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TFDEA: A New Approach for Technology Forecasting of New Product Development Targets

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TFDEA: A New Approach for Technology Forecasting of New Product Development Targets

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Veritas, Inc.

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Portland State University

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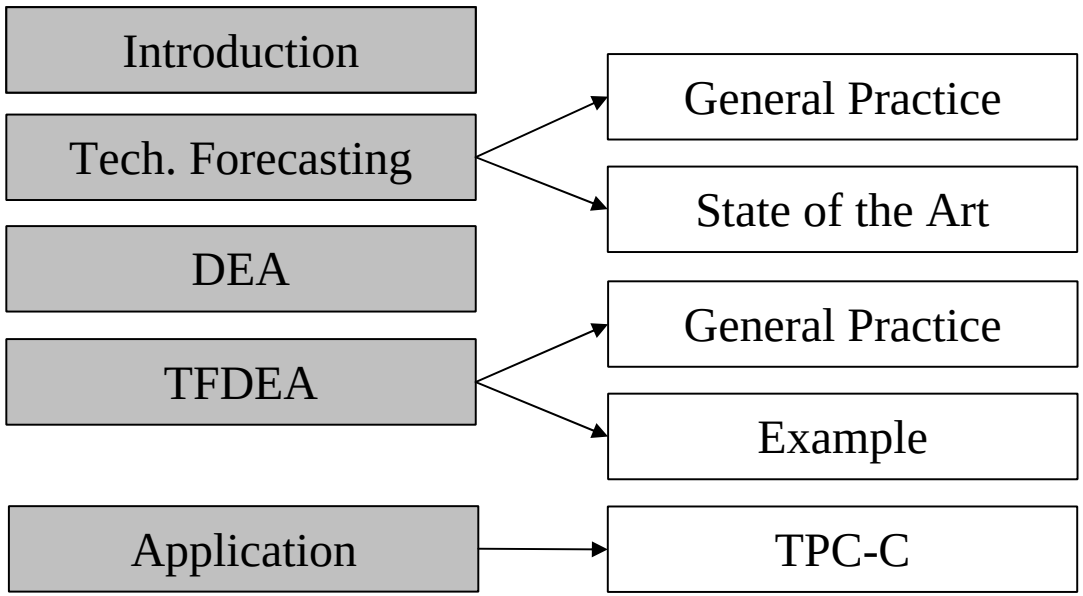
Presentation Flow



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Introduction

- *GAP1: Current quantitative technology forecasting techniques do not handle variable trade-offs.*
- *GAP2: Current DEA tools do not handle single occurrence DMUs with variable time periods.*

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Research Objectives

- Methodology:
  - Develop a methodology for technology forecasting which provides a robust means to measure the SOA and its progress by extending current temporal DEA to allow for DMUs which are introduced only once at irregular intervals.
- Application:
  - Apply the methodology to a straight forward real world application.

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Technology Forecasting

- ***What is technology forecasting?***
  - ***"to predict the future characteristics of a useful machine"***
- ***What's a machine?***
  - ***Not only physical devices, but tools, techniques and procedures that provide some function to an end-user.***

J. P. Martino, "Technological Forecasting for the Chemical Process Industries," Chemical Engineering, pp. 54-62, 1971.

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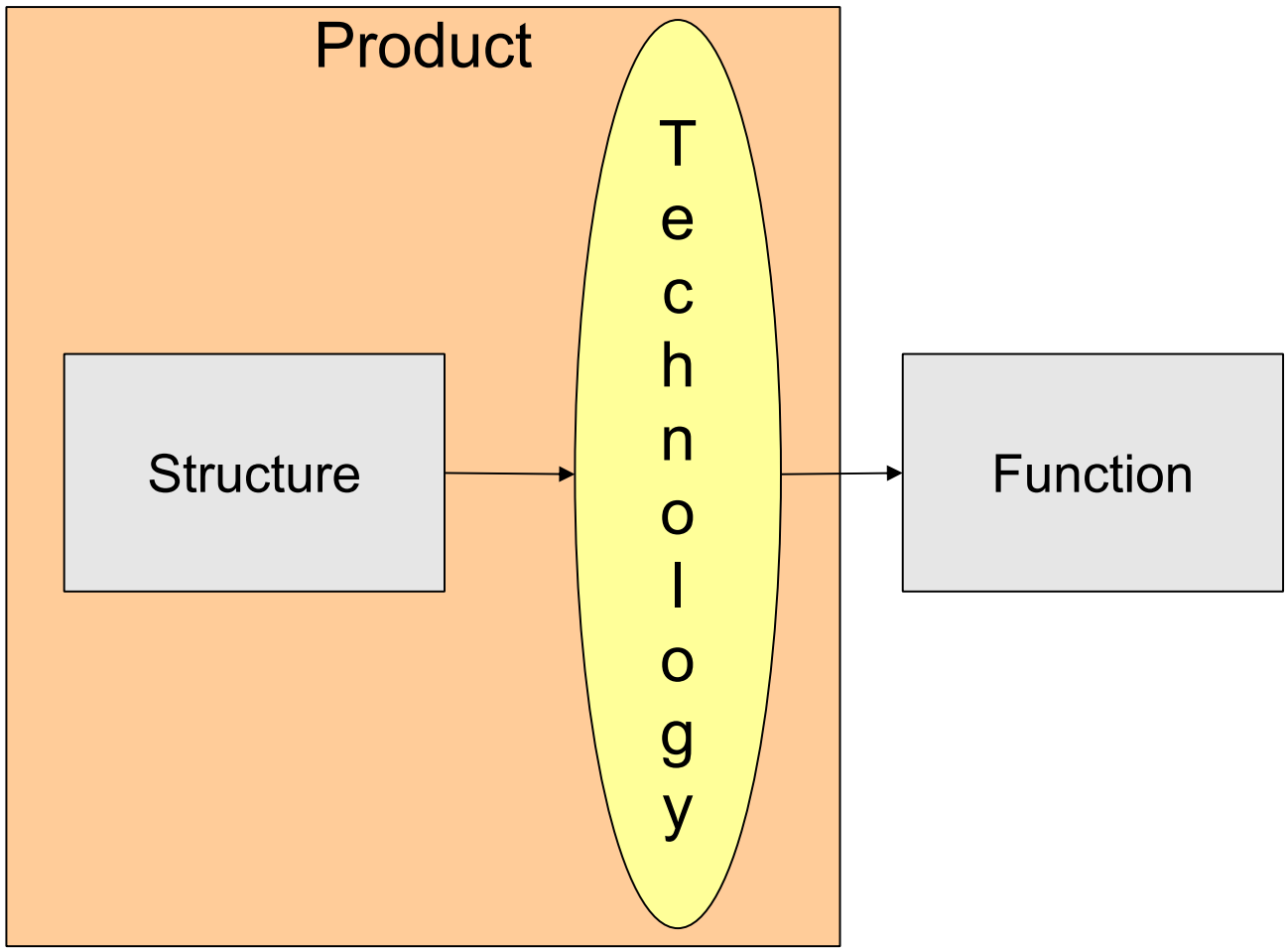
What is technology?



*Knight '74

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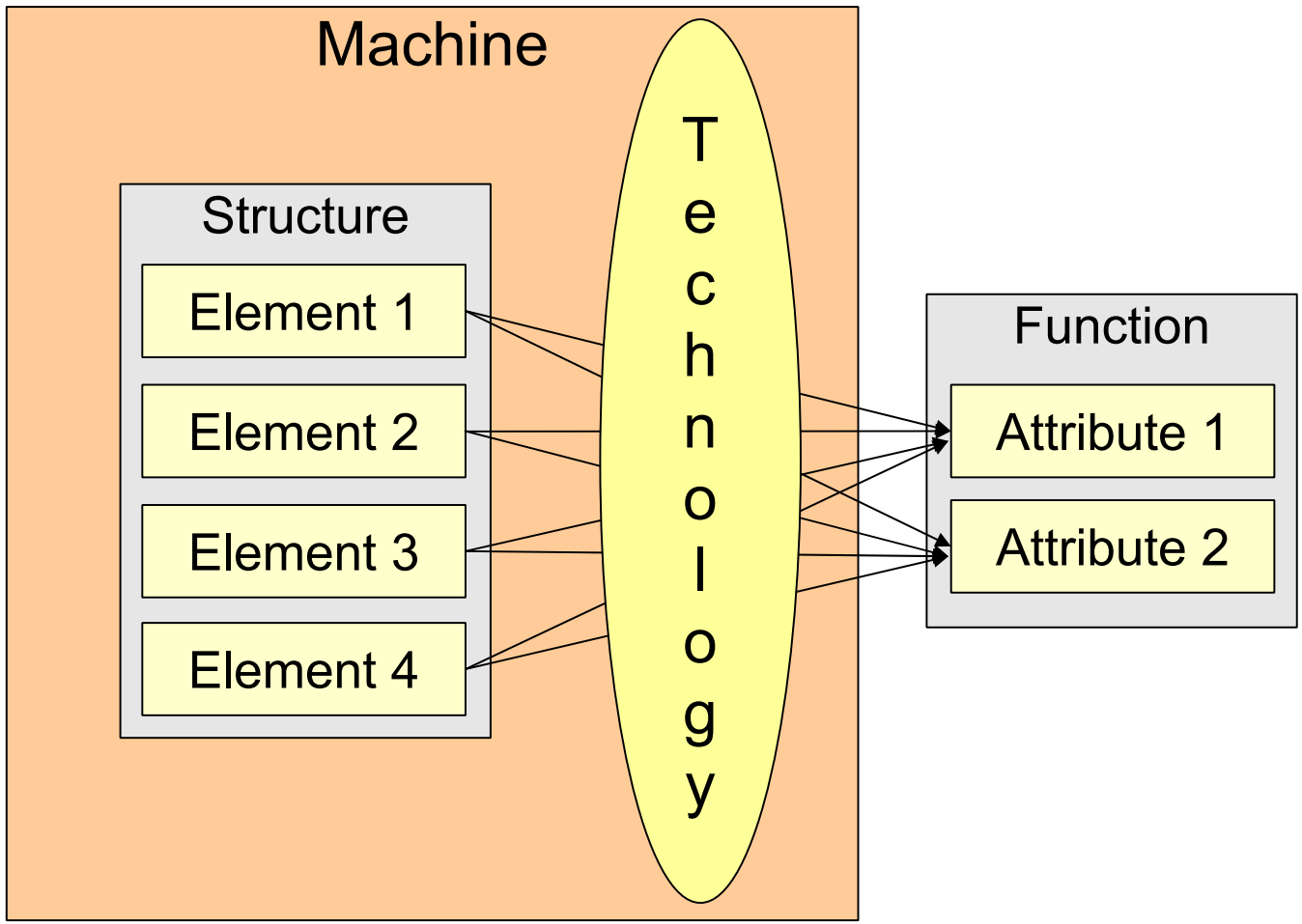
What is technology, really?



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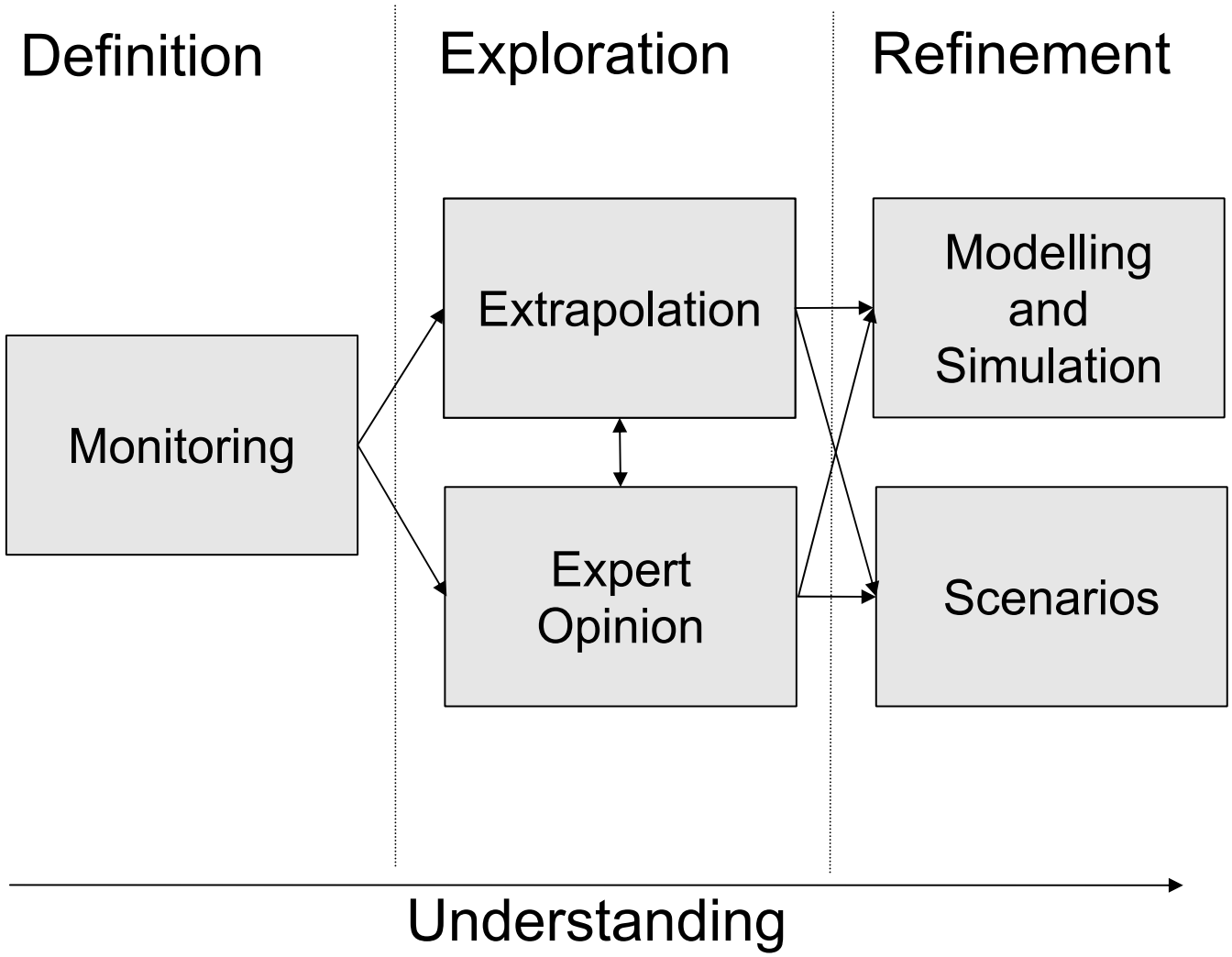
How is it currently done?



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What are the challenges?

- *It is difficult to assign a single attribute to the measurement of a technology.*
- Typically only addresses a technological approach not a single technology.

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How are these challenges addressed?

- *State Of the Art (SOA)*

"The best implemented technology as reflected by the physical and performance characteristics actually achieved during the time period in question"

–Dodson, TFSC 1 1970

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How can SOA be used?

- *Given that technology is never better than State-of-the-Art, an index may be used to measure relative to the SOA.*
- *Over time a products technology index will change – tracking that change will allow for future predictions.*

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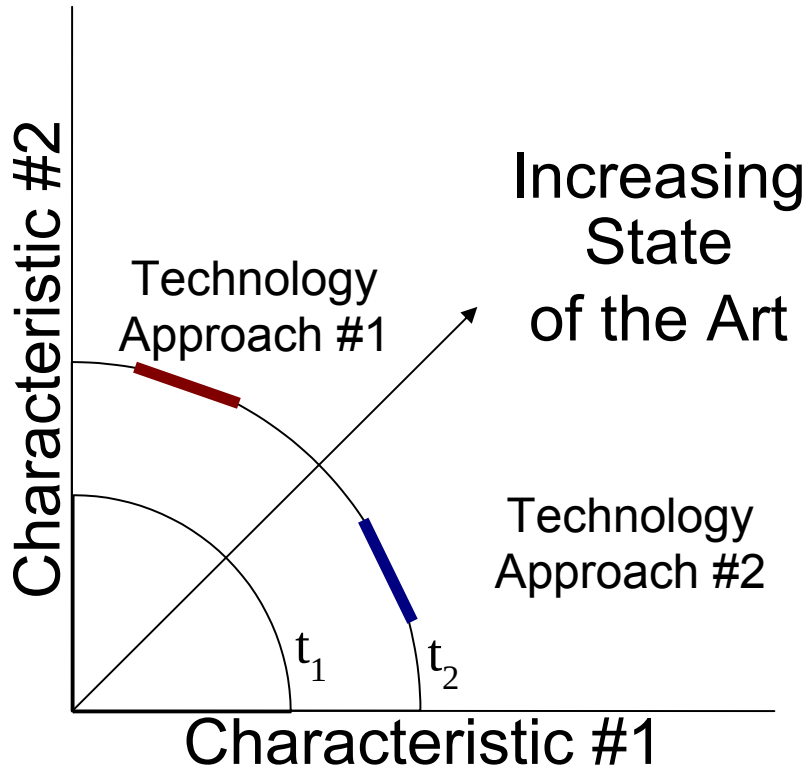
What is the SOA?



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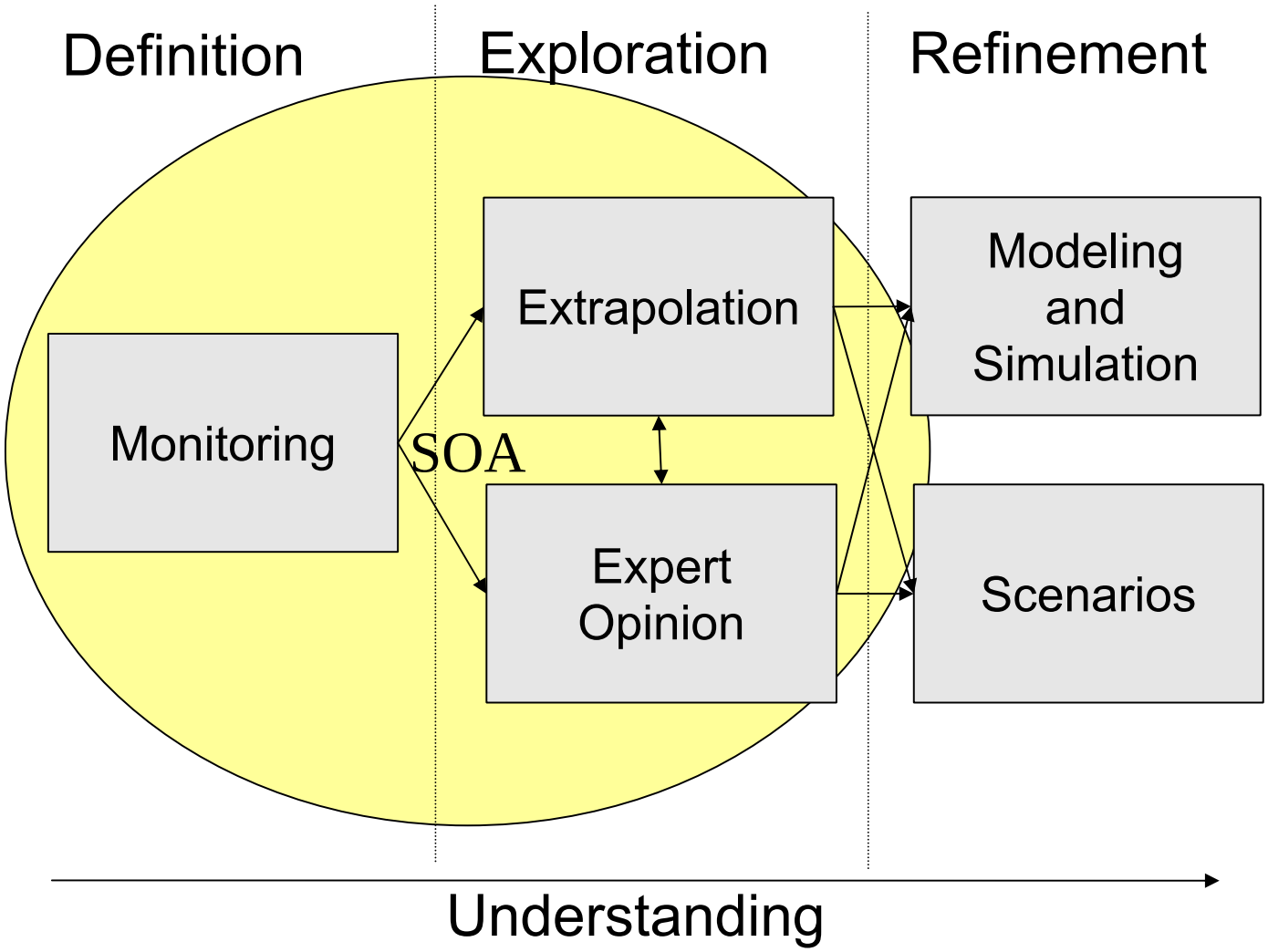
Where does SOA fit?



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Steps to Forecast SOA

T. J. Gordon and T. R. Munson, "A Proposed Convention for Measuring the State of Art of Products or Processes," *Technological Forecasting and Social Change*, vol. 2 pp. 1-26, 1981.

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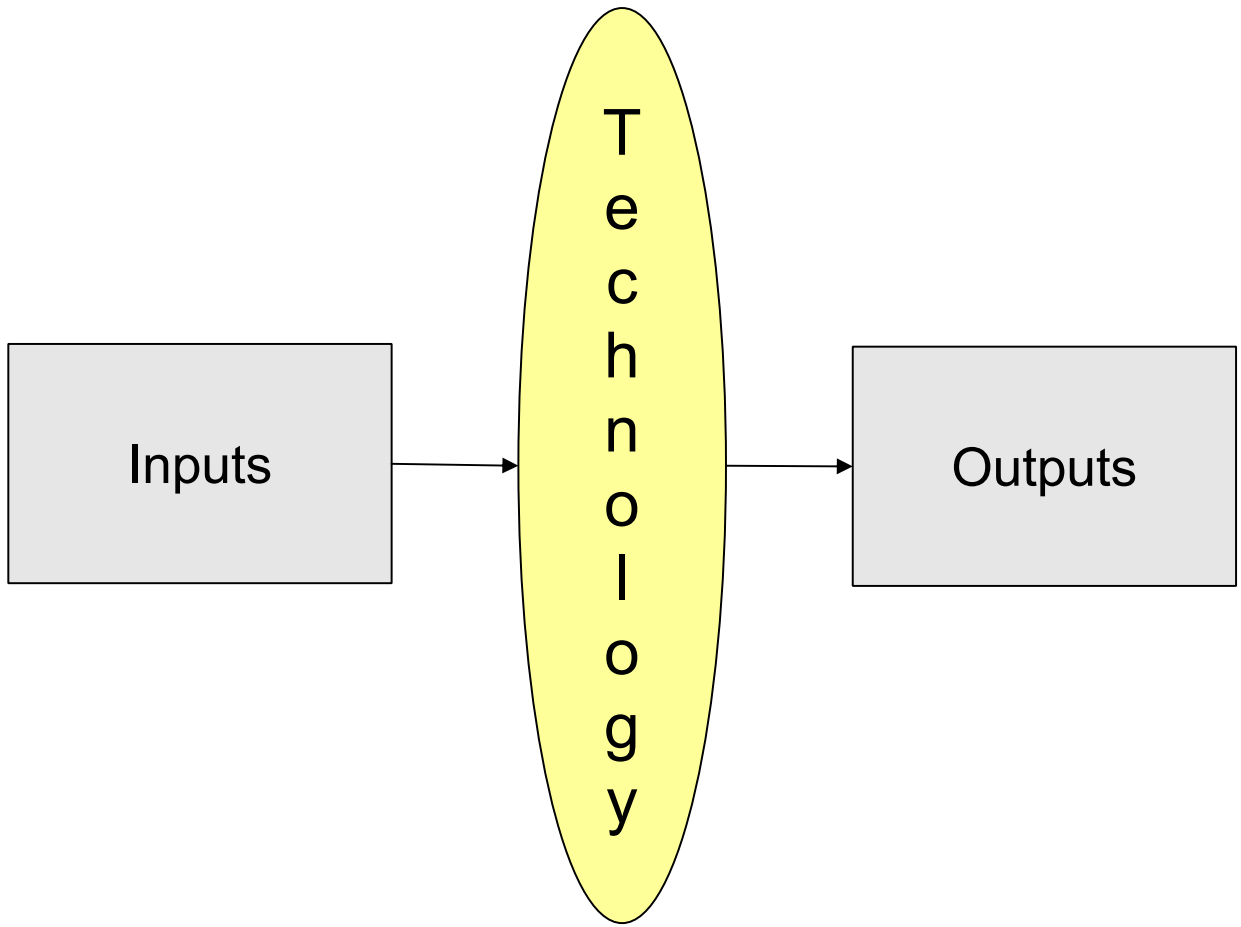
What does DEA measure?



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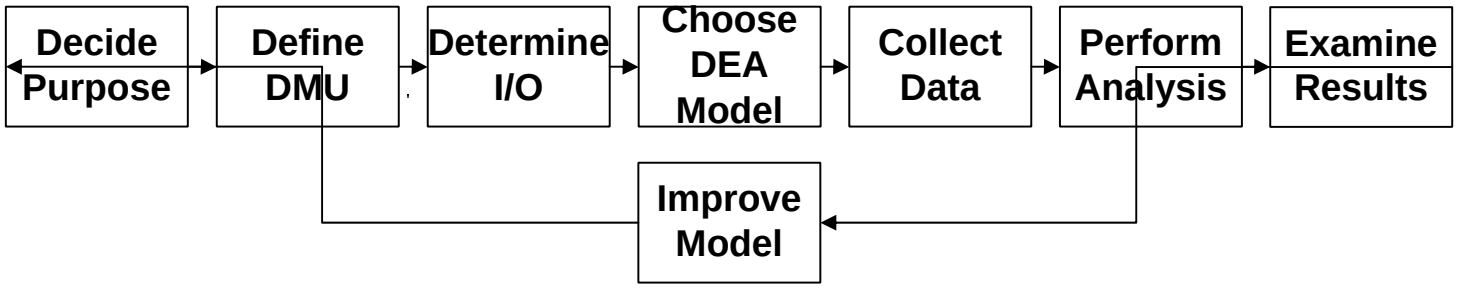
Steps For DEA



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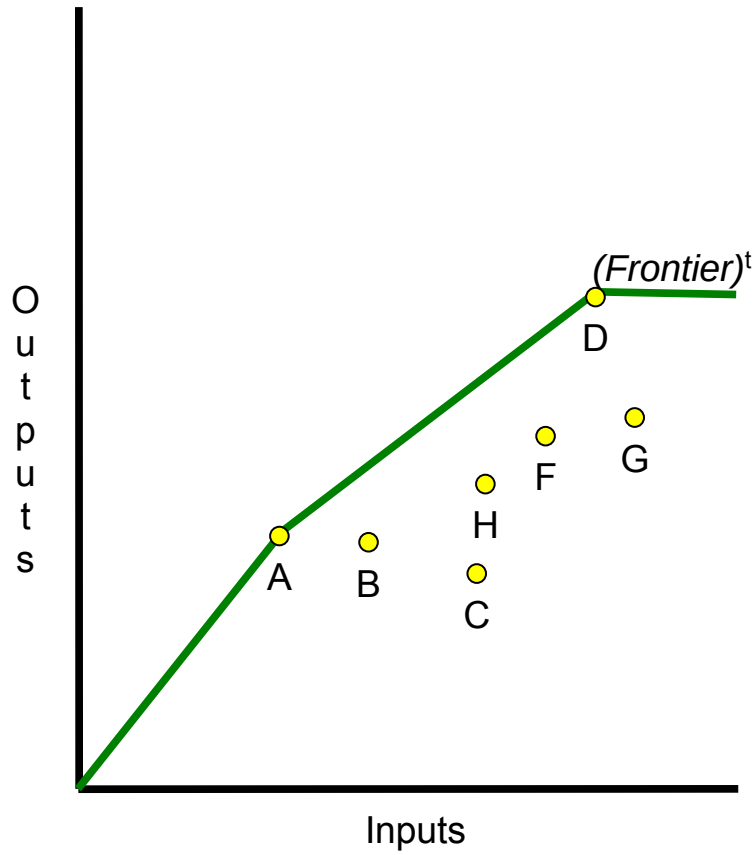
Data Envelopment Analysis



- Builds an efficiency envelope relative to its peers (extreme-point method)

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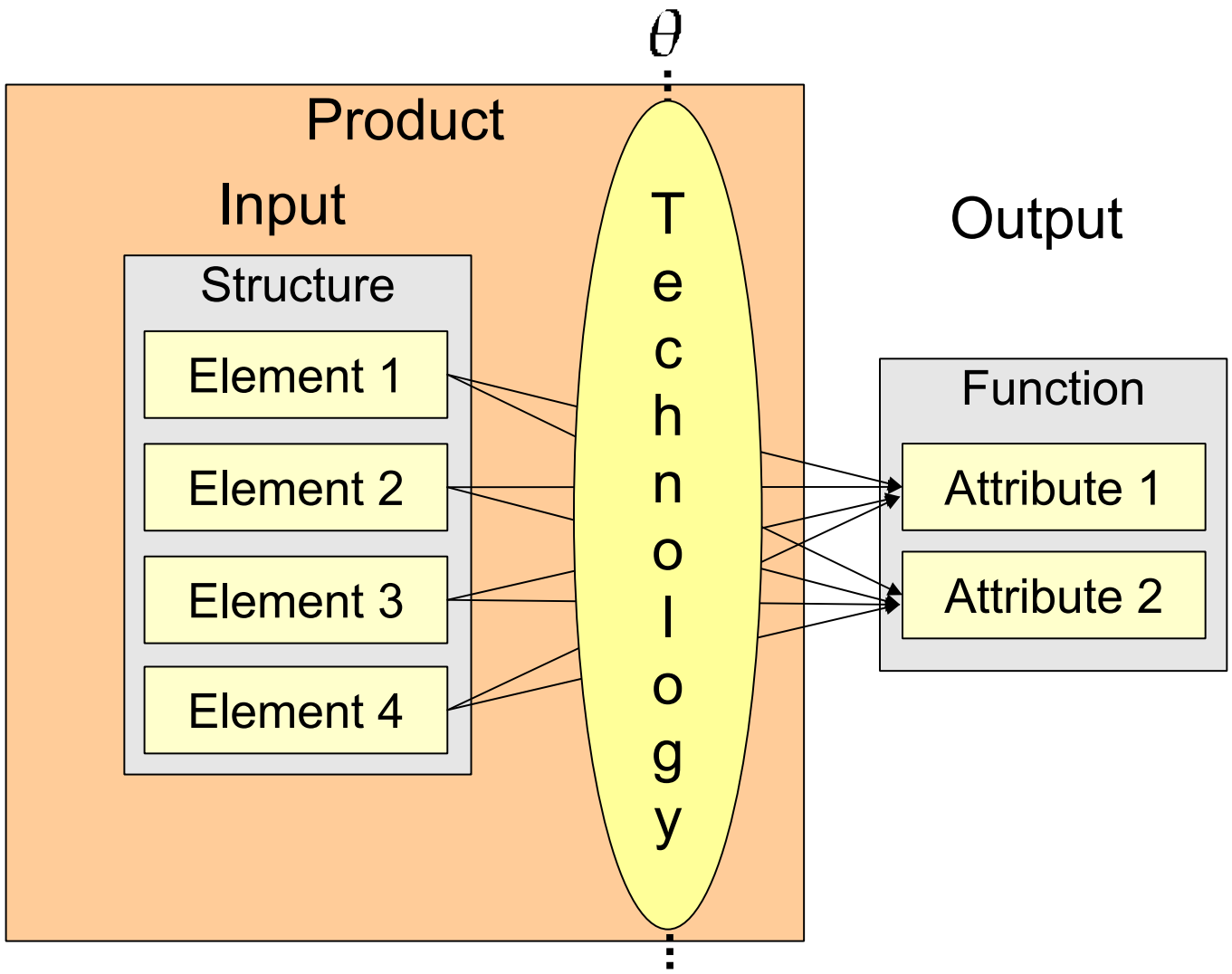
How do they go together?



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How do they fit together?

Gap: General forms do not take into account the dynamic nature of trade-off surfaces.	Attr: DMUs are independently rated against peers which are explicitly identified by DEA.
Gap: Do not address the "best" available technology.	Attr: DEA is an extreme point method.
Gap: Current methods are limited to a single output.	Attr: DEA can handle multiple inputs and outputs simultaneously.
Gap: Current methods require independent attributes.	Attr: DEA does not require attribute independence.

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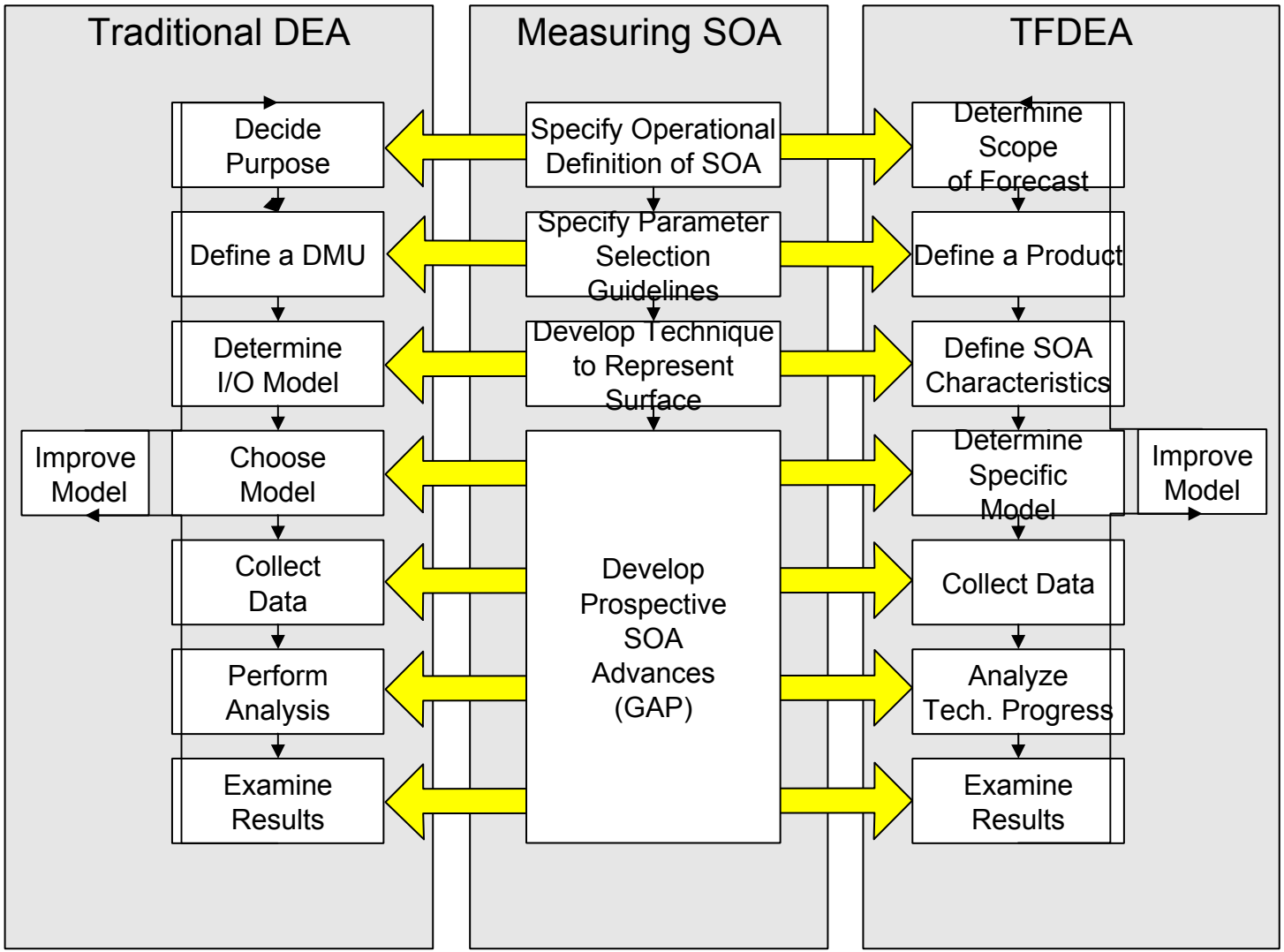
How do they fit together?



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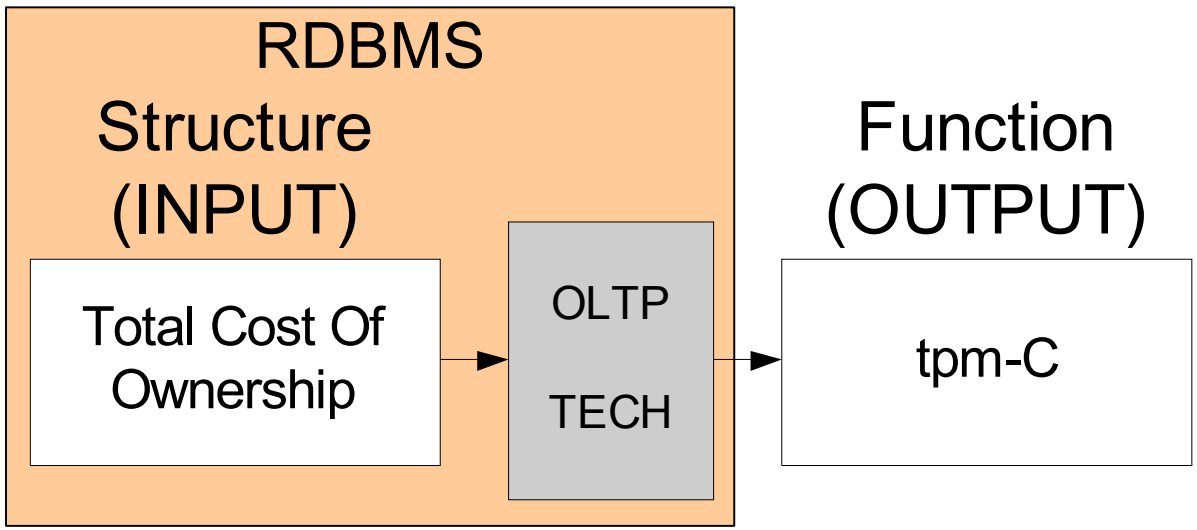
Example - RDBMS



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TPC Data

Product	Name	Year Released	Total Cost($)	Perf. (tpmC
A	Unisys Aquanta QR/6 c/s	1997	297392	7407
B	ALR Revolution 6X6 (1MB L2) c/s	1997	463821	1308
C	Compaq ProLiant 3000 6/450-512 1	1998	176042	6290
D	Unisys Aquanta QR/2V Server	1998	424297	1911
E	Compaq Proliant 3000-6/600-1P	1999	160643	8050
F	Compaq Proliant ML570	2000	201717	2020
G	Dell PowerEdge 6450	2000	334936	3123
H	Unisys e-@action Enterprise Server	2000	797935	6139

Source: Transaction Processing Council (TPC) www.tpc.org

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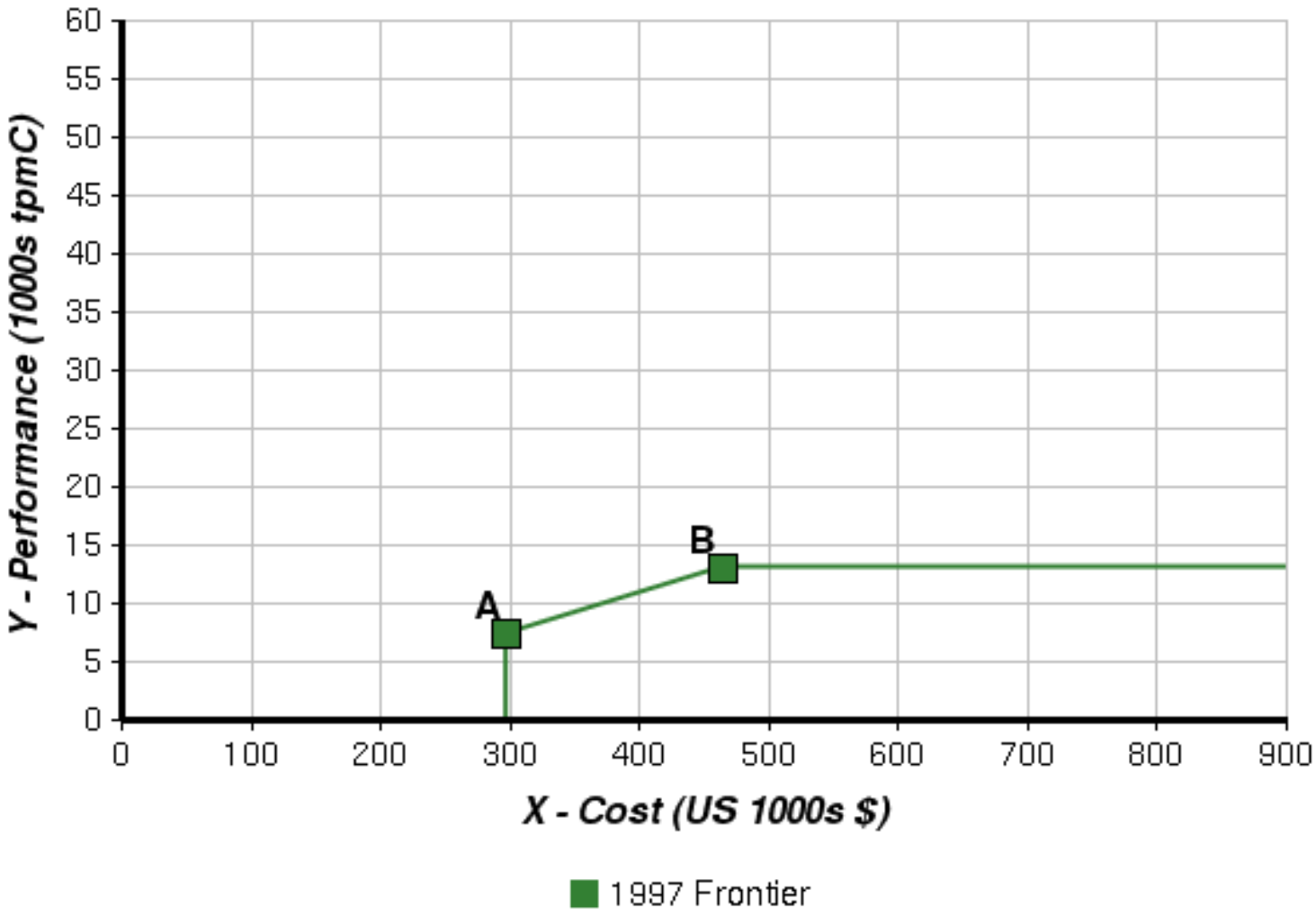
Identification of the SOA



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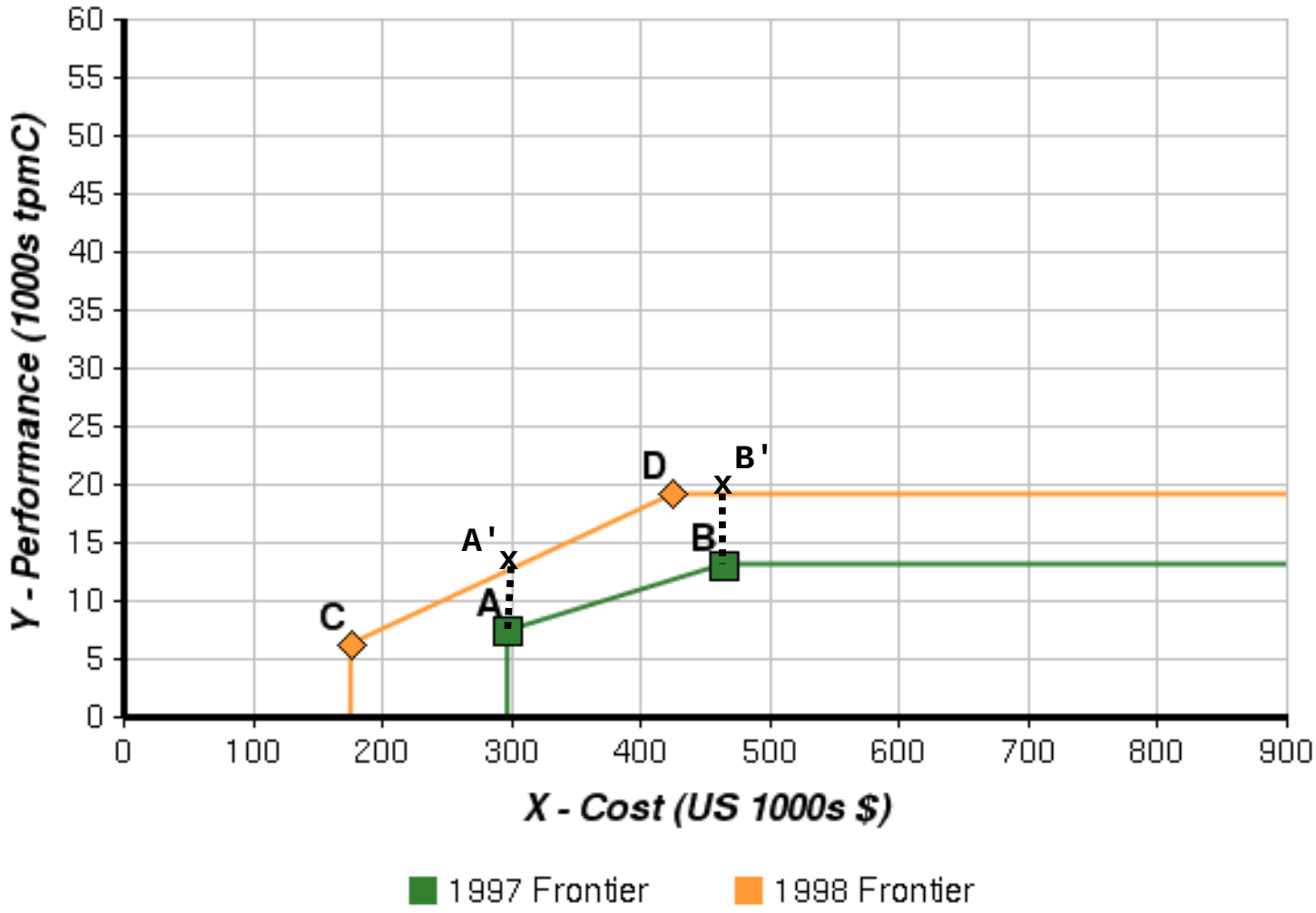
Mapping Progress



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How do we represent it?

- *Use the β determined earlier:*

$$\phi^t = (\beta)^t \cdot \phi^0$$

$$y_r^t = \beta^{\Delta t} \cdot y_r^0 \forall r \in \{1 \ldots m\}$$

- *Translation: new outputs can be multiplied by the old outputs*

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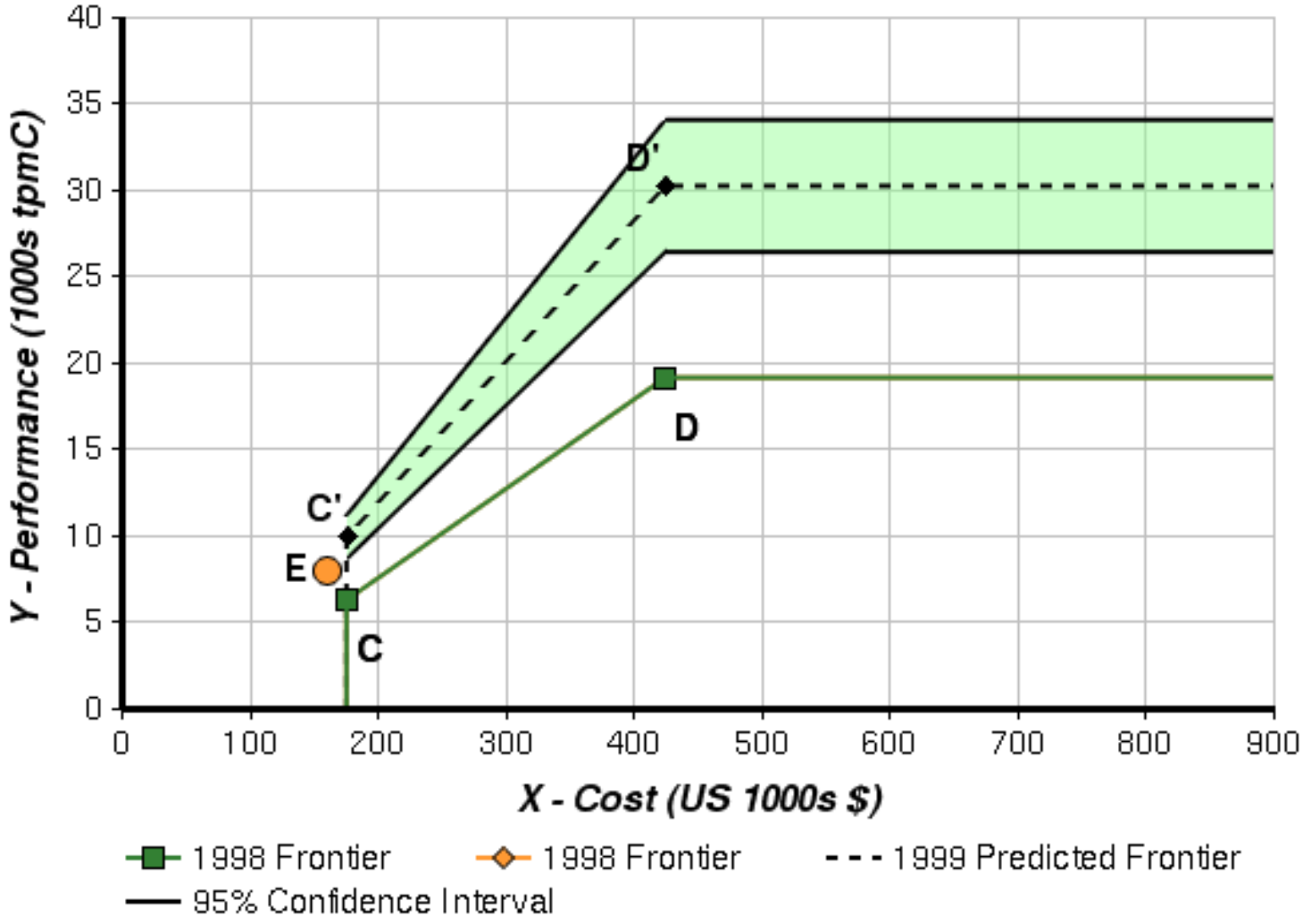
Forecasting the Future



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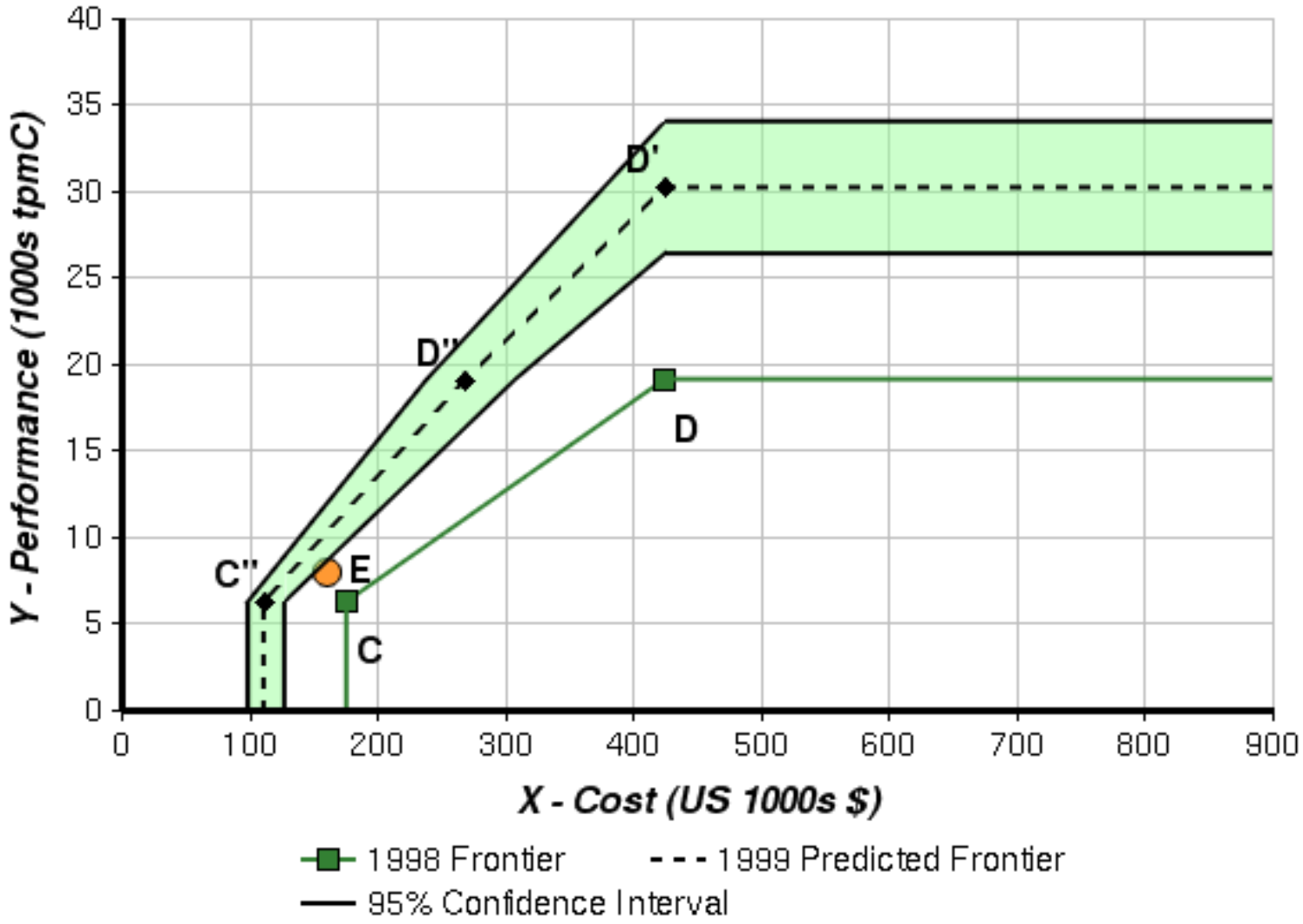
Forecasting the Future



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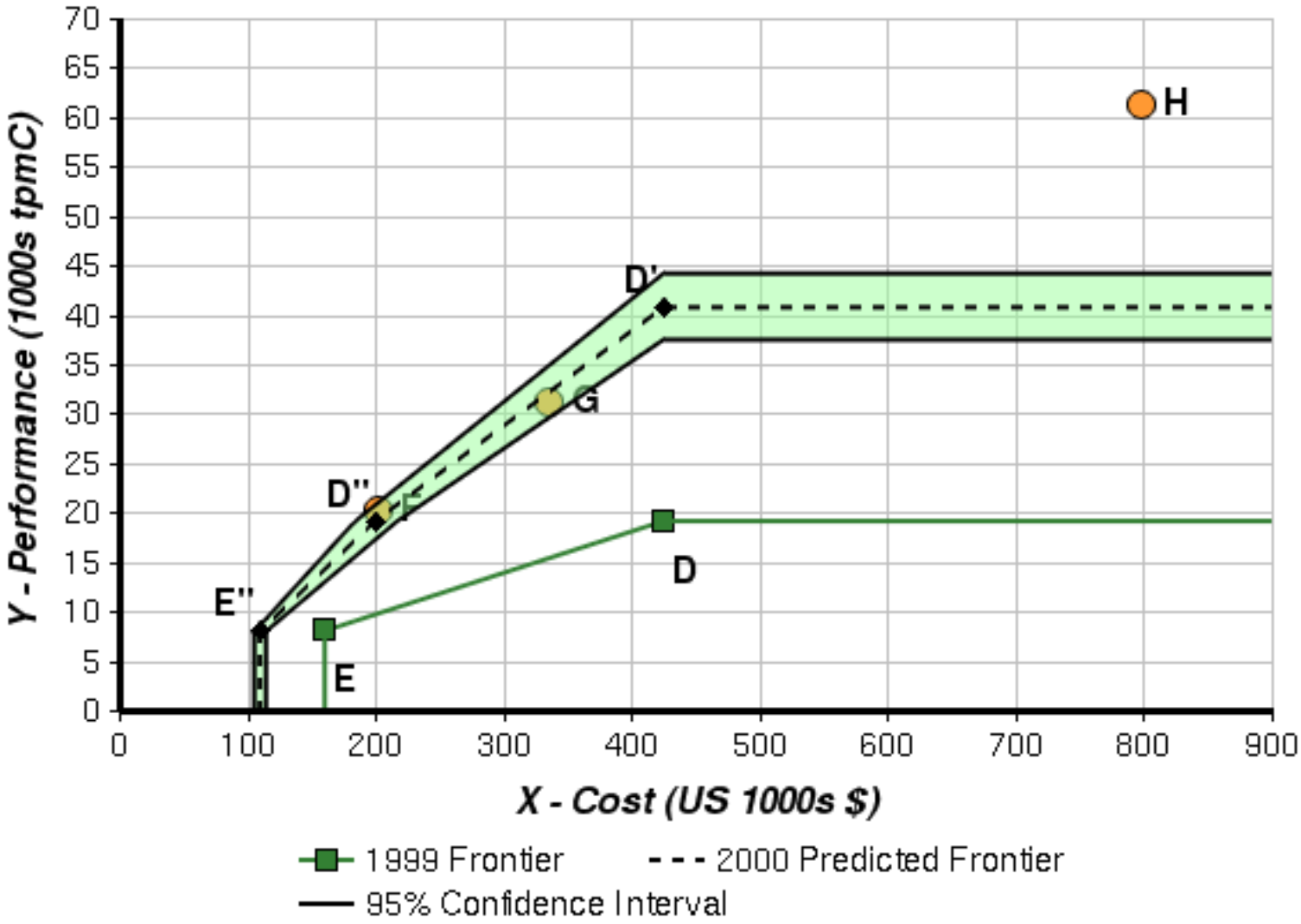

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Applications:

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TPC Results

Output-Oriented TFDEA

Predicted Range	541	42.77%
ROC Predicts Lower Bound Only	220	17.39%
ROC Predicts Upper Bound Only	241	19.05%
ROC Did not Predict SOA	263	20.79%
Total	1265	100.00%

IO-OO Output-Oriented TFDEA

Predicted Range	797	63.00%
ROC Predicts Lower Bound Only	130	10.27%
ROC Predicts Upper Bound Only	338	26.71%
ROC Did not Predict SOA	0	0.00%
Total	1265	100.00%

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TPC Results

Product	*Date Available*	Φ_{lower}	Φ_{upper}	*Status*
IBM eServer xSeries 365 4P c/s	2004-03-31	1.23	1.30	Low
HP Integrity Superdome	2004-04-14	0.95	1.02	Target
HP rx8620	2004-04-15	1.04	1.07	Low
Unisys ES7000 Aries 420 Enterprise Server	2004-04-20	1.20	1.24	Low
HP Integrity rx5670 Cluster 64P	2004-04-30	0.82	0.89	RISK
PRIMEPOWER 2500	2004-04-30	1.64	1.77	Low
IBM eServer pSeries 690 Model 7040-681	2004-08-16	1.08	1.21	Low
IBM eServer Xseries 445 8P c/s	2004-08-31	1.44	1.59	Low

*HP Integrity made its debut – but it used RedHat Linux for its Operating System.

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TPC - Conclusions

- Method provides a good estimate of future trends.
- IO-OO offers additional insight.
- Still prone to disruptive technologies