Pratt & Whitney Canada

A United Technologies Company

Project Management (PM):

Towards Right Task Sizing for Higher Added Value Product Development (PD) Production System

Yvan Beauregard PhD, Ing, MBA, PMP, AVS

AGENDA

- Importance of Research
- Objectives
- Literature Review
- Engineering Job Sizing Models
- Results
- Conclusion & Future Work

IMPORTANCE OF RESEARCH

1. Aerospace is an extremely competitive industry.

2. Most important factor to improve in product development (PD) is flow of information.

3. Opportunities do exist for improvement.

OBJECTIVES OF THIS RESEARCH

- Improve flow in product development (PD):
  - Develop economic Design quantity (EDQ) analytical model and incorporate relevant factors.
  - Leverage discrete event simulation modelling that ascertained key factors influencing PD performance.
  - Leverage lean engineering PD performance model previously published.

A MAJOR CANADIAN EMPLOYER

P&WC KEY BUSINESS SEGMENTS

Corporate

Cessna Sovereign

Dassault F7X

General aviation

Hawker Beechcraft King Air 350

Embraer Phenom100

Regional

ATR 72

Bombardier Q400

Civil helicopters

AgustaWestland AW139

Eurocopter EC135

Military

Hawker Beechcraft T-6A JPATS

Embraer Super Tucano EMB-314

Aftermarket

Customer First Centre

Maintenance, Repair and Overhaul

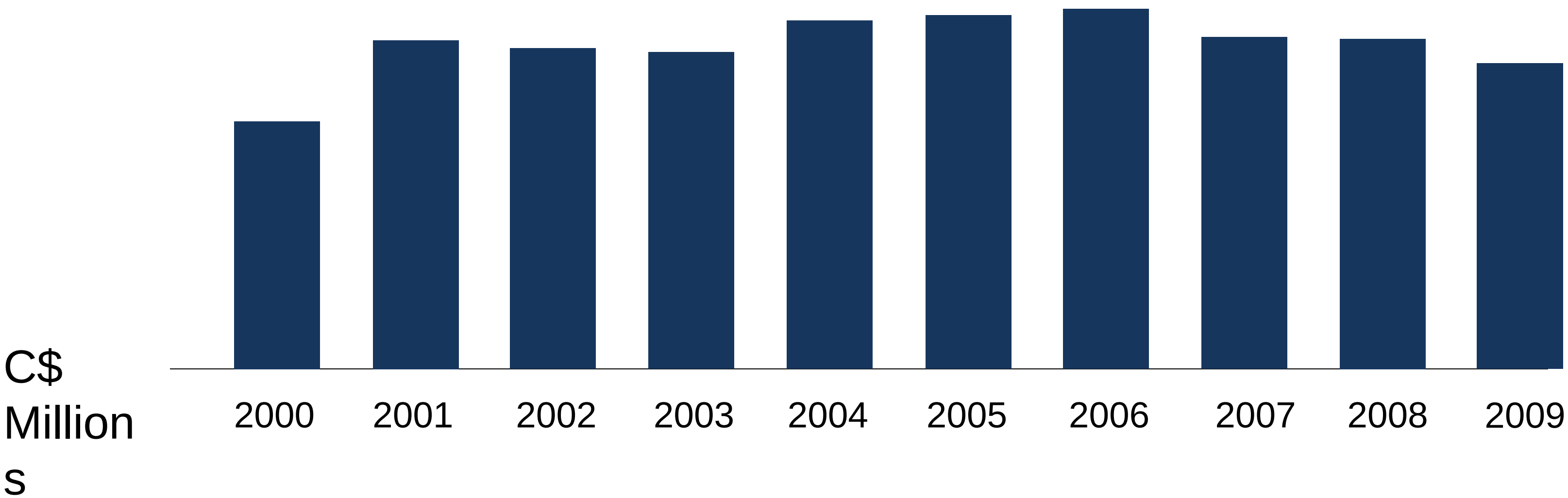
NUMBER 1 R&D INVESTOR

In Canadian aerospace

Top five in Canada overall (all industries)

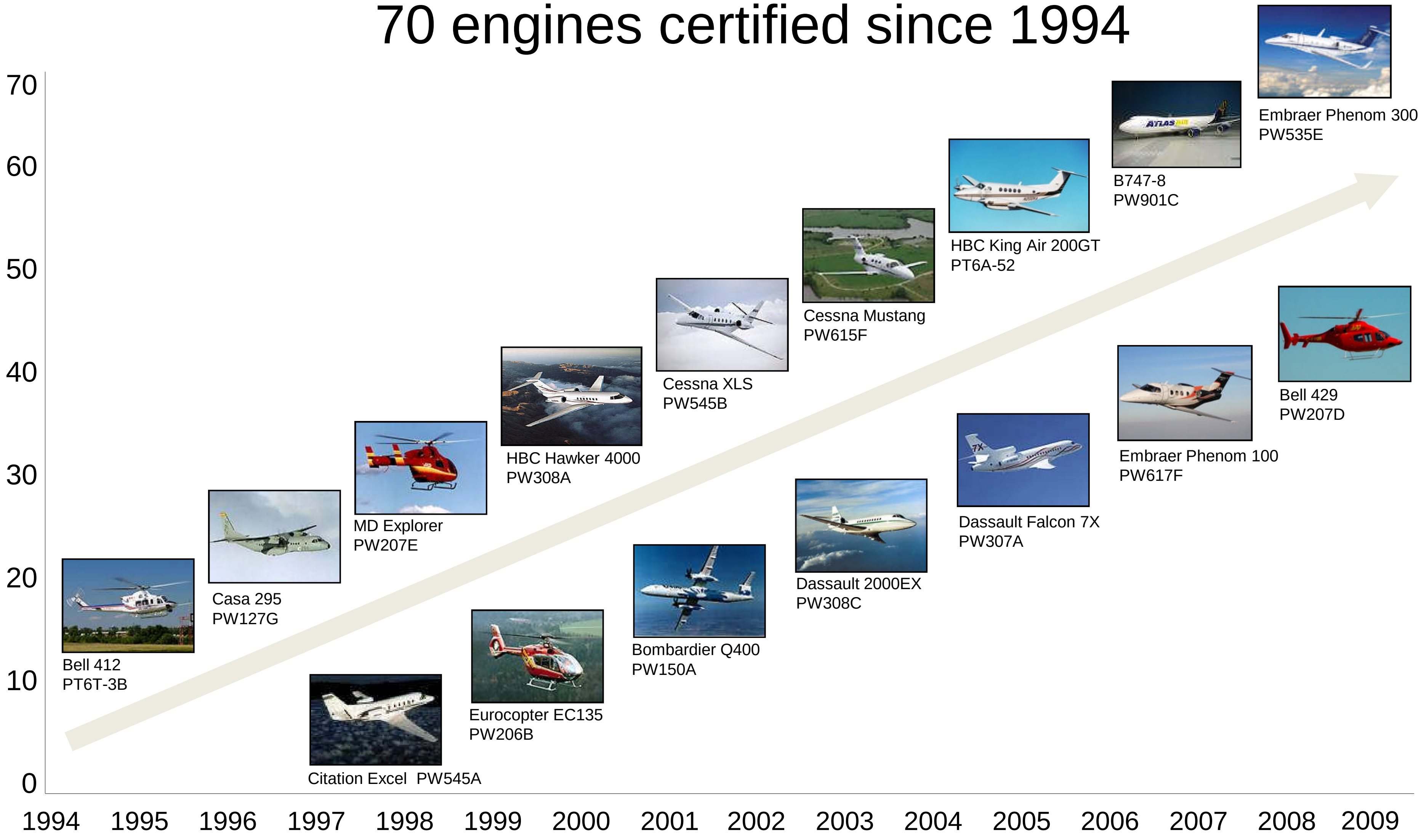
50% of aerospace R&D in Canada

Over 1,300 engineers in Canada



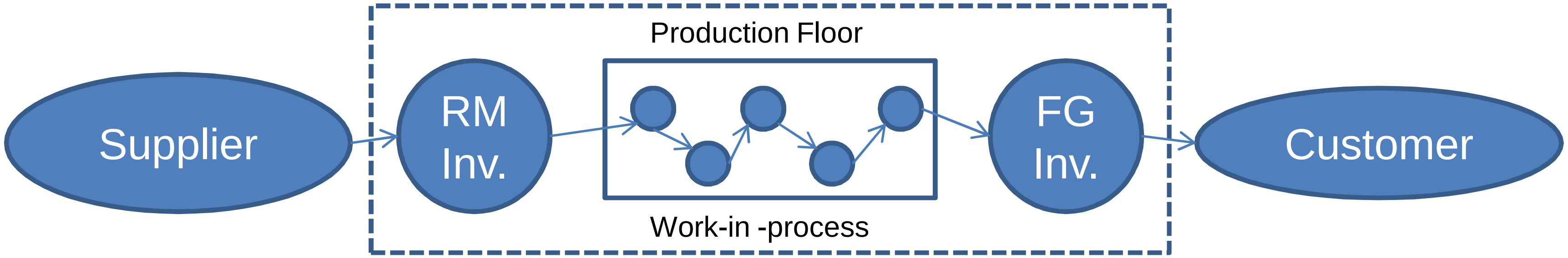
SUSTAINED R&D INVESTMENT

70 engines certified since 1994

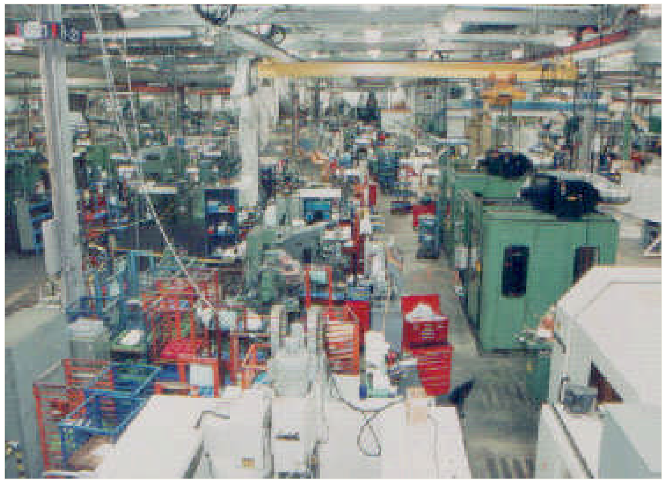


Production System

Anything that takes input and transform them into output with inherent value (Sipper and Bulfin, 1997).



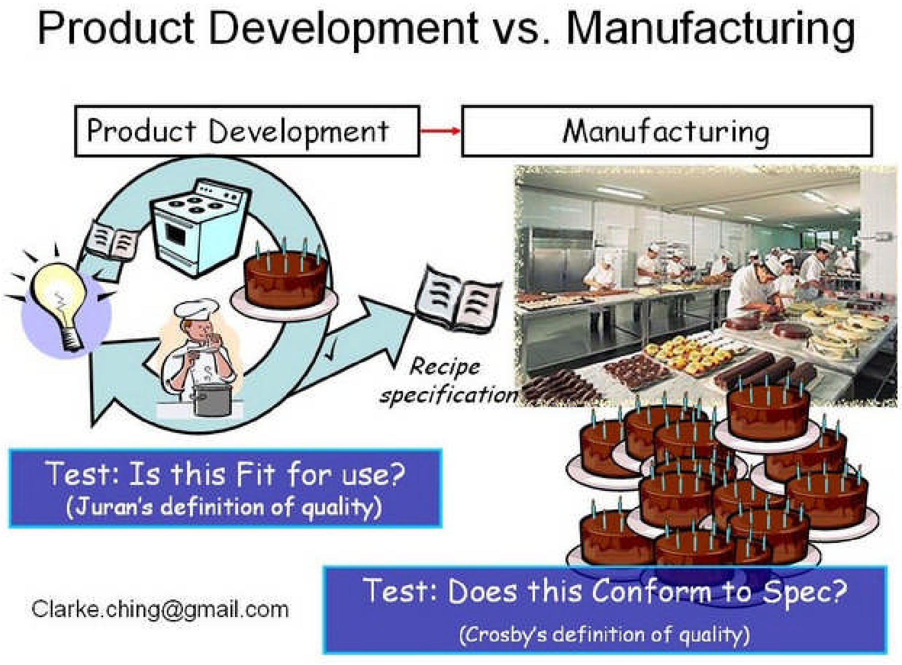
Physical →Intellectual



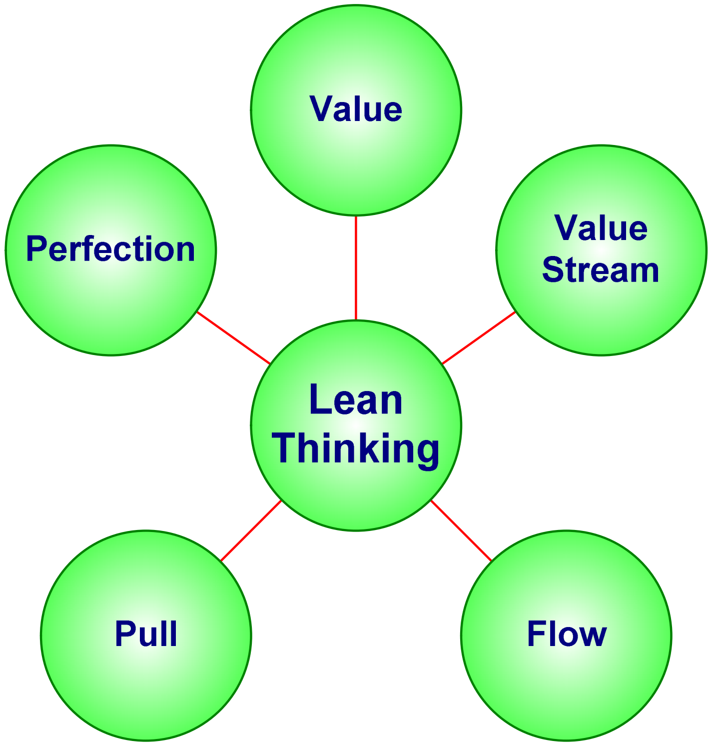
Product Development

Set of activities beginning with perception of market opportunity and ending with the production, sale and delivery of a product (Ulrich and Eppinger, 2004).

"A process of eliminating the uncertainty about the product" (Browning, 2000). → *Hence importance of improving flow of information*



Lean Principles



Lean Thinking (Womack and Jones, 2003):

<u>Value</u> – Ensuring that added-value is defined from the customer's perspective

Value stream – Ends with the customer

<u>Flow</u> – Consistent identification and elimination of barriers to workflow, Reduce waste, enable value to flow

Pull – Use of Kanbans, Supermarkets, etc

<u>Perfection</u> - A culture of continuous improvement.

Toyota Product Development System (Morgan and Liker, 2006):

<u>1-Value</u> – Establish customer defined value to separate value added from waste

<u>3- Flow</u> – Create a leveled product development process flow

<u>10- Perfection</u> – Build a culture to support excellence and relentless improvement.

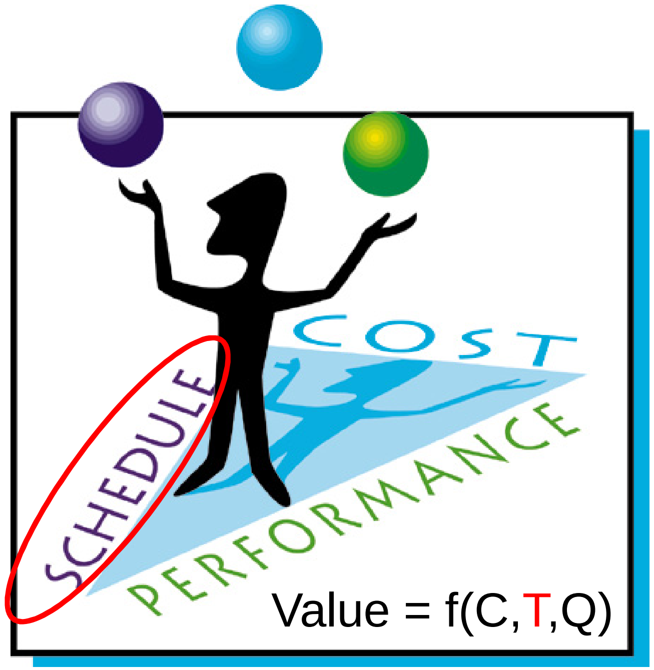
Improving Information Flow

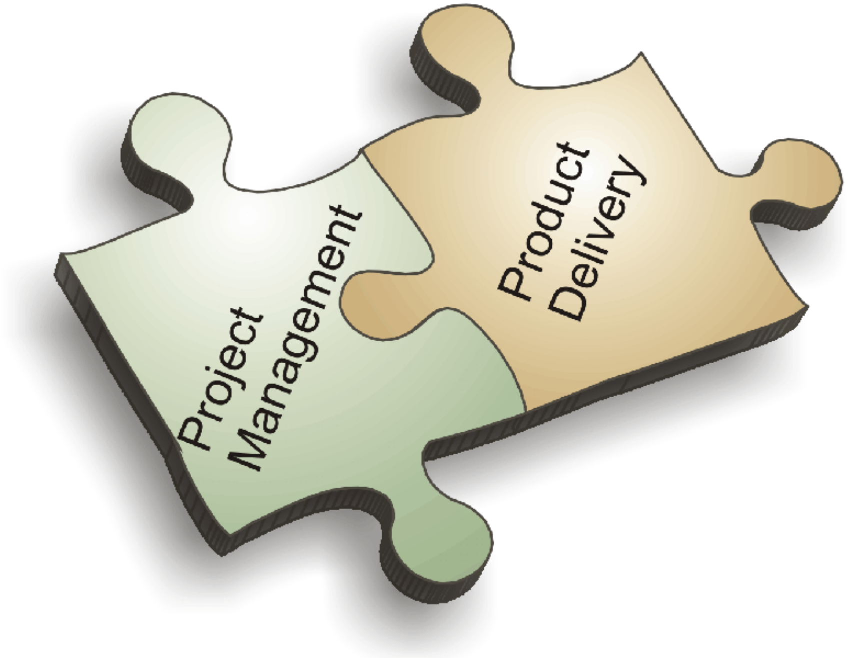
- PD Information Value:
  - Timeliness, Uncertainty Reduction, Business Impact, Customer Impact, etc
- Development Lead Time:
  - Task size, Utilization, Multitasking, Concurrency
- Little's Law:
  - Intellectual Work in Progress = Demand x Development Lead time

Project Management

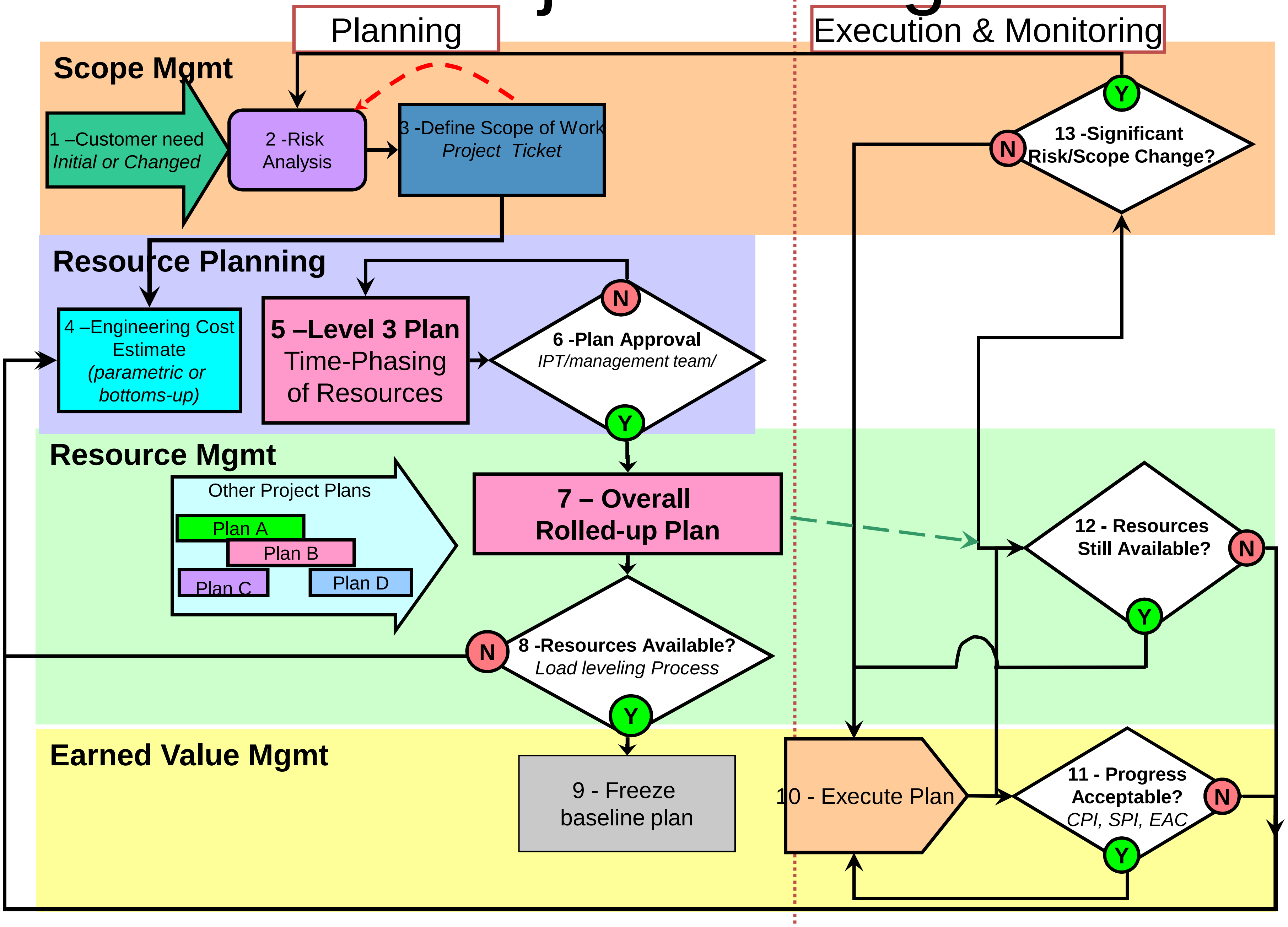
Project: *Temporary endeavor undertaken to create a unique product, service or result (PMI, 2008).*

Project Management (PM): *Application of knowledge, skills, tools and techniques to project activities to meet the project requirement (PMI, 2008).*





P&WC Project Management



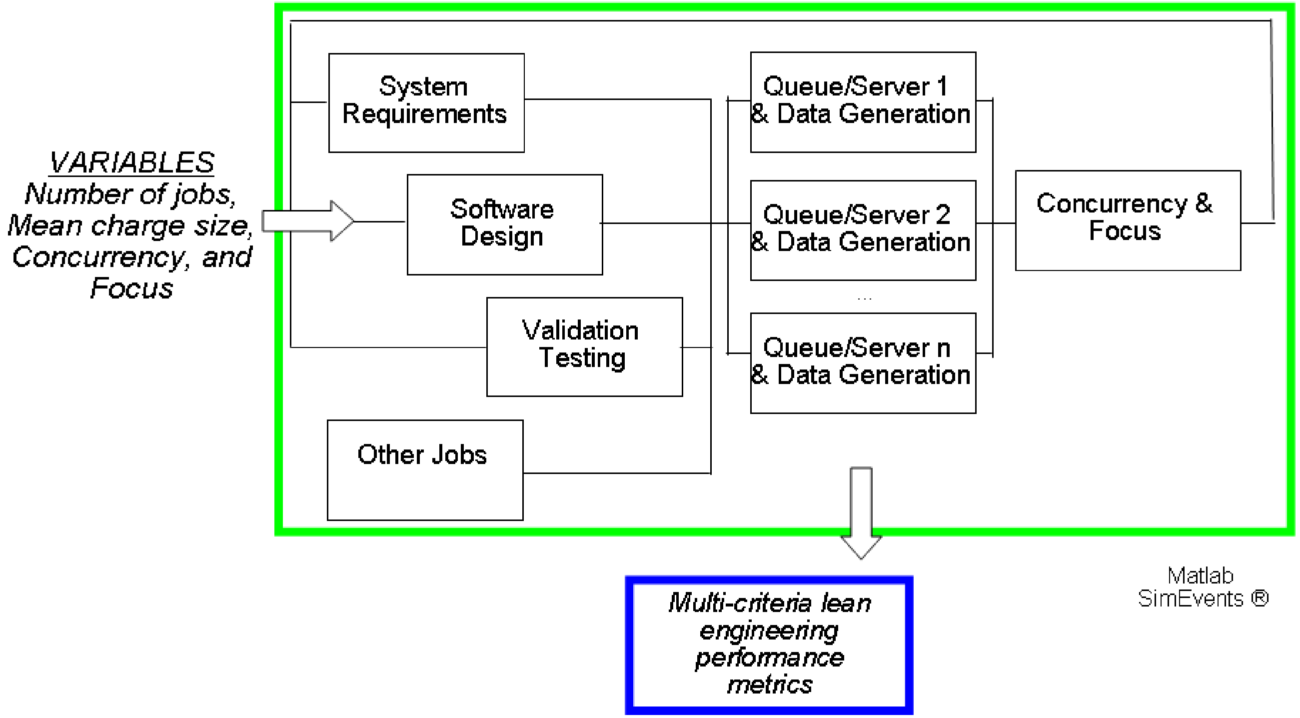
LITERATURE REVIEW – JOB SIZING

- Arguments for an appropriately sized engineering job (Raz, Globerson,1998):
  - "Reduced estimation error, clearer ownership, enhanced progress control, easier network construction", etc...

- "Need to determine an appropriately sized work breakdown structure" to improve flow (Storch, 1999).

- Call for "application of batch size reduction techniques and queue management principles to PD" (Reinersten, 2007).

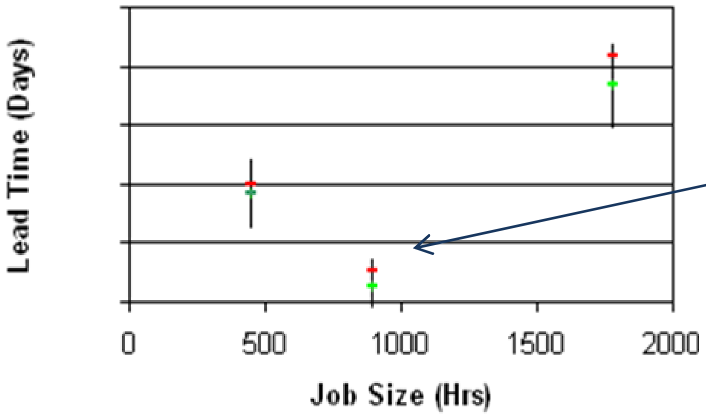
JOB SIZING MODEL - SIMULATION



- DES, DOE & Anova → task size, concurrency and focus key factors influencing lead time.

JOB SIZING RESULTS - SIMULATION

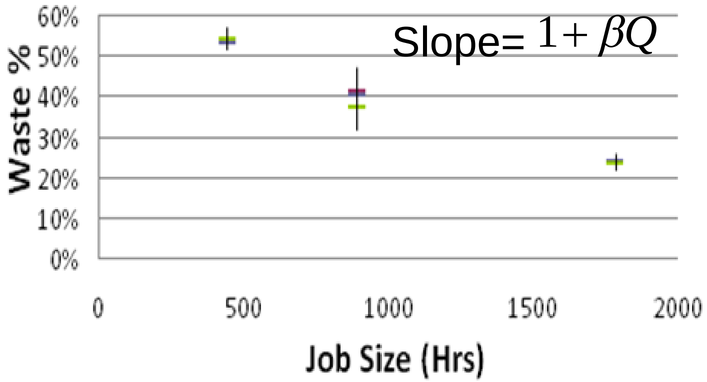
Discrete Event Simulation



Convex relationship: average lead time to task size

Optimal PD job size?

3 replications at each level
5 to 7% error at 3 sigma



Decreasing relationship: average percent waste to task size

3 replications at each level
1 to 3% error at 3 sigma

EDQ MODEL - OPTIMAL TASK SIZE

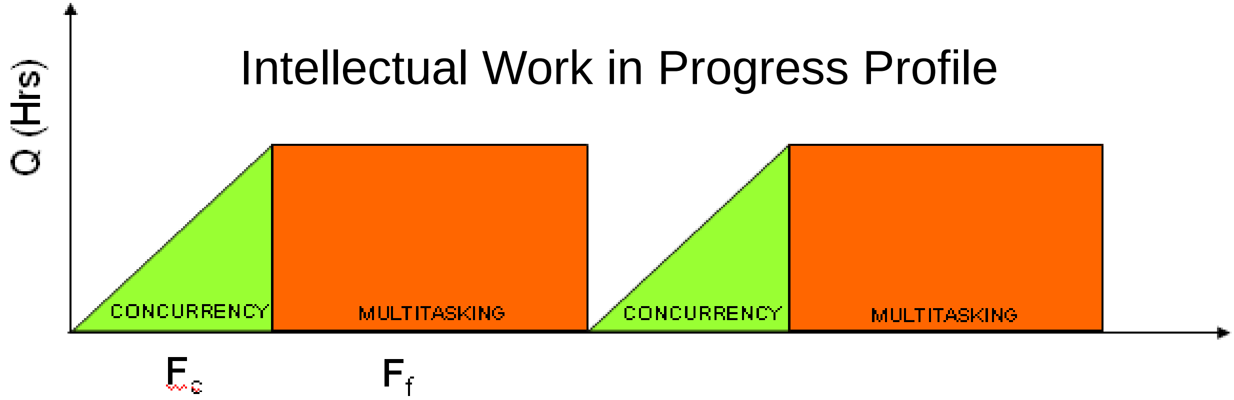
Total Relevant Cost

$$TRC(Q) = \frac{AD}{Q} + \frac{Qvr[(\frac{1}{n} - 1)c + 1]}{2} + Qvr[(\frac{1}{n} - 1)c + 1](\frac{1}{f} - 1) + vDcw + vD[1 + \beta Q])$$

Optimal PD task Size

$$Q^* = \frac{dTRC(Q)}{dQ} \longrightarrow Q^* = \sqrt{\frac{2AD}{\{vr[(\frac{1}{n} - 1)c + 1](\frac{2}{f} - 1)\} + 2vD\beta}}$$

EDQ TOTAL RELEVANT COST (TRC)



Term	Description
$\frac{AD}{Q}$	Administrative setup cost
$\frac{Qvr[(\frac{1}{n}-1)c+1]}{2}$	Concurrency IWIP illustrated in green
$Qvr[(\frac{1}{n}-1)c+1](\frac{1}{f}-1)$	Multitasking IWIP illustrated in red
$vDcw$	Cost of waste rework due to concurrency
$vD[1+\beta Q]$	Restart and wasted setup cost from DES model

IWIP: Intellectual Work in Progress

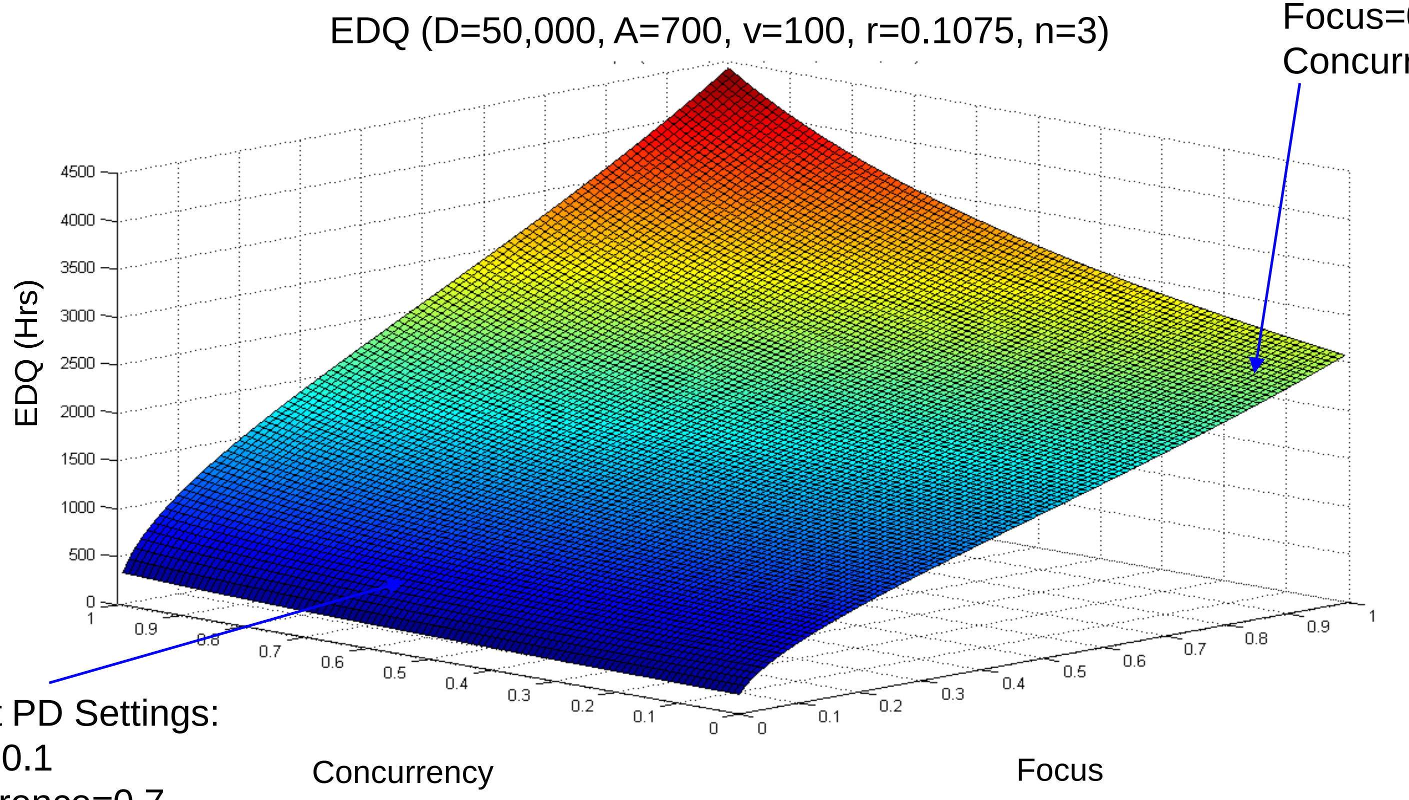
EDQ, TRC MODELS & ASSUMPTIONS

Factor	**Description**
Yearly Demand (D)	Continuous and constant over infinite time horizon
Administrative Setup (A)	Incurred during engineering job lifecycle
Hourly Rate (v)	Similar rate for all core engineering groups
Carrying and obsolescence factor (r)	Includes the opportunity cost associated with intellectual inventory, cost of borrowing money, and obsolescence
Number of Phases (n)	PD system characterized by n phases operating somewhat concurrently
Focus (f)	Ratio of studied value stream charged hours over total hours charged by employees
Waste rework (w)	Influenced in a linear fashion by concurrency level (c)
Waste percent (β)	Setups, restart and wasted setups observed in DES model.
Project task size (Q)	Project deliverables can be combined to correspond to EDQ model optimal job size

Q* - OPTIMAL TASK SIZE SURFACE

Economic Design Quantity

Alternative PD Settings:
Focus=0.9
Concurrence=0.1

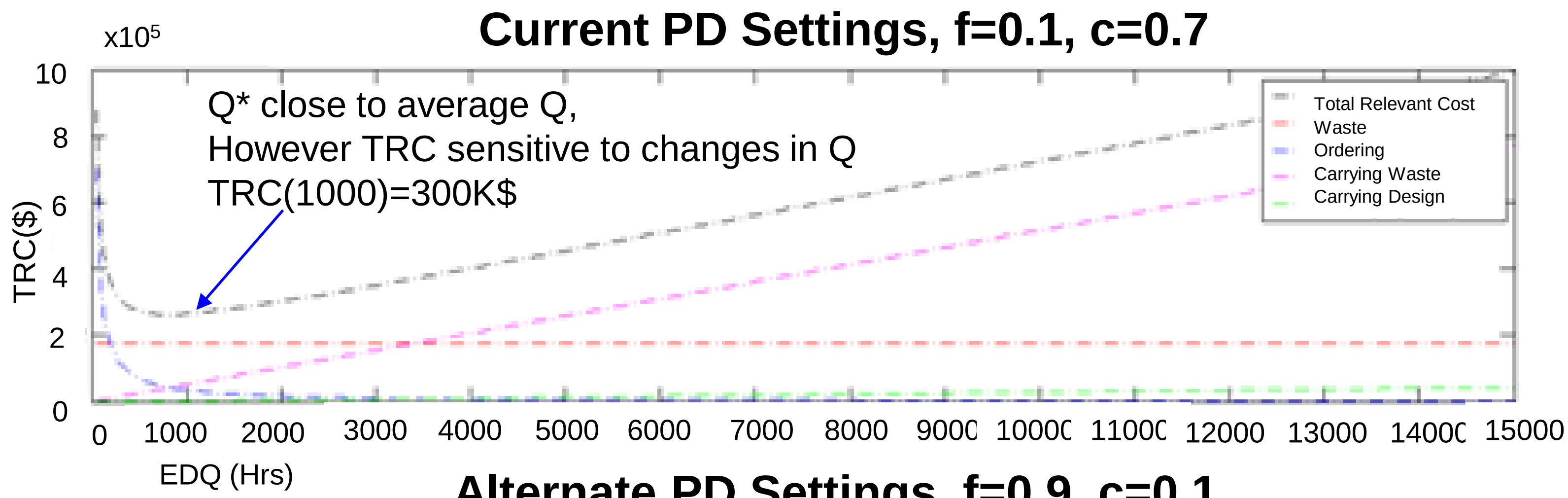


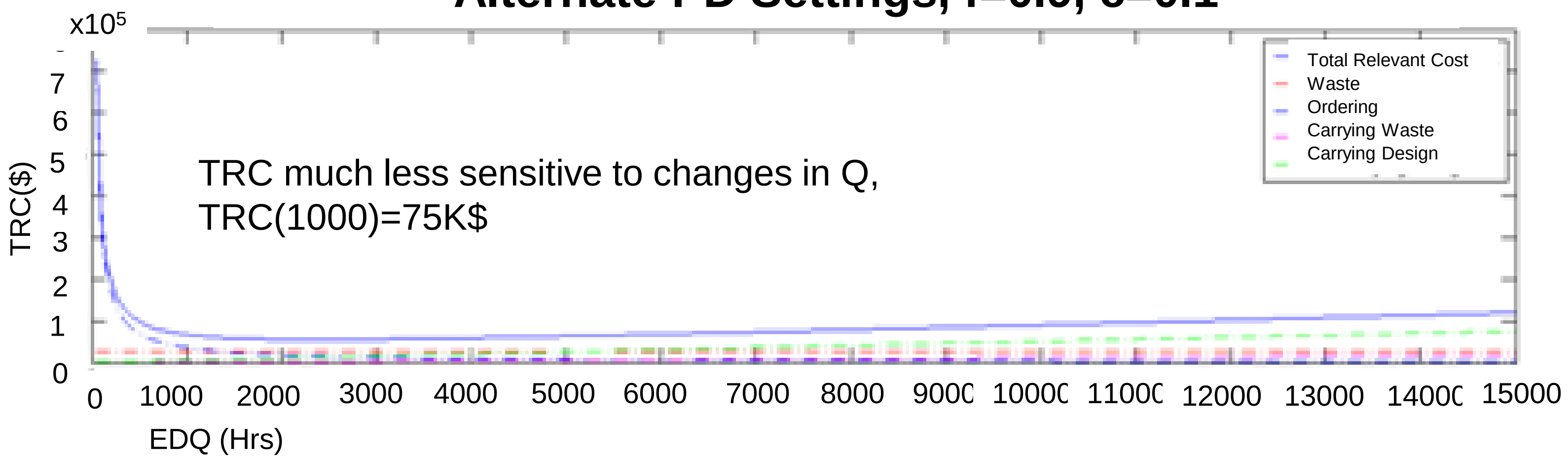
Current PD Settings:
Focus=0.1
Concurrence=0.7

Joint use of EDQ and DES for optimum job size and determination of number of jobs in the PD system for span time reduction.

TOTAL RELEVANT COST COMPARISON

TRC vs Job Size





CONCLUSION

- Most important factor to improve in PD is flow of information.
- Job size influences PD system lead time performance
- TRC model enables evaluation of alternative engineering task management policies, including concurrency and focus settings.
- EDQ model enables determination of optimal job size for given settings of focus and concurrency.
- Work performed in this research supports establishment of system level PD task management policy to optimize flow of information, and improve PD competitiveness.
- Incorporate in TRC model Markov chain based correction factor to address non-linear relationship between utilization and lead time claimed by Preston (2007).

Future Work

What is the optimum level of multitasking and utilization in PD system for improved performance?

- McCollum and Sherman, 1991
  - Failed to validate that 'fewer project assignment to R&D personnel will result in higher performance level.
- 'Wheelwright and Clark, 1992
  - As the number of projects increases above one, productivity rises and then falls
- Aral and Brynjolfsson and Van Alstyne, 2007
  - An inverted U shape relationship between multitasking and productivity such that beyond an optimum more multitasking is associated with declining project completion rates

PRATT & WHITNEY

DEPENDABLE ENGINES