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G2:2019: April 22-25

Predicting the Future

Part 3/3: Trends of System Evolution Predictions

Key Learnings

- **Trends of Engineering System Evolution (TESE)**
  - Empirically observed directions of system development that describes the natural transitions of systems from one state to another. These directions are applicable to all categories of systems.

- **TESE are used to effectively predict inflection points in system development**
  - The further out in time, the more accurate
  - The trends can be applied to technical, business, and other systems

- **Beginner's usage of the TESE is not all that complex**

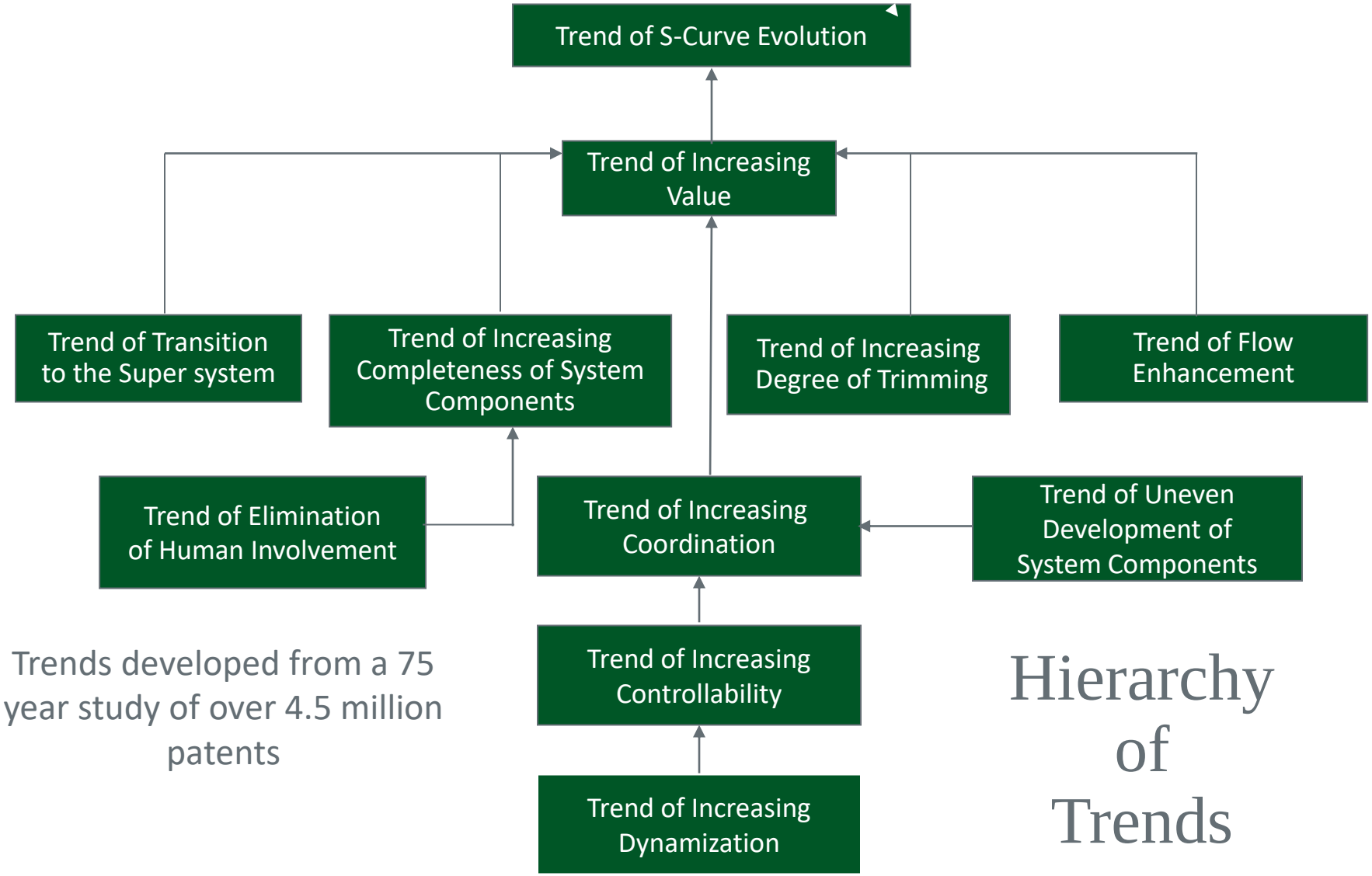
  1.) Choose a system to analyze

  2.) Place the entire system (or sub-components of that system) on a trend line

  3.) Imagine what that system (or sub-component) might look like if progressed down the trend in question

  4.) Repeat for other trends and combine ideas into a newly evolved product or service

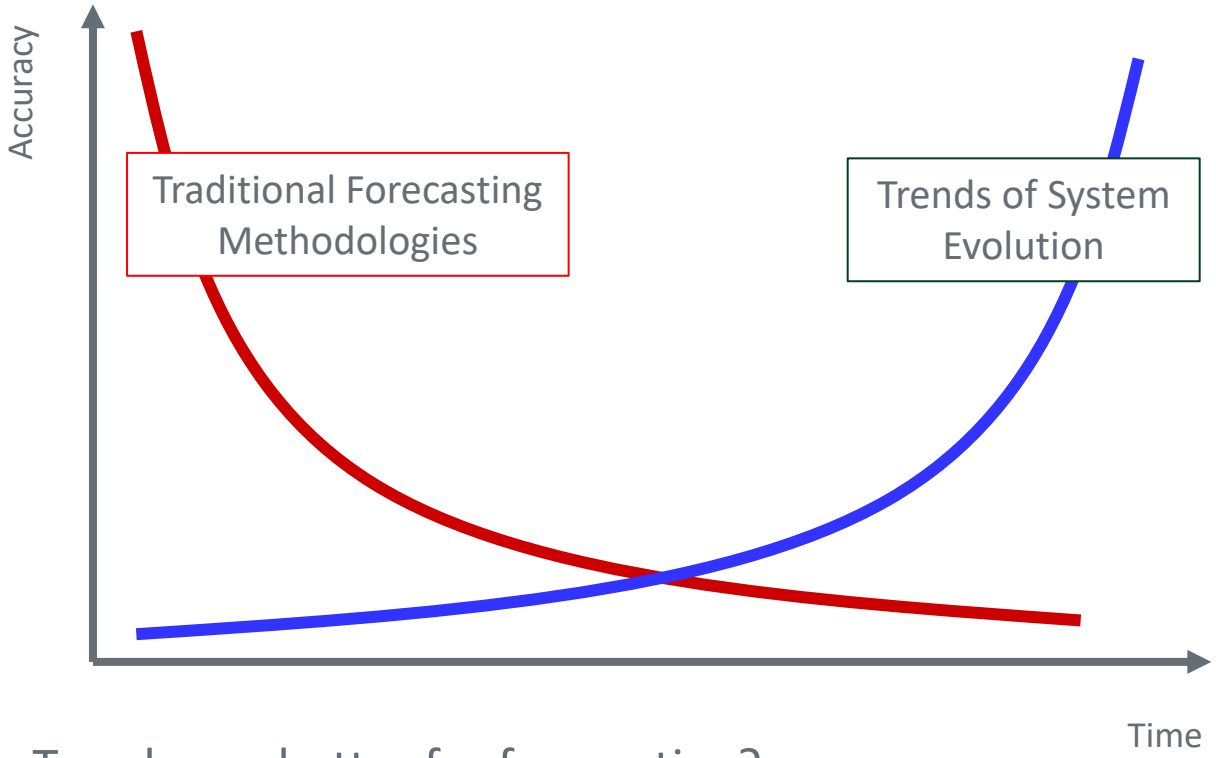
Trends of Technical System Evolution



Trends developed from a 75 year study of over 4.5 million patents

Hierarchy of Trends

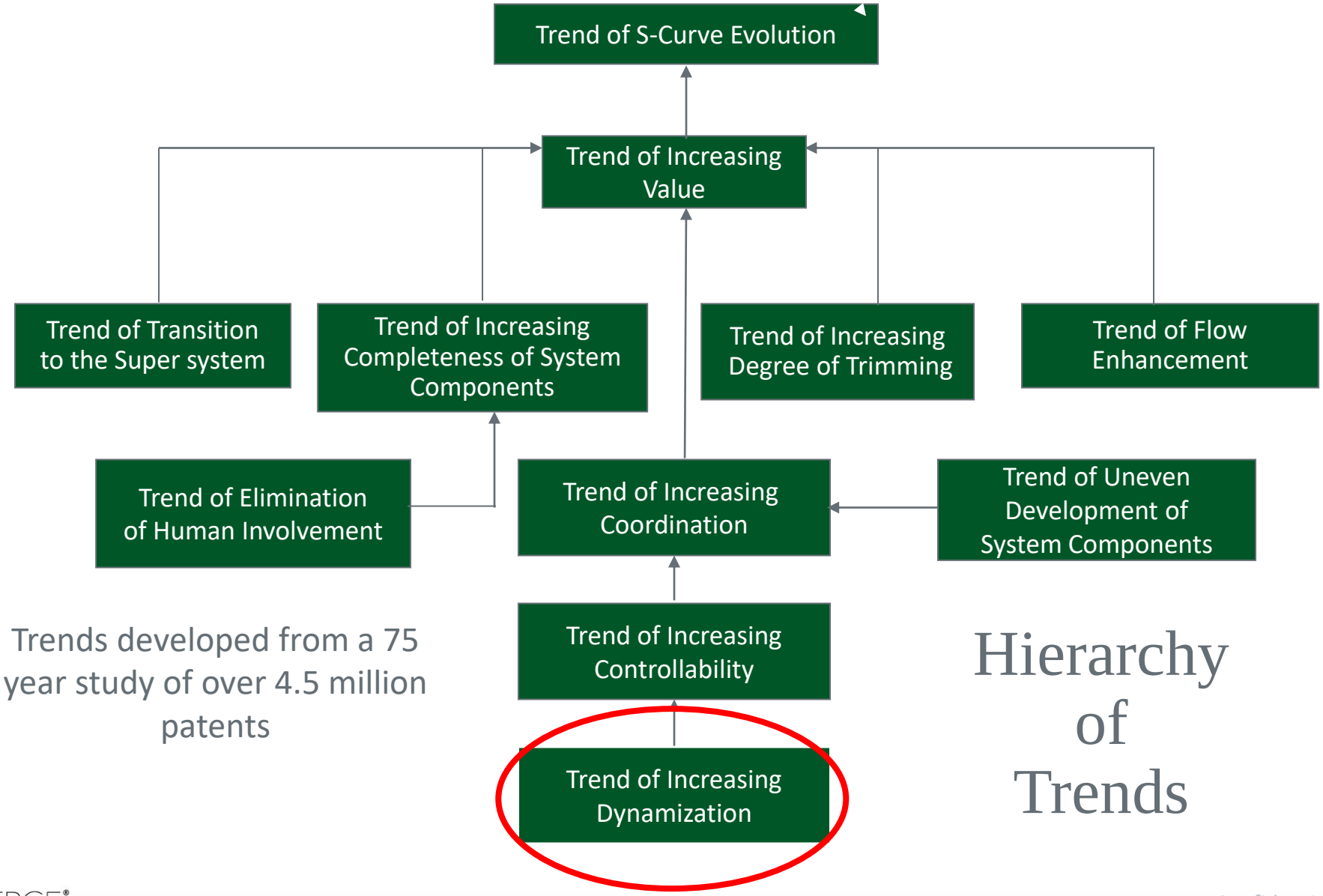
Trends of Technical System Evolution



Why are Trends any better for forecasting?

- Qualitative not Quantitative
- Excellent long-range accuracy
- Effectively predicts jumps in technology and business advancements
- Effectively identifies new product, production and service opportunities

Trends of Technical System Evolution



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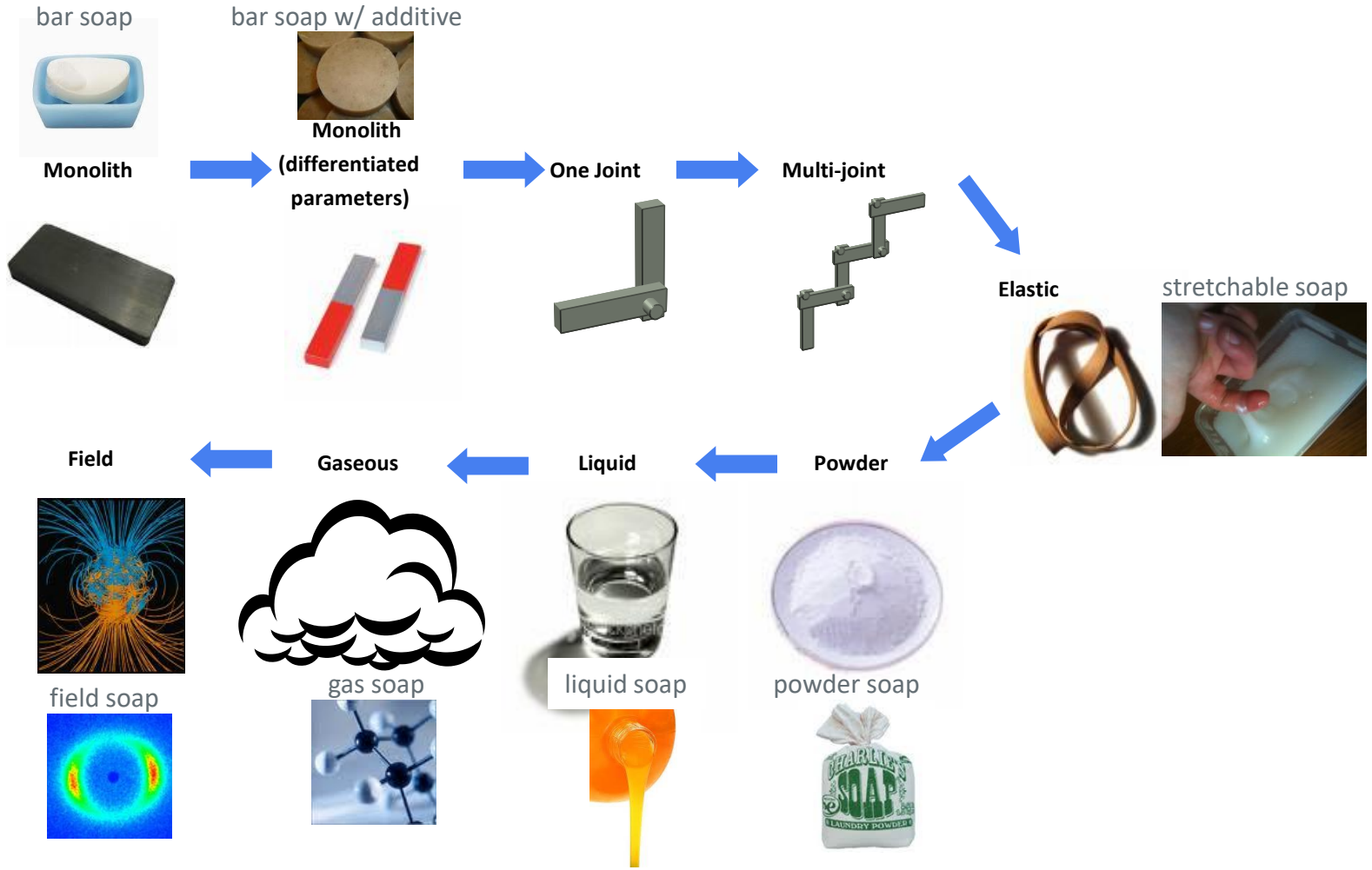
Hierarchy of Trends

Trends of Technical System Evolution

Trend of Increasing Dynamization

Example: Surfactant *(soap)*

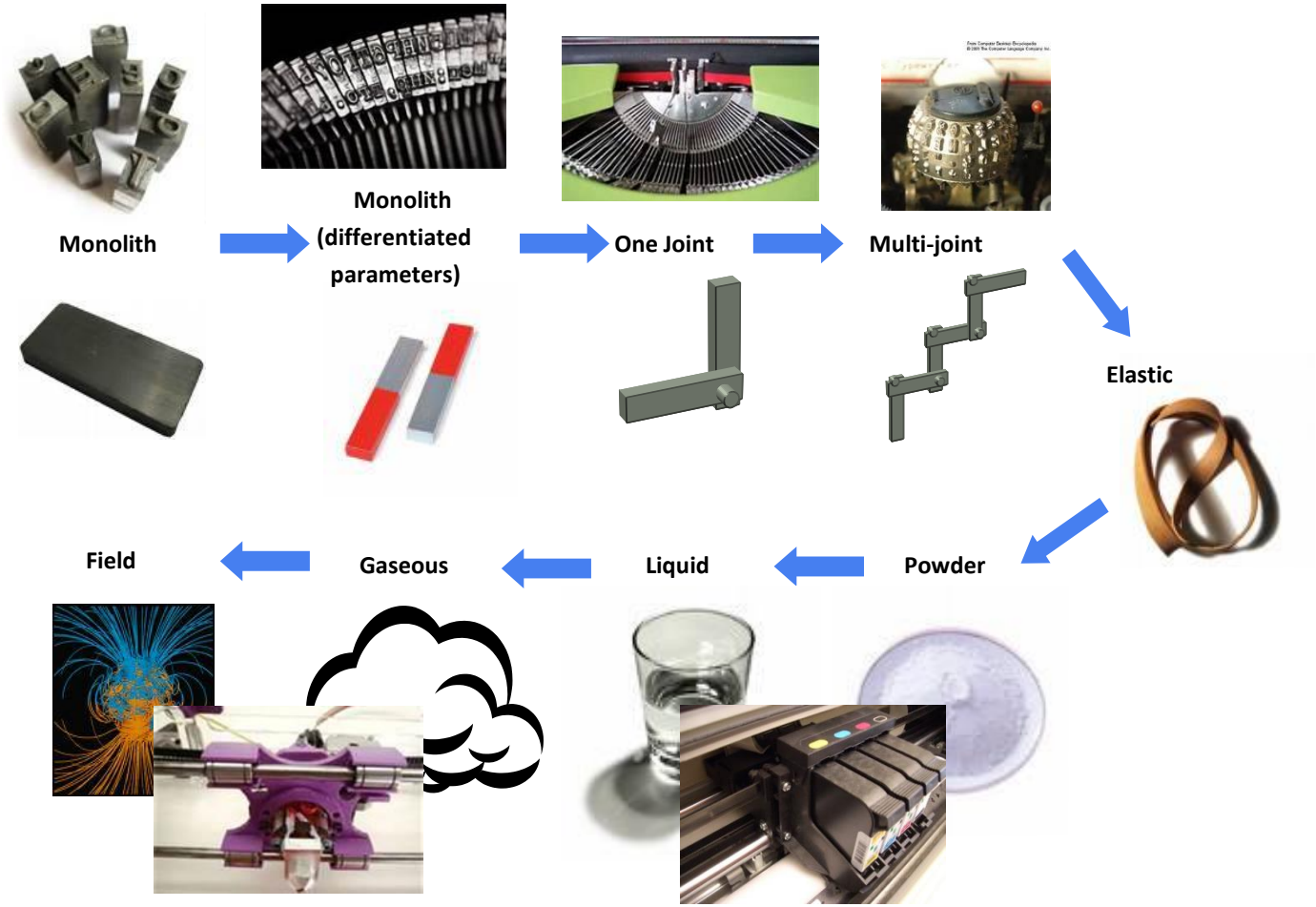


Trends of Technical System Evolution

Trend of Increasing Dynamization

Example: Print Methods

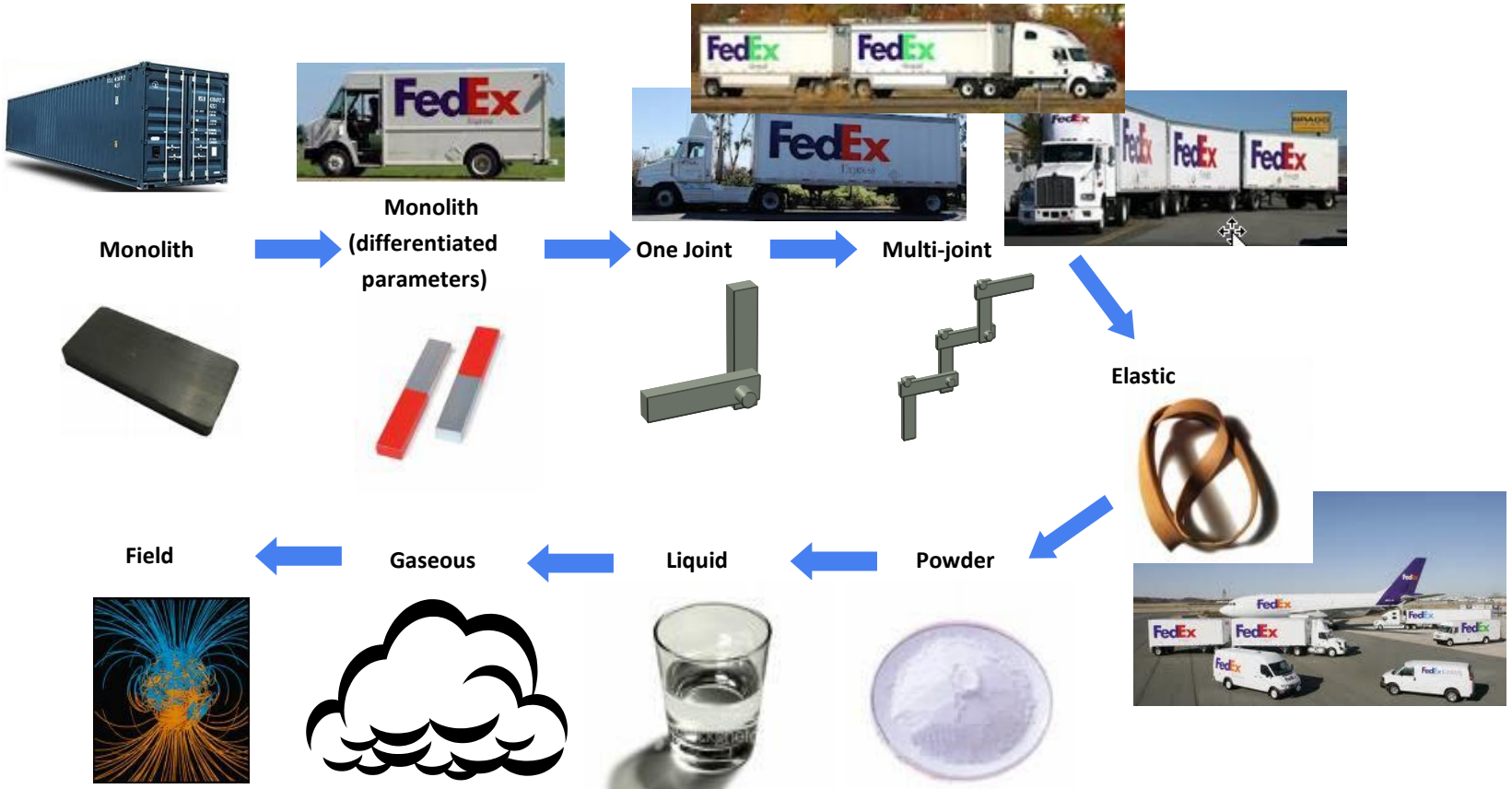
Also applies to internal system components



Trends of Technical System Evolution

Trend of Increasing Dynamization

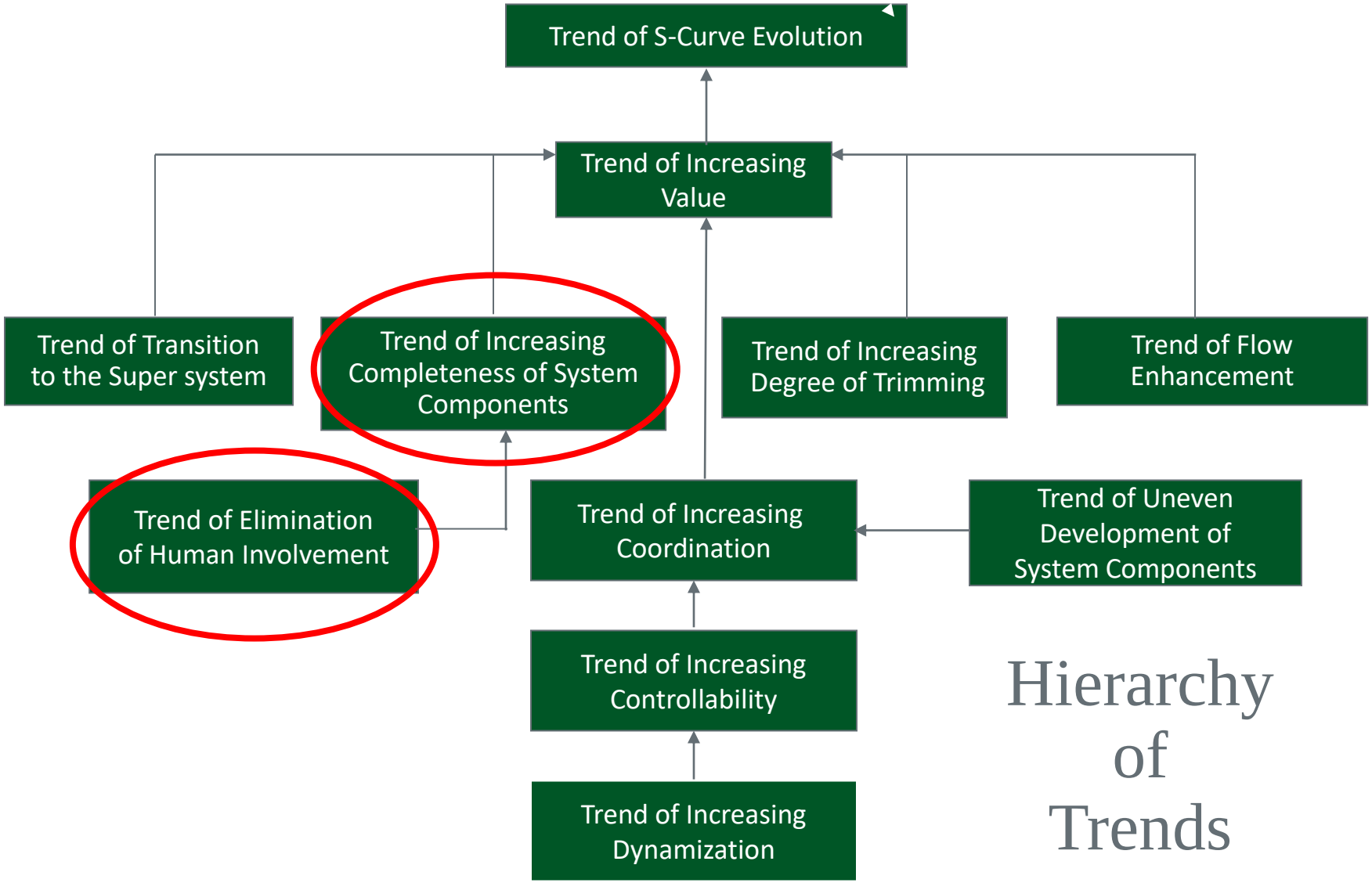
FedEx Example: *moving* Material



How can FedEx incorporate aspects of high dynamization into their primary function of moves*?*

?

Trends of Engineering System Evolution



Hierarchy of Trends

Trends of Technical System Evolution

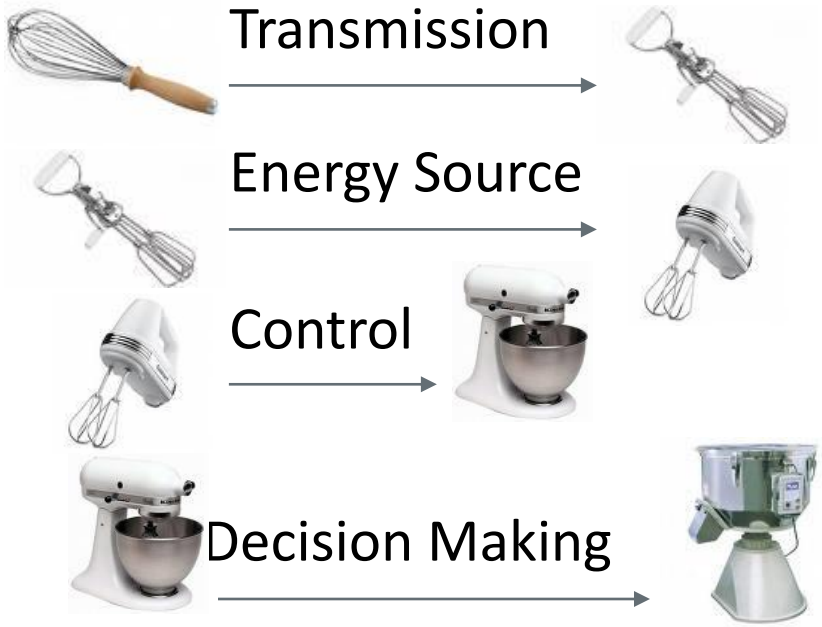
- As an eng. sys. evolves the number of system functions performed by humans decrease.
- A decrease in human involvement leads to an increase in system completeness.

Trend of Decreasing Human Involvement

Humans Stop Performing:

Trend of Increasing System Completeness

System Starts Performing:



Trends of Technical System Evolution

- As an eng. sys. evolves the number of system functions performed by humans decrease.
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Trend of Decreasing Human Involvement

Humans Stop Performing:

Trend of Increasing System Completeness

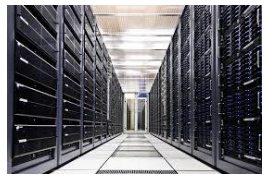
System Starts Performing:

Transmission →

Energy Source →

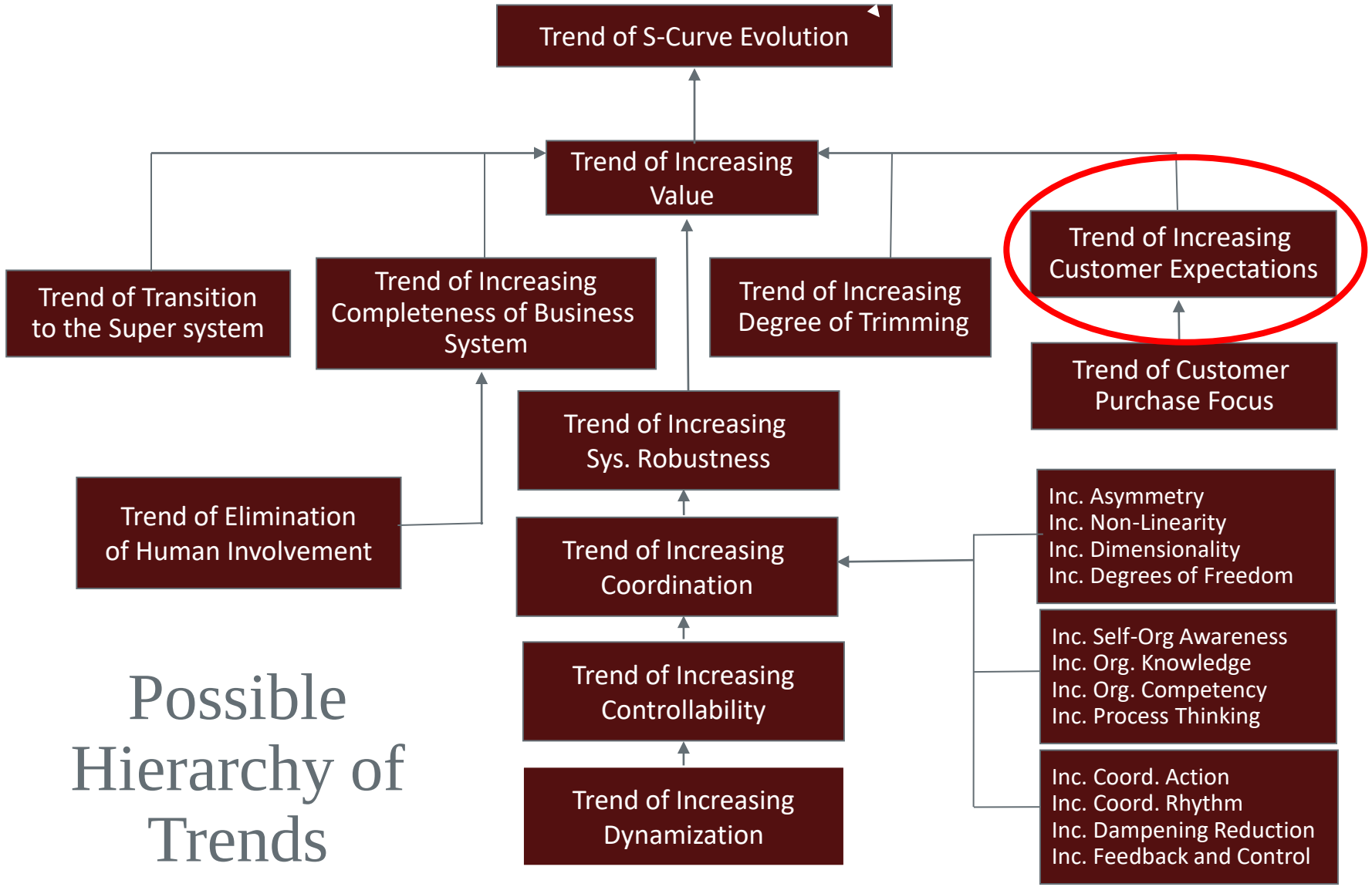
Control →

Decision Making →



How else can FedEx push decision making out into the system?

Trends of Business System Evolution



Possible Hierarchy of Trends

Trends of Business System Evolution

Trend of Increasing Customer Expectations

- **As customers have more understanding of a business system their expectations of the process increase.**

commodity

product

service

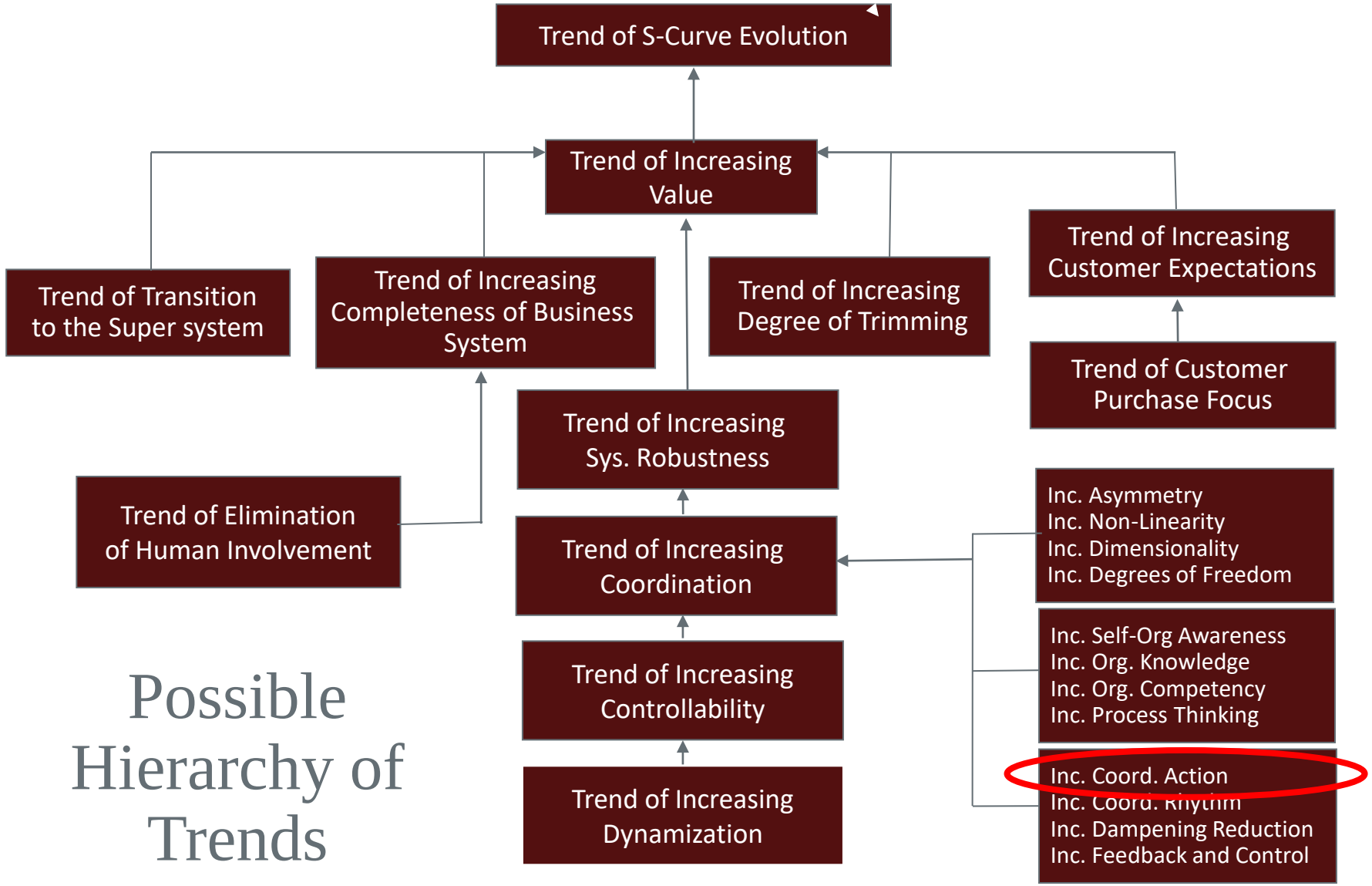
experience

transformation

FedEx

What will FedEx look like when they move to the transformation stage (custom products target to individuals based on company's expertise)?

Trends of Business System Evolution



Possible Hierarchy of Trends

Trends of Business System Evolution

Trend of Increasing Action Coordination

- **As processes mature they increasingly coordinate with their internal operations and with the environment**

Non-coordinated action

Full route usage even if no freight (equipment must be moved to support subsequent operations)

Partially coordinated action

Freight coordinated at distribution points

Fully coordinated action

All shipping is specifically coordinated with shipping demand (i.e., shipped when ordered, direct route to destination, no transfer delays)

Different actions during intervals

Switching to assembly during shipping intervals to increase the customer experience

How can FedEx fully coordinate its operations and provide additional services to its customers during intervals?

Trends Solution Generation

FedEx

- Trend of Increasing Dynamization
  - Powder
  - Liquid
  - Gaseous
  - Field

Ideas?

- Trend of Decreasing Human Involvement/Increasing System Completeness
  - Push decision making out into the system

Ideas?

- Trend of Increasing Customer Expectations
  - Custom products pushed to individuals

Ideas?

- Trend of Increasing Action Coordination
  - Fully coordinate operations and provide interval services

Ideas?

Trends Solution Generation

FedEx

- Trend of Increasing Dynamization
  - Dynamic data transfer followed by on-site manufacturing

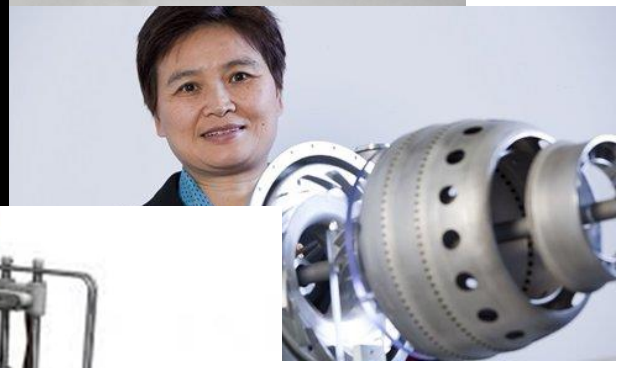
- Trend of Decreasing Human Involvement/Increasing System Completeness
  - System “delivers” freight when and where it is needed – customer driven

- Trend of Increasing Customer Expectations
  - Freight can be customized and delivered when and where most convenient to customer

- Trend of Increasing Action Coordination
  - Fully automated “shipping” (data) and assembly services

3D Printing

3D Prin

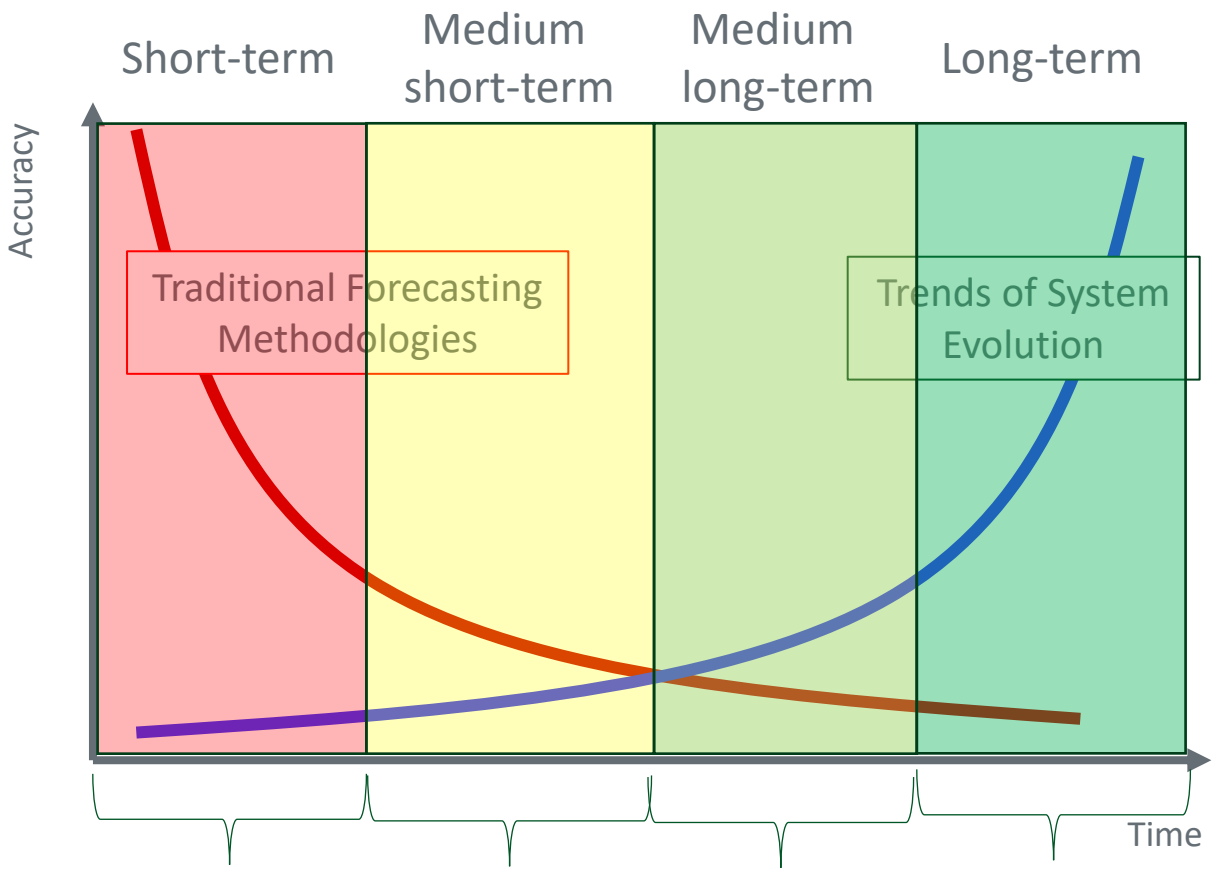


Monash University researchers along with collaborators from CSIRO and Deakin University have printed a jet engine.

Jet Engine

3D Printed Human Kidney

Trends of System Evolution (TSE)



*Integrating the use of Trends of System Evolution into your planning process will allow you to see and drive more and more inflection points, opposed to responding to them as they appear.

*Not much choice but extrapolation with focus on short-term economic forecasts and known internal and competitor activities.

*Modify your extrapolations with TSE analysis.

*Focus on TSE w/ extrapolation for general guidance only.

*Trends of Sys. Evolution highly accurate and extrapolation very inaccurate. Rely on TSE and utilize CI to know who, when and how much.