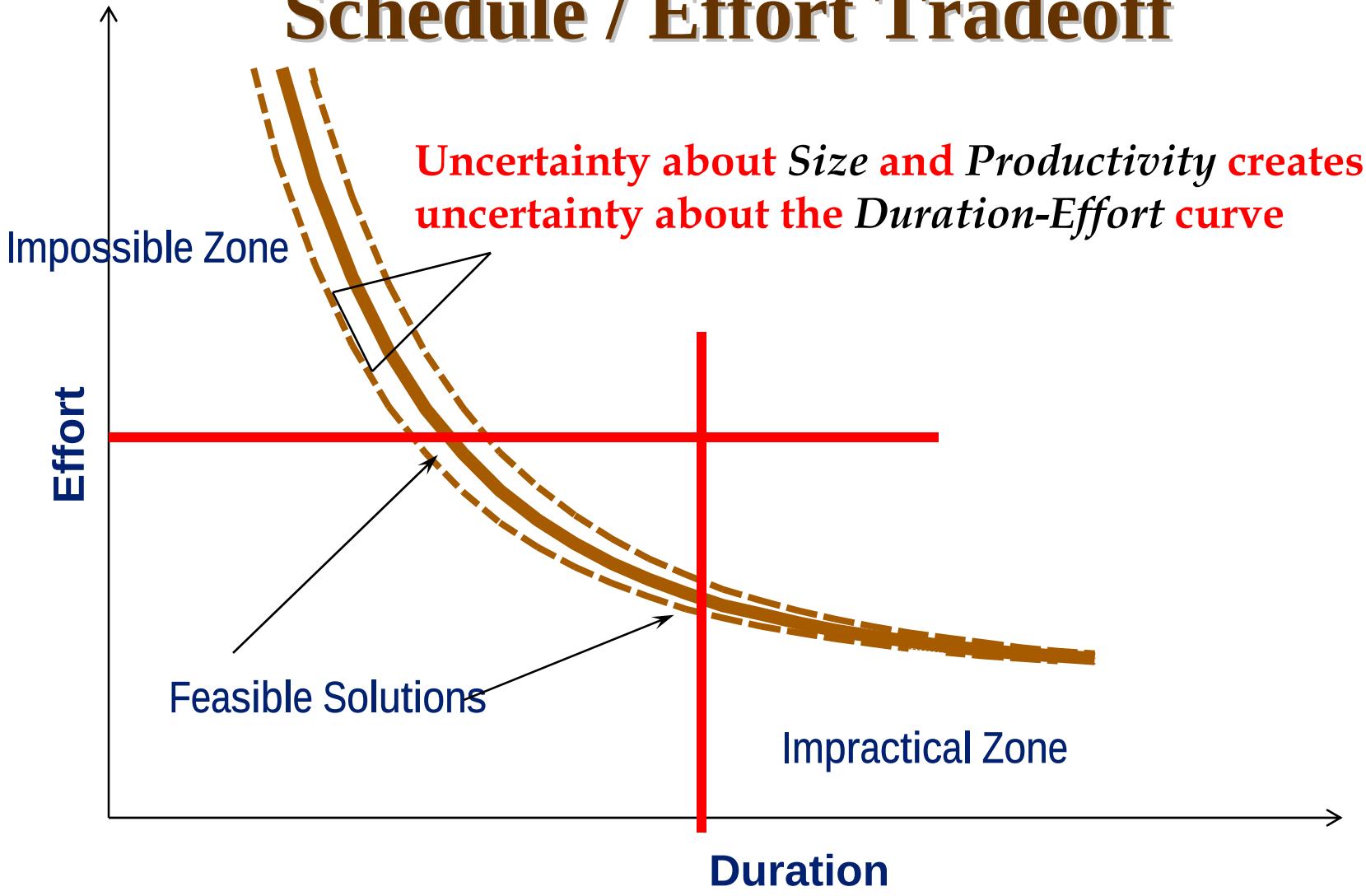
Understanding Trade-offs

$$\text{Size} = \text{Effort}^{a} \times \text{Time}^{b} \times \text{Productivity}$$

where $a = \frac{1}{3}$ and $b = \frac{4}{3}$

Additional schedule has a much larger impact on a software project than increased effort

The Estimating Conundrum
Schedule / Effort Tradeoff



Conclusions

- **Measurement is an integral part of management**
- **Information required to make precise estimates is unavailable at project start-up**
  - **Estimate uncertainty decreases rapidly with more information**
- **Project estimates historically understate effort, schedule, & size**
  - **Estimating based on a larger size or at a higher assurance level can account for this**
- **The trade-off between schedule & cost/effort is non-linear**

Conclusions

- **Effort spent in Analysis & Design pays big dividends**
  - **Reduces overall project effort (cost$$$$)**
  - **Reduces overall project schedule**
  - **Improves project quality**

Questions
?

