Academia / Industry Collaborative effort
Towards End-to-End Innovation

Background:

Substantial collaborative work has progressed inside of India for more than a decade now.

Part 1: Prof. Babu: Real life experience – home grown - success in Industry/academia collaboration

Part 2: **Dr. Subramanian: Origins and Strategy (based on over 40 years of experience in inter-industry and Industry / Academia Collaboration).**

Strategies for End-to-End Innovation - "System Thinking" and "Transformational Skills"

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COPEN 13

An International Conference on

PRECISION, MESO, MICRO AND NANO ENGINEERING

December 13-15, 2024

Strategies for End-to-End Innovation: "System Thinking" and "Transformational Skills"

Dr. Krishnamoorthy (Subbu) Subramanian

President, STIMS Institute.

Dec. 14, 2024

Organised by

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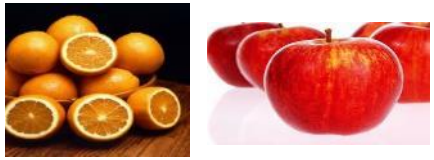
System Thinking: What is it?

2 + 2 = ? **4 (No Brainer! ☺)**

"What does each of the "2" stand for ?"



+


= ?






2 + 2 = Fruit Plate; Decorative arrangement ? ☺

= New solutions and rewards!

2 + 2 = 5? ☺ **or** **2 + 2 = 3?** ☹

Fruit Salad

Simon Sinek: Start with why? -- How great leaders inspire action?

https://www.youtube.com/watch?v=u4ZoJKF_VuA

Always ask: What? - "Technical output"

Why? – "System Output"

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Task Vs. System

TASK

- Any action,
- Something you are asked to do.
- In response to a command:
  "Do this"
- Plug and Play!

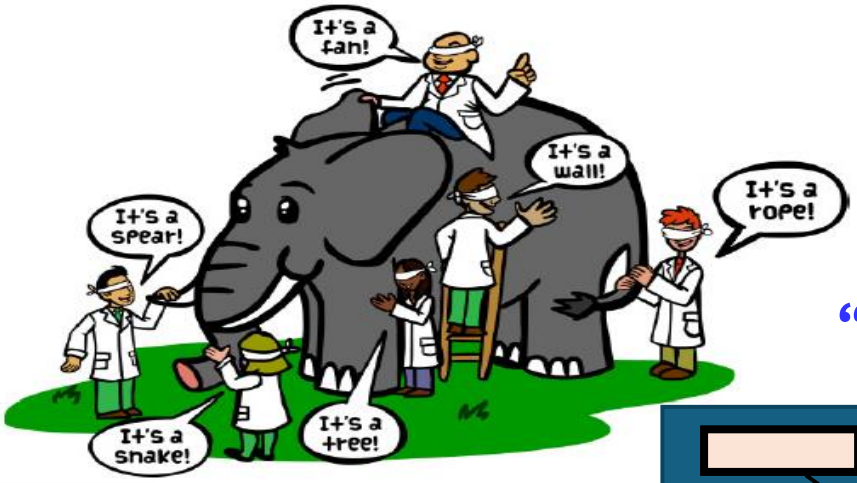


Image Source:
https://www.theblindelephant.com/the_blind_elephant_fable.html

SYSTEM

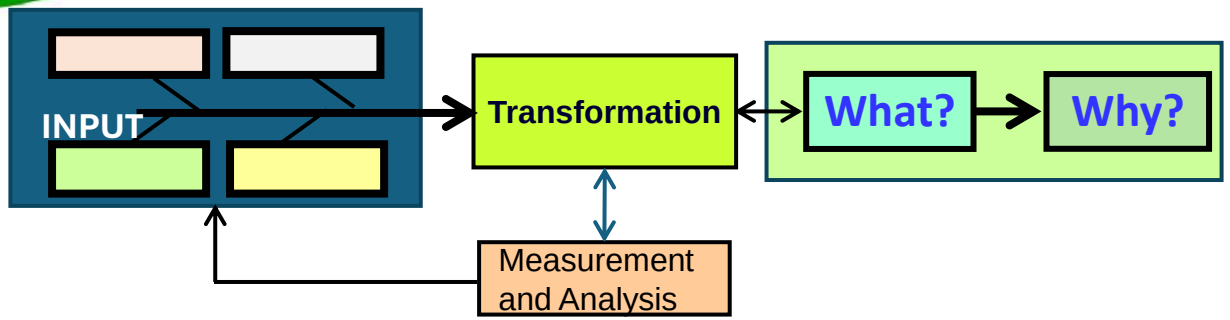
Organized work with prior thinking:

- What "needs" to be done?
- Why am I (we) doing this?

The sum (end result) is larger than the mere collection of tasks.

Results / benefits are shared by everyone (Eco-system Dev.) (Everyone is a stake holder).

"Transformation" is the "Science"?



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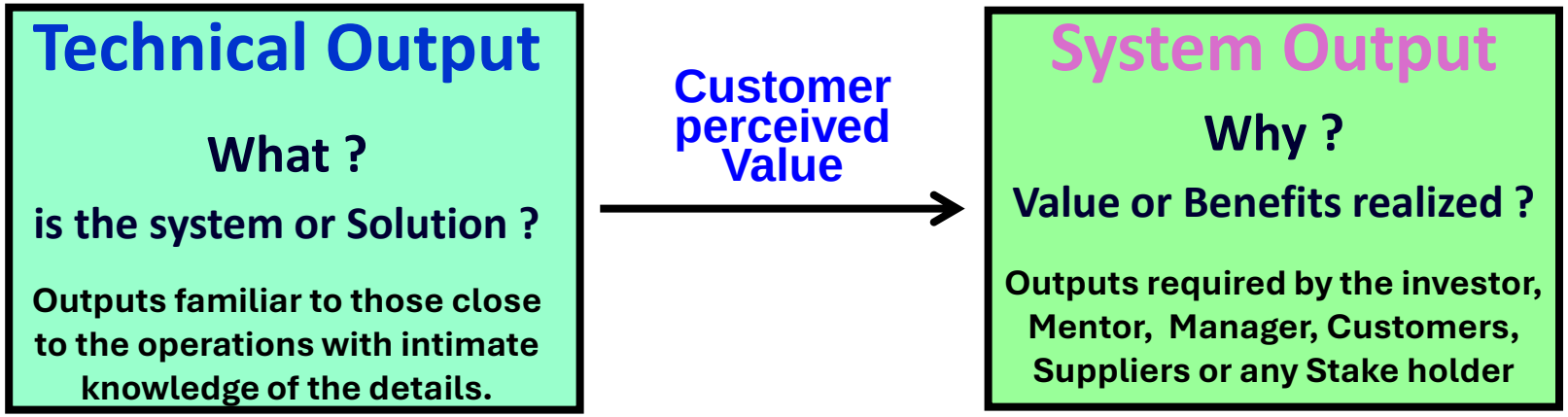
Technical Output Vs. System Output



Course	Knowledge, Expertise
Grade	Capability, Professional Skill
Project Report	Project Outcome
Test Bed	Test Results, Validation
Invention	Innovation, New Outcomes
Product	Performance, Value, USE.
Process	Solution, Value addition
USE	Benefits realized, Reward.
Job	Knowledge Worker

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System Thinking: What is it?

2 + 2 = ?

INPUT:

What is the first "2"?

What goes into the next "2"?

TRANSFORMATION:

What does the transformer "+" really mean?

(e.g.): How do you add the first "2" ? next "2"?

- **All at once? Little bit at a time?**
- **In some new method or new way?**

OUTPUT:

Technical: What do we WANT?

System: Why do we want that? Who else needs that?

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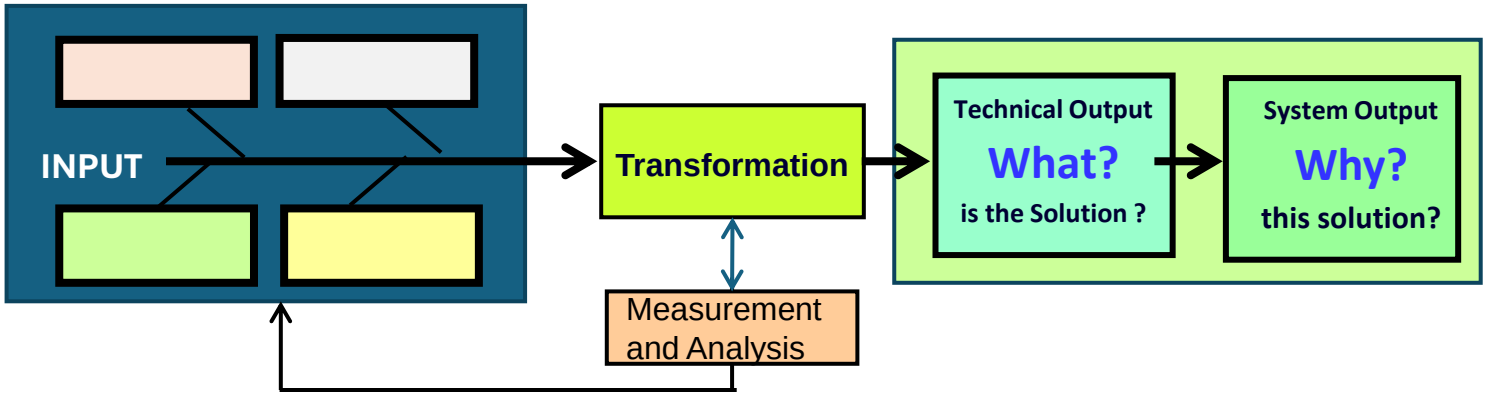
System Thinking: Three levels of system Skills



- **Awareness (Common Language) :**
  - **Fill all the boxes.**
  - **Where are the boxes empty? How to fill them?**
  - **Question to ask? in what order?**

- **Analysis (Develop):**
  - **Apply the principles of Science, Engineering and Management in an interactive manner.**
  - **Resolve process problems; Develop solutions and validate impact**

- **Synthesis (Deploy / Implement):**
  - **Configure "New Solutions" based on new knowledge and its refinement**
  - **Develop them into "New Solutions";**
  - **Implement, validate and get rewarded: END to END Innovation!**

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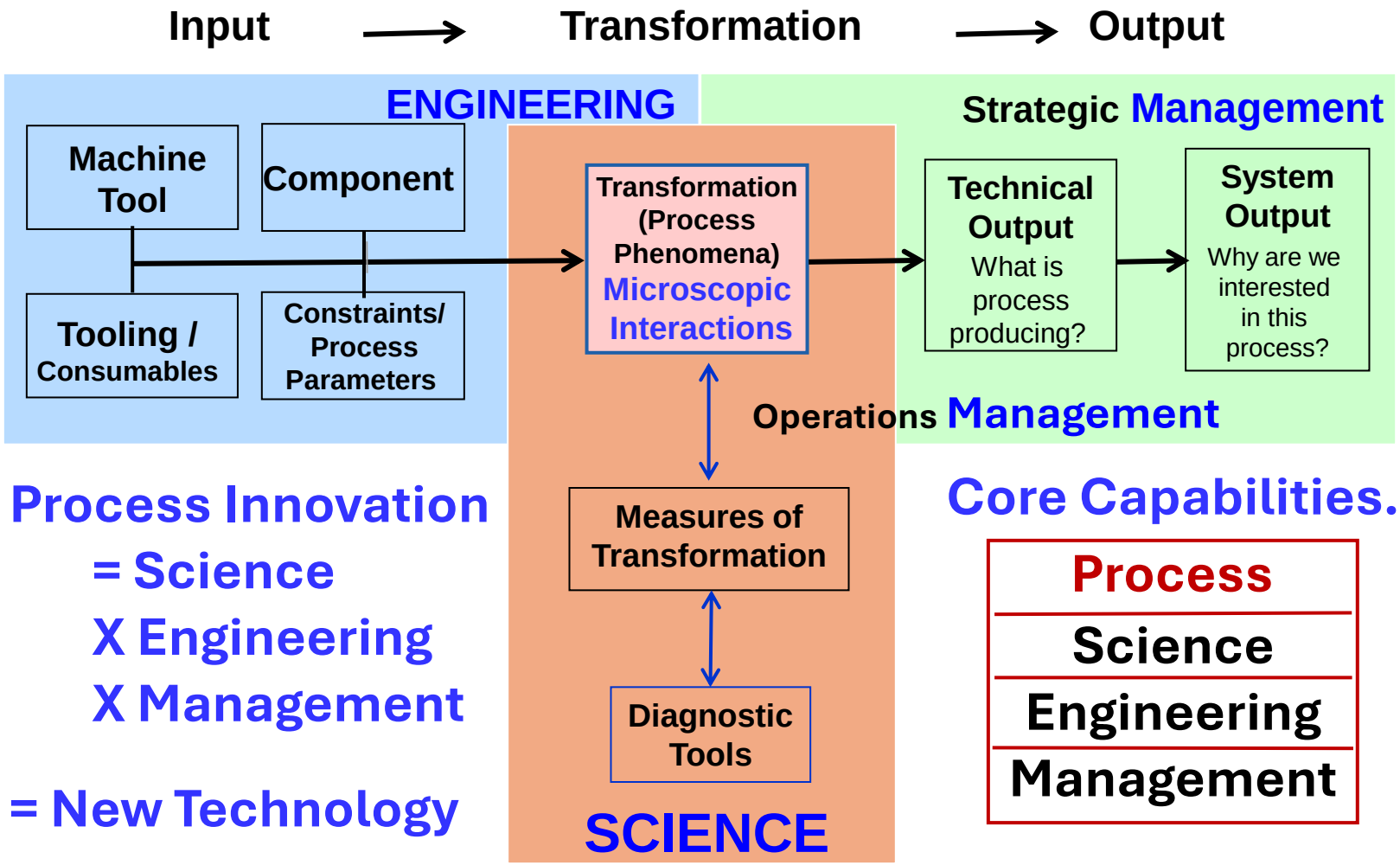
The STIMS - System Approach for Processes Innovation.



Source: Figure 6.3. https://www.amazon.com/Thriving-Transformational-Technical-Professionals-Managers/dp/0791860167

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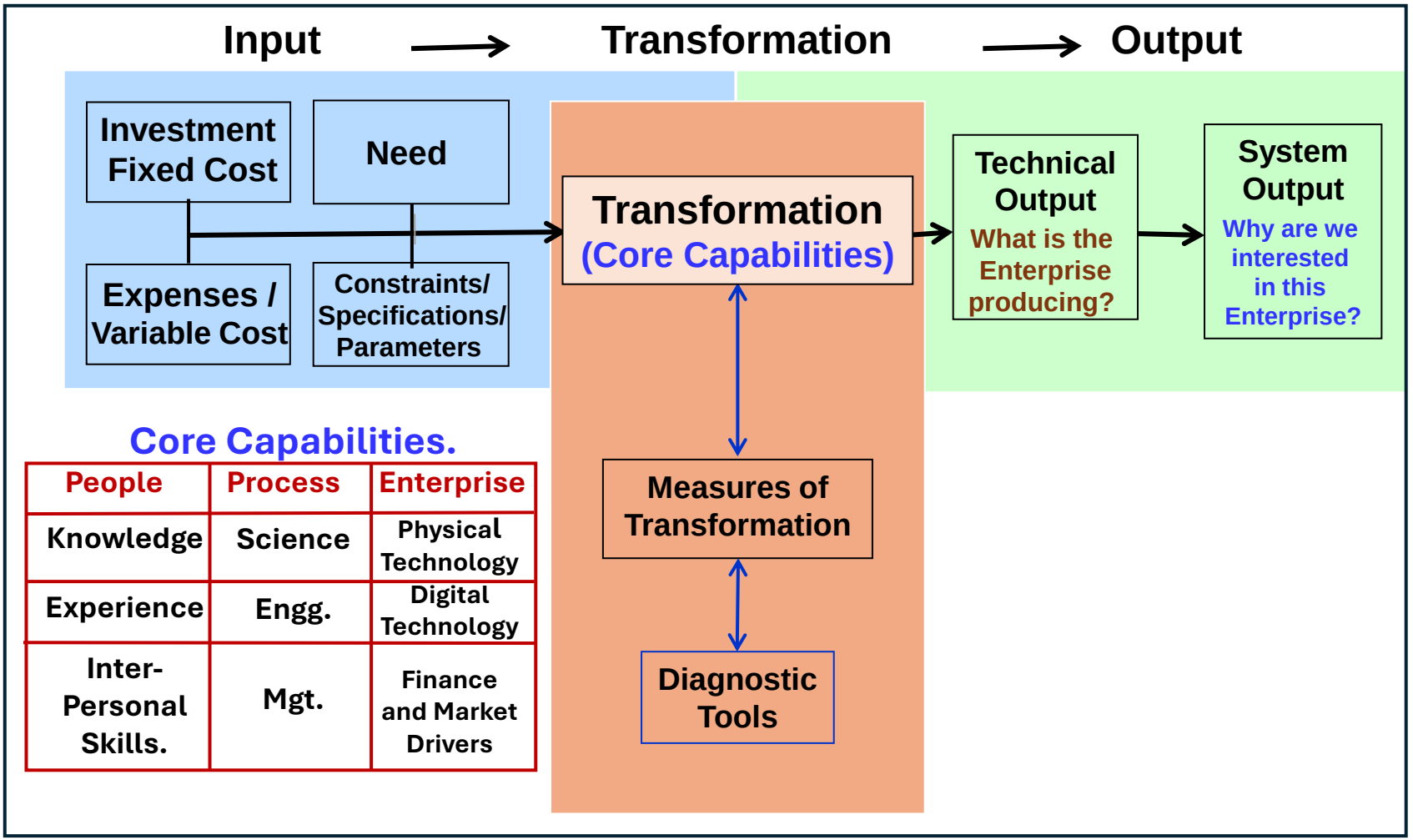
The STIMS - System Approach for Innovation - R&D Center or Enterprise level.



Core Capabilities.

People	Process	Enterprise
Knowledge	Science	Physical Technology
Experience	Engg.	Digital Technology
Inter-Personal Skills.	Mgt.	Finance and Market Drivers

Source: Figure 6.3. https://www.amazon.com/Thriving-Transformational-Technical-Professionals-Managers/dp/0791860167

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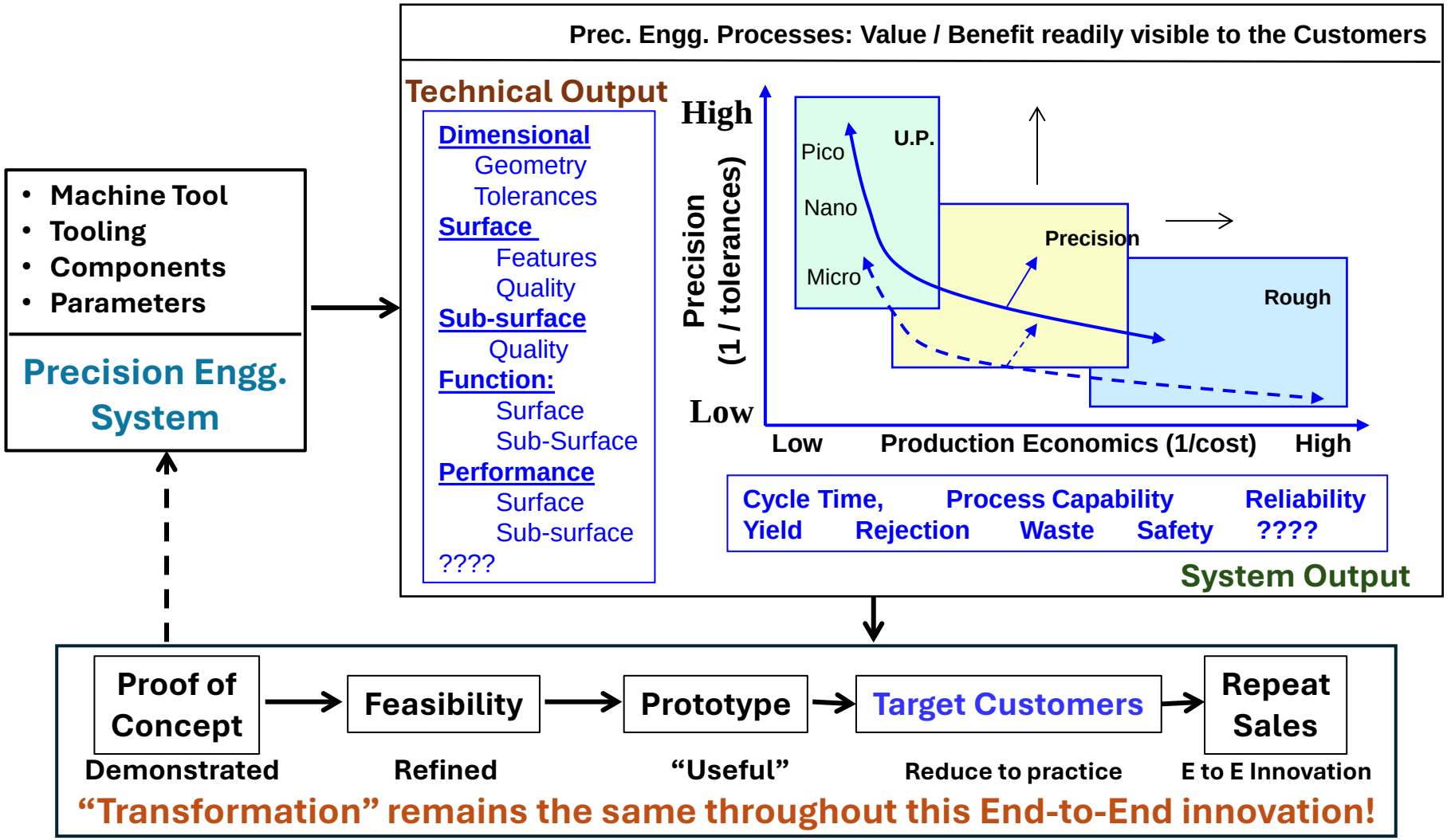
End to End Innovation – Capability Roadmap for Precision Engineering.



Target Customers: Close interaction with the "end users"
- to identify the immediate and emerging needs!

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End-to-End Innovation
– "Transformation" Microscopic Interactions
is at the root; from beginning to end.

Simulation – Testbed.

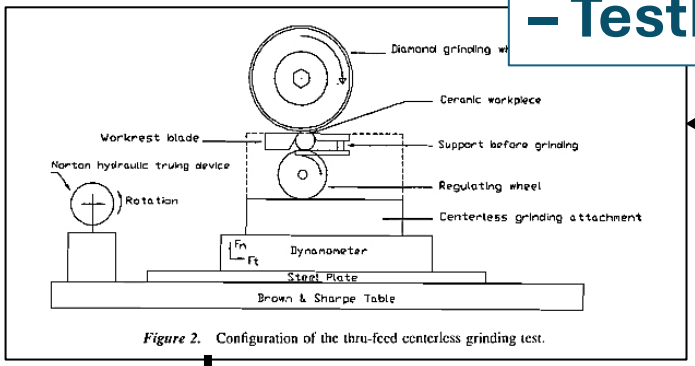
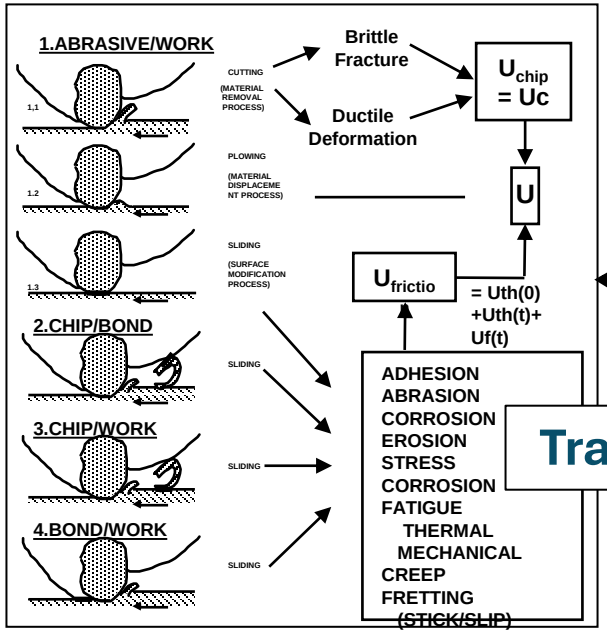
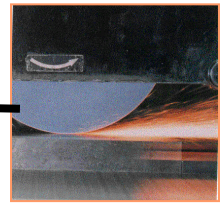


Figure 2. Configuration of the thru-feed centerless grinding test.





Transformation

Proof of Concept → **Feasibility** → **Prototype** → **Target Customers** → **Repeat Sales**

Demonstrated | Refined | "Useful" | Reduce to practice | E to E Innovation

End-to-End Innovation: Preserving the "Transformation"

Source:
A Systems Approach for Simulation and Production Implementation of Thru-Feed Centerless Grinding of Ceramics , Darryl J. Gust, Albert J. Shih, Marc Tricard, K. Subramanian https://asmedigitalcollection.asme.org/IMECE/proceedingsabstract/IMECE96/15458/281/1165589

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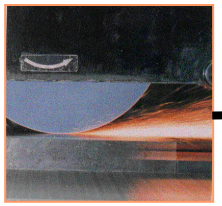
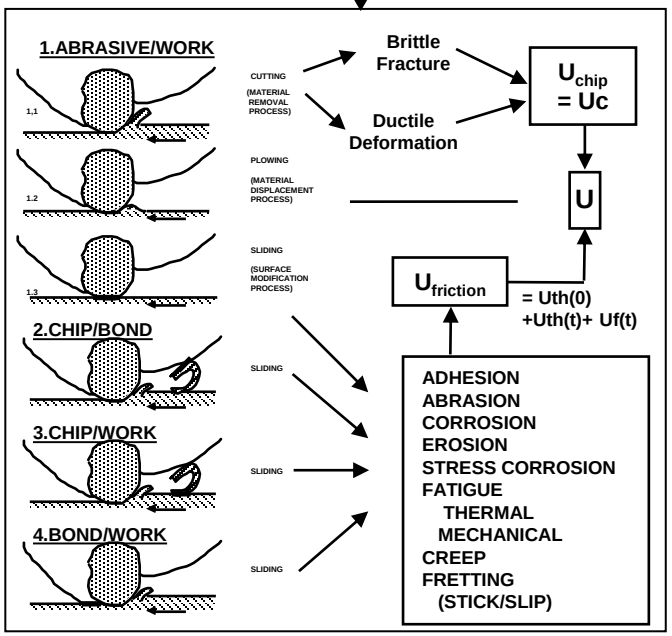
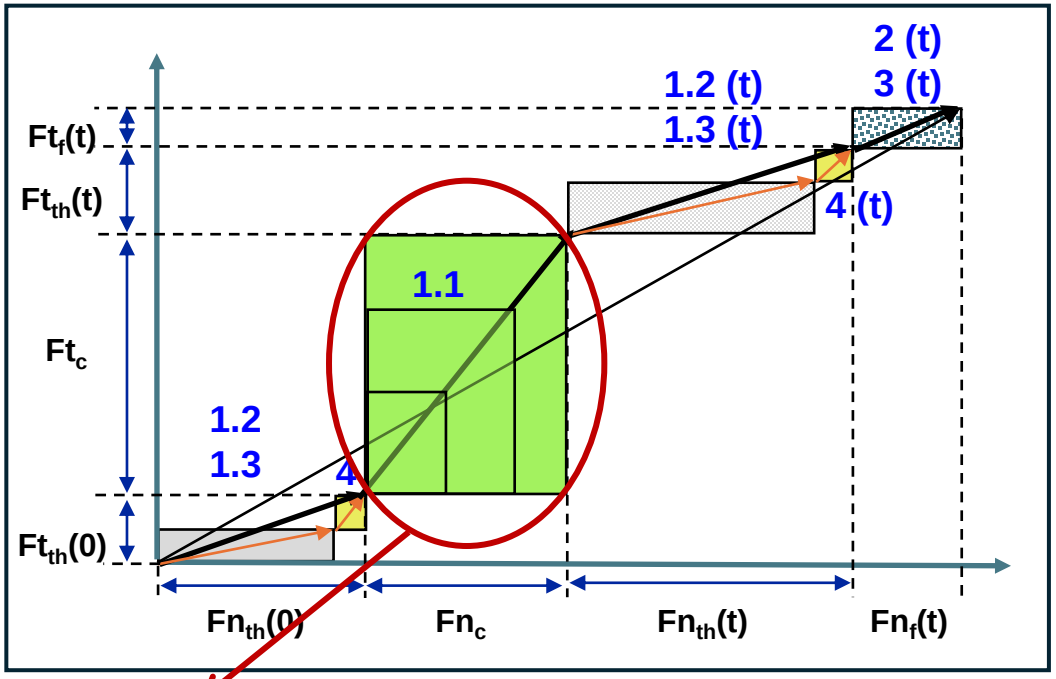
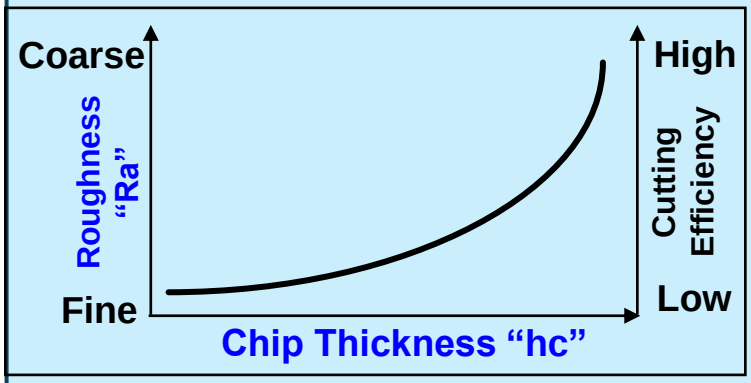
Transformation /Science - as the control element.
Driver for Process Innovation









Process Innovation through "Machining"

Grinding Cycle Design - Interaction 1.1 : Ra = f (hc)

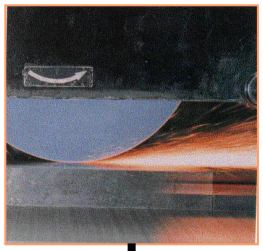
Increase MRR: Increase "hc"

- Increase "d"- the D.o.c. -- Creep Feed Grinding
- Increase "(Vw*d)" -- MRR' -- High MRR' Grinding
  -- Grinding from Simple Solid Shape (GS^3)
- Increase "(Vw/Vs) – High productivity Grinding
- Increase "(Vw*d/Vs)" – High Efficiency Deep Grinding

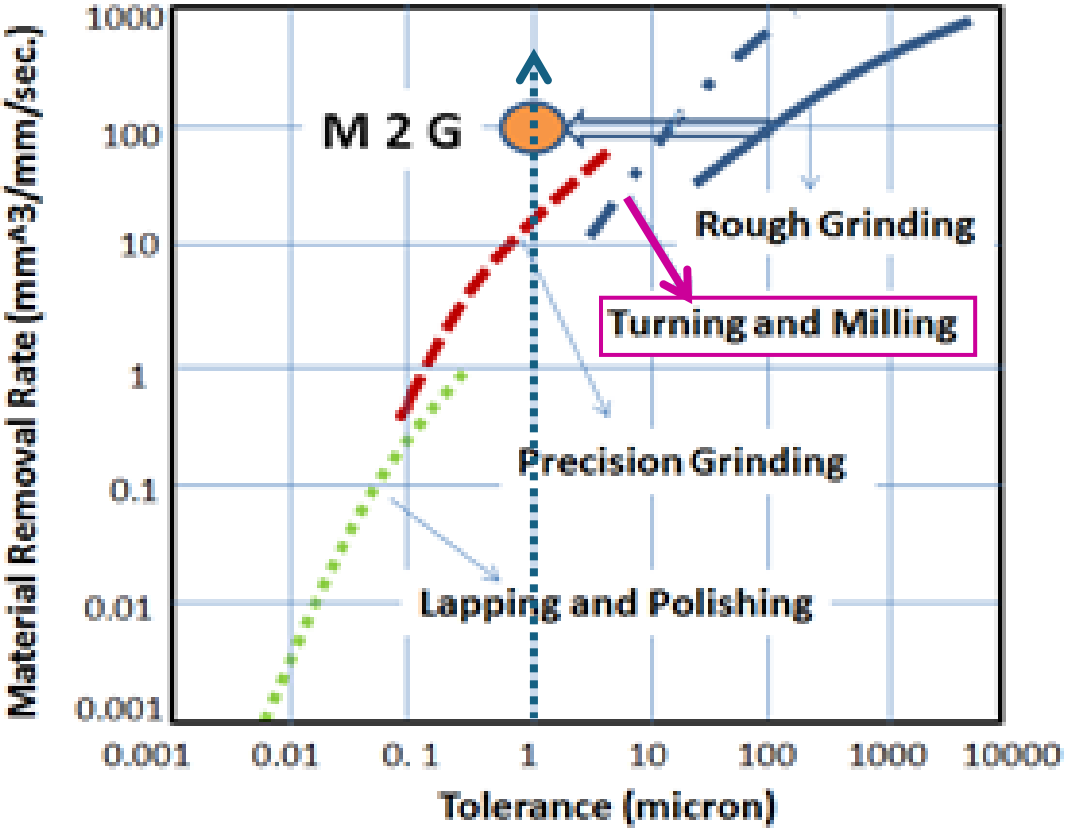
Achieve Fine Finish: Decrease "hc"

- Increase "C" -- use finer abr. grain sizes – Micro grinding.
- Increase "Vs" -- High Accuracy Grinding

Transformation /Science: driver for Process Innovation



- **Grinding = Machining (Interaction 1.1) + Tribology (Interactions 1.2, 1.3, 2, 3, and 4).**
- **Grinding – Tribology = Machining (using abrasive tools and processes)? (M2G)**



Source: Figure 23. Microscopic Interactions in Surface Generation Processes Using Abrasive Tools
https://stimsinstitute.com/wp-content/uploads/2018/01/manu-17-1209-final.pdf

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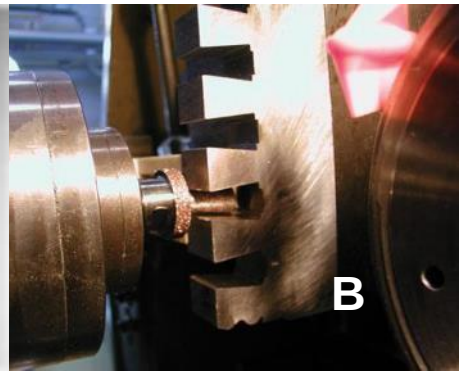
M 2 G of complex shapes from simple solid blanks

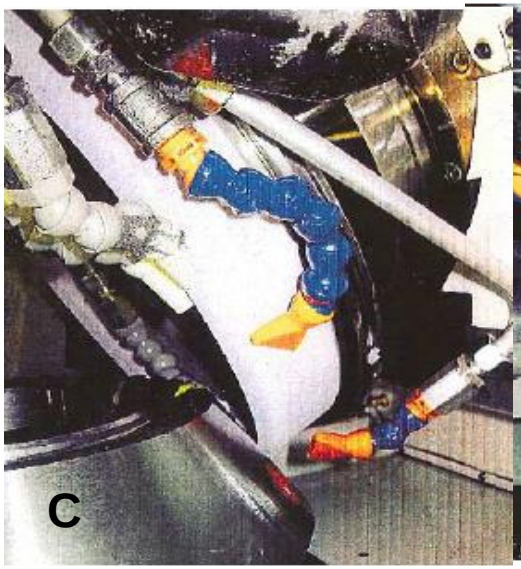
A, B: Aerospace Components

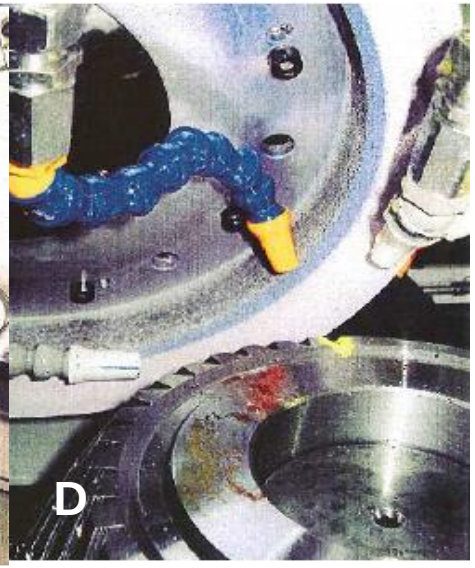
C, D: Hypoid gears from solid blank

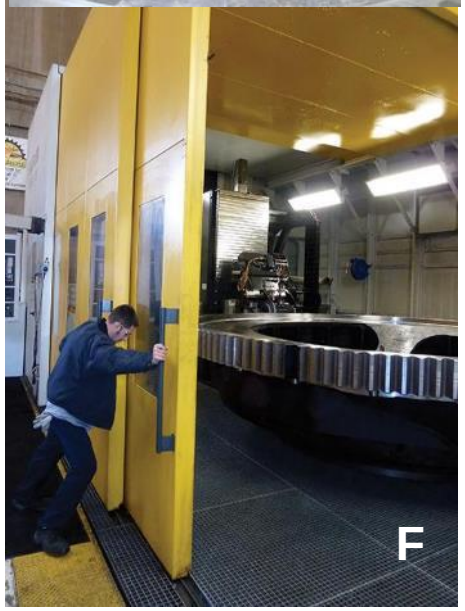
E, F: Large Wind Mill gears from solid blank

- **Higher Productivity**
  - **Better Quality**
  - **Closer tolerance**
  - **High Material removal rates**
  - **Reduce secondary operations**









http://www.mmsonline.com/articles/grinding-turbine-rotors-has-advantages
http://www.gearsolutions.com/article/detail/6368/advances-in-abrasive-technology-for-grinding-gears-from-solid
http://www.mmsonline.com/articles/grinding-big-gears-from-blanks

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Knowledge Integration through the "System Approach"

- Design, Mfg.
- Customer Test support
- Customize Wheel fabrication
- Distribution services

Machine Tool

- Design, composition, process
- Finishing – Solution, Eqpt., Inspection
- Pricing, Distribution, Supply Chain. Qty.

Abrasive Tool

Microscopic Interactions and their judicious deployment

- New Products with Fast Growth for all players involved
- Growth opportunity in a "stagnant" manufacturing sector in USA
- Interdisciplinary jobs and Career growth for many.

INPUT

Component:

TF head substrate

- Materials Technology
- Dedicated pull customer
- Rapid growth market
- Many start ups

Operational Factors

- Work support / fixtures
- Coolant nozzles / Application.
- Dressing sticks / process
- Process know-how
- Inspection methods

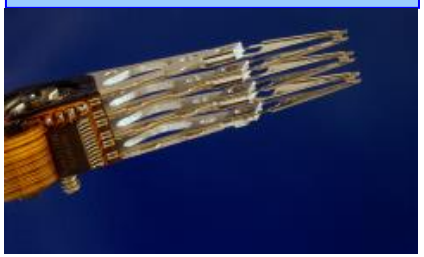
TRANSFORMATION

Measurement and Analysis

OUTPUT

- **Higher recording Density and speed**
- **Floppy Disk to Hard Disk**

Thin Film (1X1mm) Magnetic Recording heads



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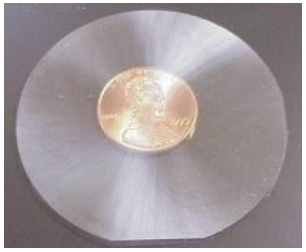
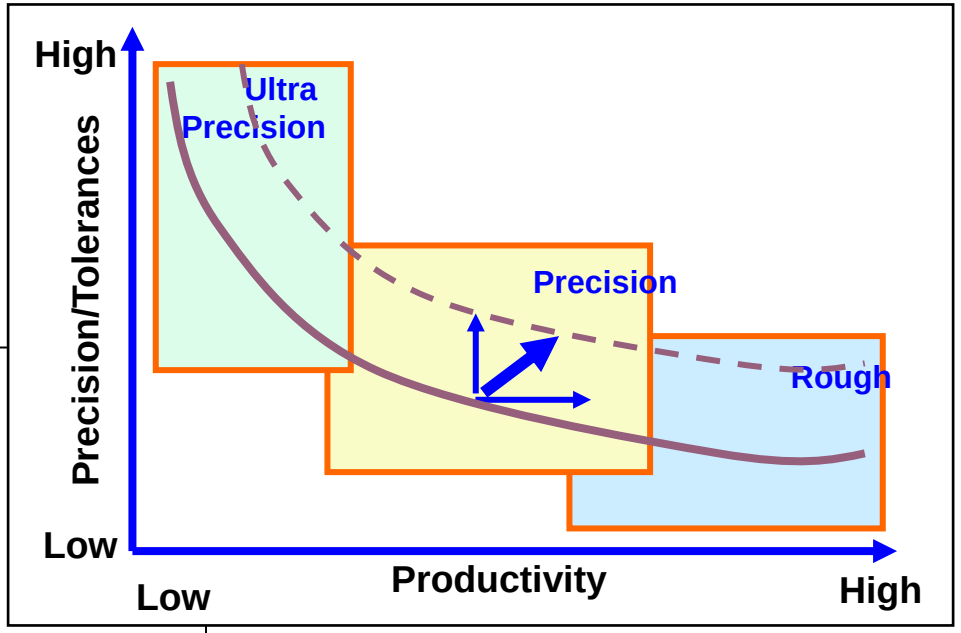
End to End Innovation: From Science to Strategy:
There are always needs for Precision Engineering Solutions, with every new or emerging need!

STRATEGY

Si Wafer (50µ)



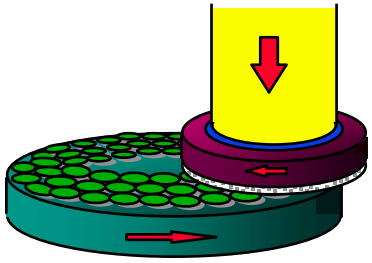
Sapphire Wafer (150 µ)



HDD IC, LED and PV Solar

Double Disc Grinding of Bearing and auto parts

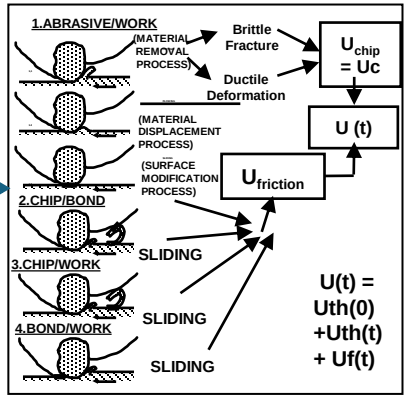
Disc Grinding of Springs



Blanchard Grinding

ENGINEERING

SCIENCE



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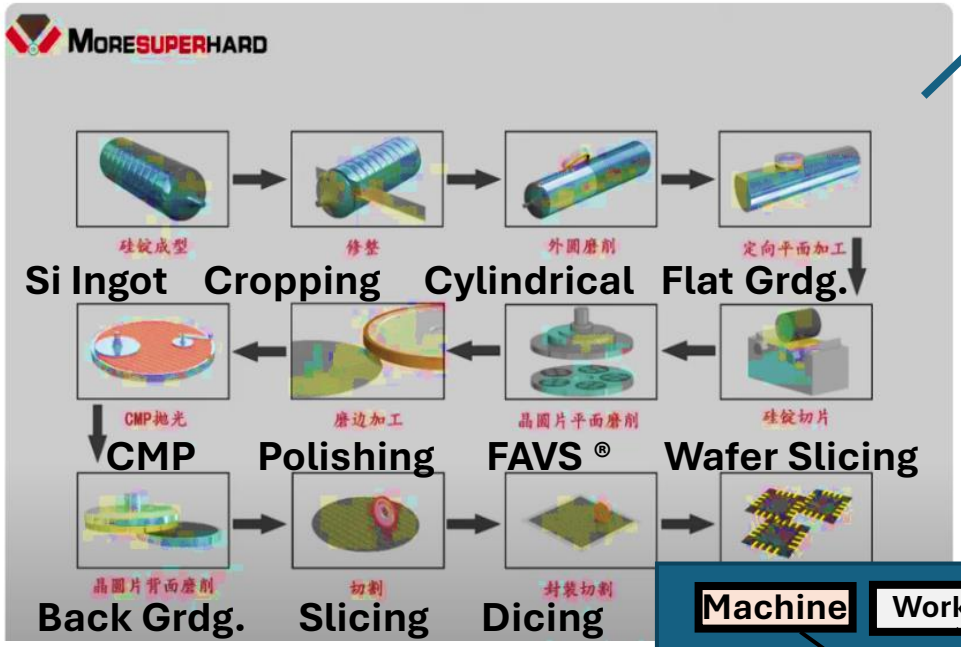
Strategies for End-to-End Innovation - "System Thinking" and "Transformational Skills"

Looking ahead:

End to End Innovation for Semiconductor Si Wafer grinding and Processing:



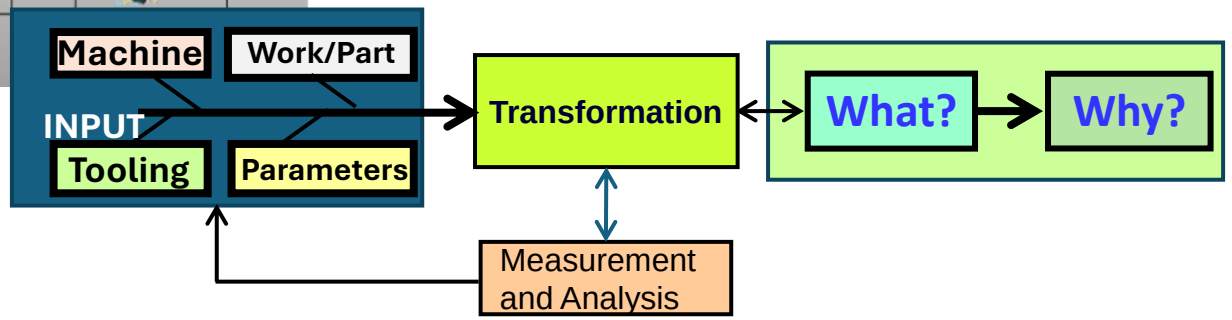
https://www.youtube.com/watch?v=a8ojTwibn7A

Each of these processes need Innovation:

- **Machine Tool**
- **Tooling:** Abrasive Tool, Dia. Dresser, Coolant, Work Holding, Part Handling, ...
- **Part / Component:** Supplier, Manufacturer, Supply Chain, ...
- **Parameters:** Process Engg., Know-how, Machine setting, ...

Every one of the above need:

- ❑ Awareness
- ❑ Analysis
- ❑ Synthesis: End to End Solutions!



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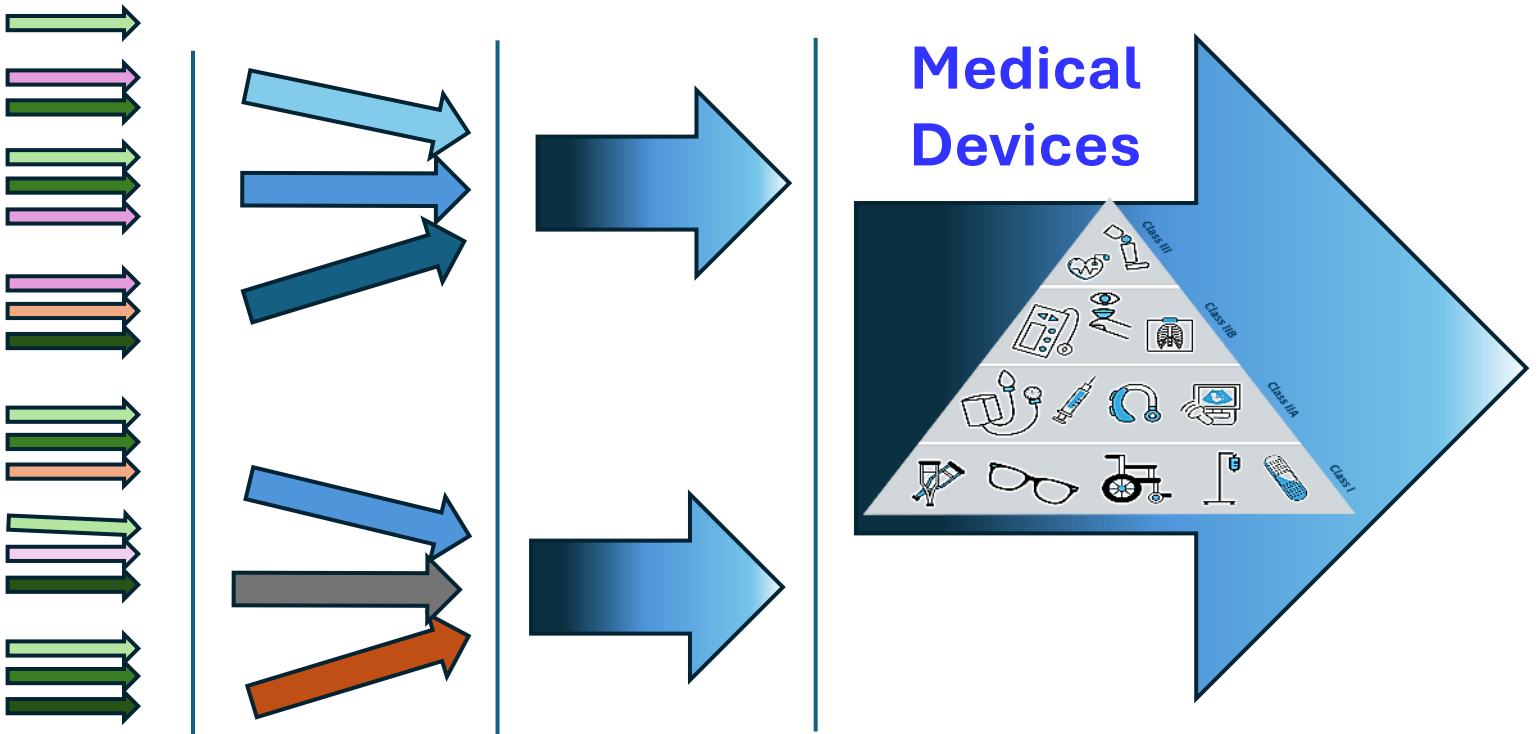
Sector Specific End to End Innovation:
Requires sustained Eco-System Development.

Each of these processes need:

- Machine
- Tooling
- Work / part
- Process Engg.; Know-how.



Tier 1 → Tier 2 → Tier 3 → OEM

Success of Tier 1 innovators depends on indigenous OEM pull and support!

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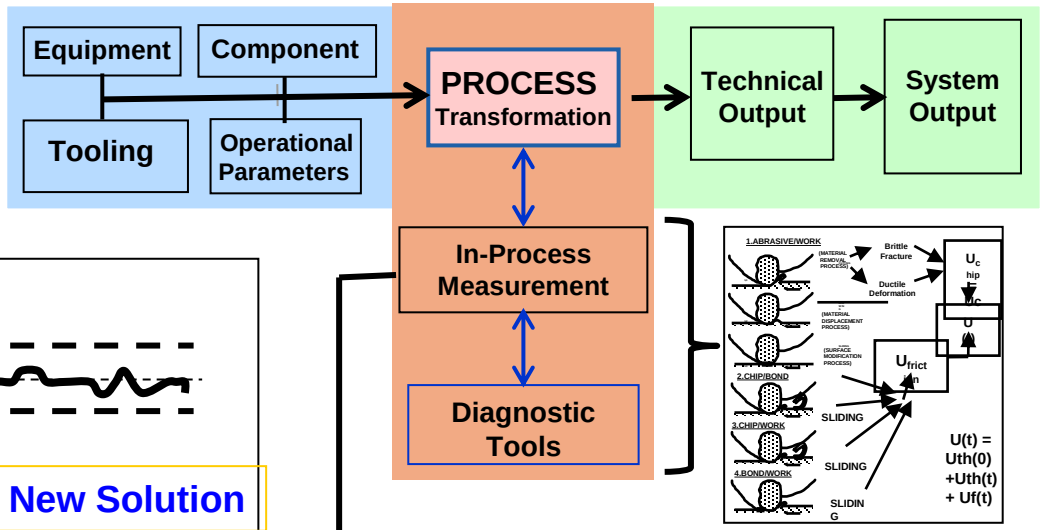
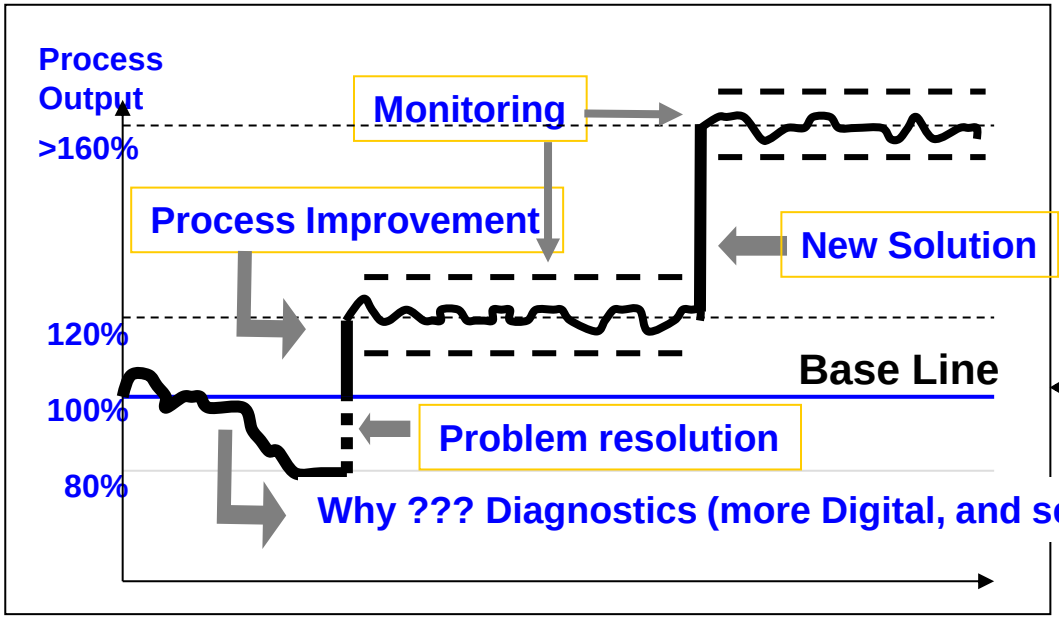
"Science" = Academic Research, needed, but only when it is useful!

Five Pathways to make your impact:

—Diagnostics
—Problem Solving
—Process Improvement
---Process Maintenance
—New Solution or Step Change





Progressive Impact of "Science" backed Up by Diagnostic Tools

Source: Figure 6.5. https://www.amazon.com/Thriving-Transformational-Technical-Professionals-Managers/dp/0791860167

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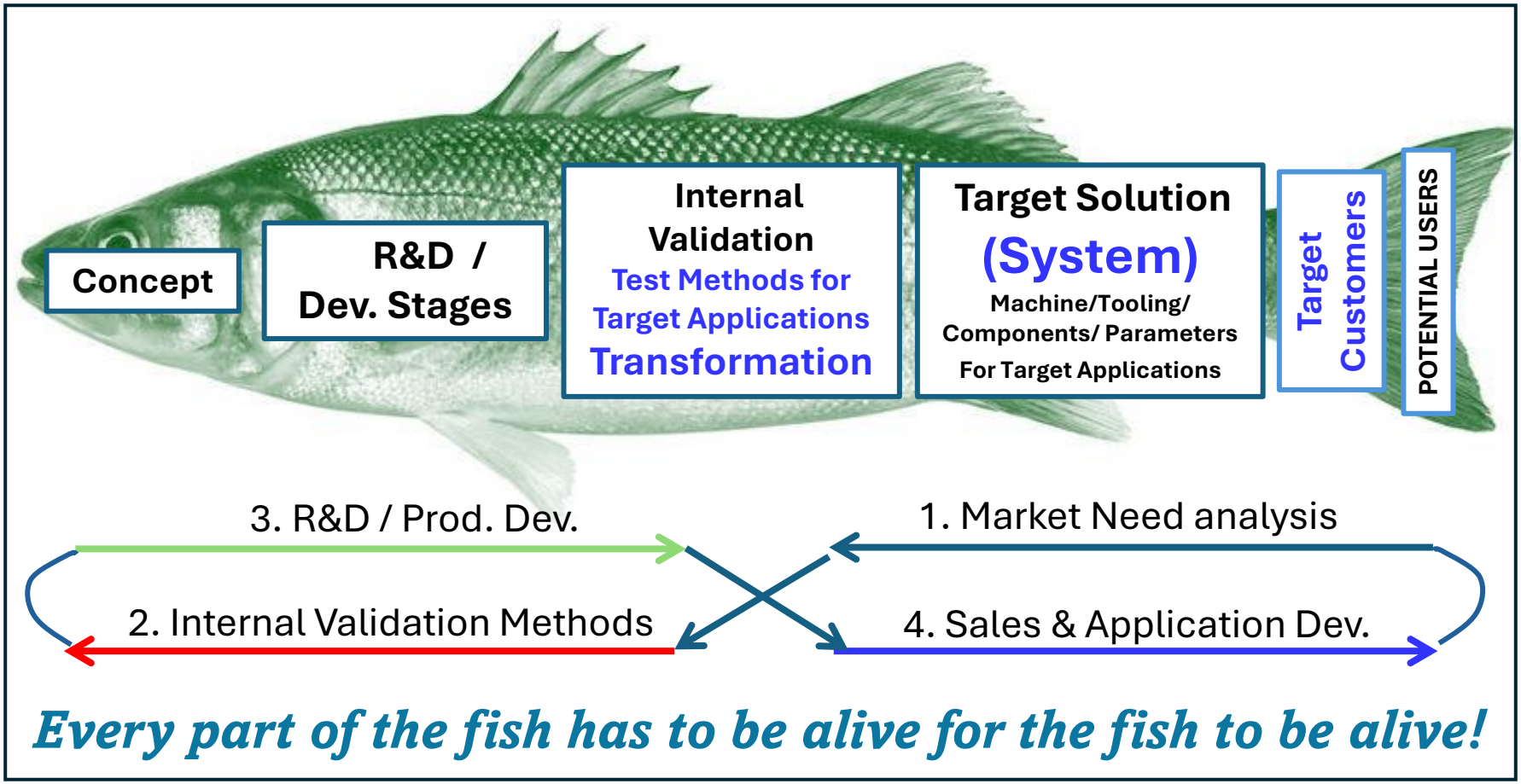
End-to-End Innovation requires:
Target Customers and Eco-System Development



Reference: https://stimsinstitute.com/2020/02/19/developing-talent-pool-every-part-of-the-fish-has-to-be-alive-for-the-fish-to-be-alive/

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Strategies for "End-to-End Innovation"

—Identify opportunity that can offer an immediate benefit and a new pathway to customers in the long run.

—Look for a structural opening.

Excess capacity, government subsidies, and other incentives Reduce the risk of innovation investment.

AMTDC Collaboration is a form of leveraging "Structural Openings"!

All equipment and resources in R&D Labs. are "Excess Capacity"

Faculty and student resources – beyond education and degree – are underutilized resources?

— Strike a partnership – EMOTIONAL INTELLIGENCE!

Partner with smaller companies or institutions to fuel their growth

Infuse the start-ups' innovative ideas with resources, customer relationships, and other competitive advantages they lack.

AMTDC is in the middle - not a startup or a "big" research group.

AMTDC projects could help larger Co. grow through process knowledge and equipment needed (Robot consortium)

AMTDC partners with small entrepreneurs (e.g.) https://www.gimsindia.in/

— Provide tools to enable others' growth.

Innovators can spread their risk across numerous industry participants through Knowledge Integration resources (e.g.): KITE Platform.

Source: McKenzie Report on Innovation success models.

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Harsh Realities – Not Everything is "Rosy"!

Case Study:

A recent personal experience working with a Precision Component Manufacturer in Bangalore, India

We reduced the cycle time by over 33% with the potential to reduce another 33%. more!

Results accomplished remotely, relying on Digital Data – Smart Mfg.?

Customer engineers were supposed to follow up to gain the next 30 %

Neither the engineers nor their managers have the aptitude to follow through.

- **Lack System Thinking:**
- **Need Eco-system:**

Set up R & D Projects for real life problem solving – "System", with shared commitment, to leverage all resources; stake holders with need for commercially relevant innovation. --- This was the motivation behind AMTDC.

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Sources of Knowledge

Academic

NEW Solutions

Replicate / Plug & Play

Transformational Skills

Knowledge
Experience
People Skills

AMTDC Project Experience

AMTDC

Industry/ Specific

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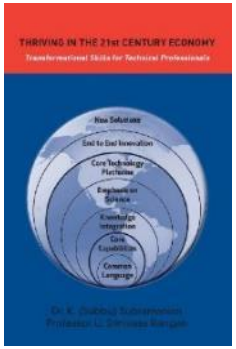
System Thinking and Transformational Skills are required at all levels.

AMTDC Project Experience

- System Thinking
- Hands on learning
- Look before you leap
- **Leap you must: to stay ahead in this Knowledge Economy**
- **Transformational Skills: Leap Boldly and land safely!**

Transformational Skills



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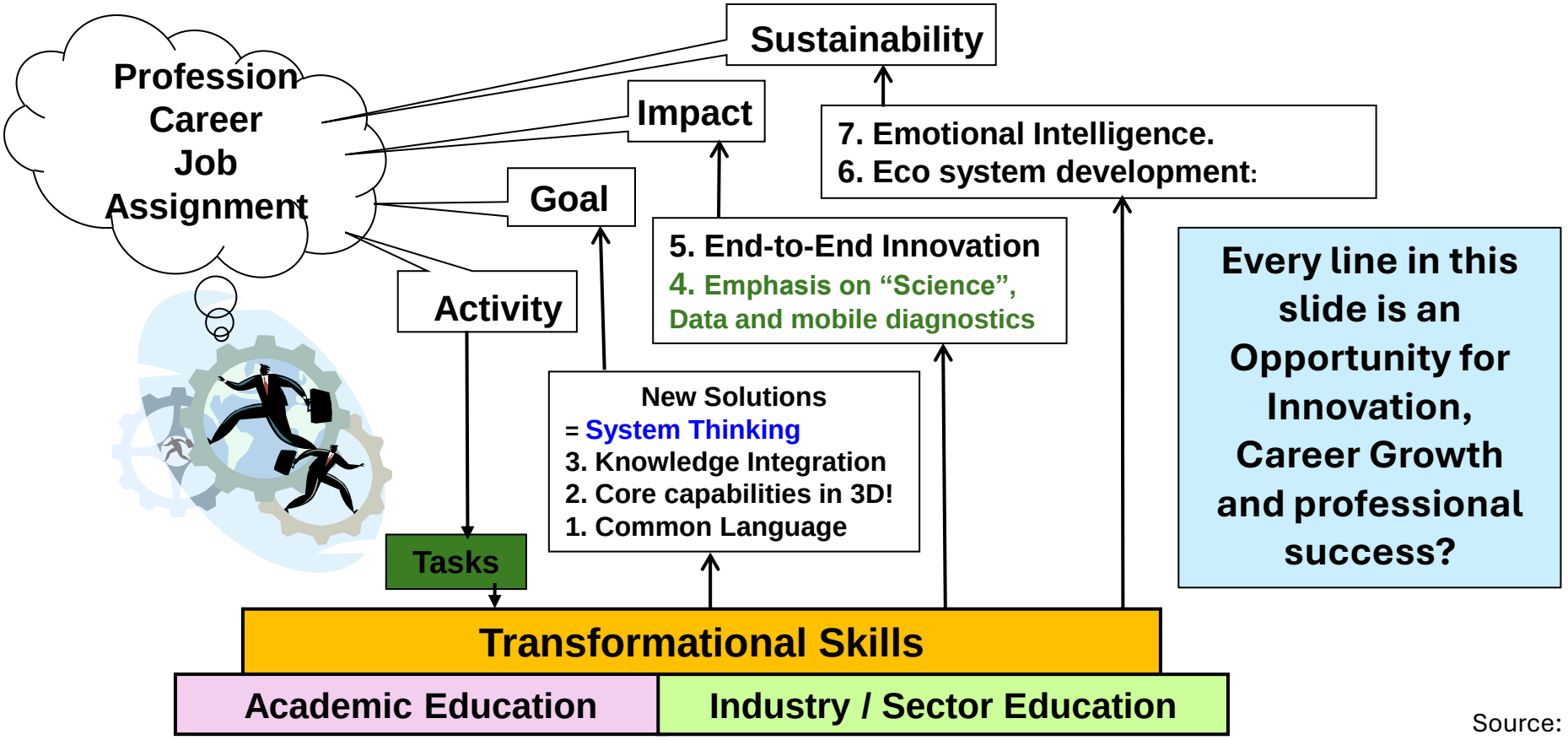
System Thinking and Transformational Skills: Strategy for Lifelong learning:

Progressive Evolution of Professionals and Their Solutions



Source: www.STIMSInstitute.com

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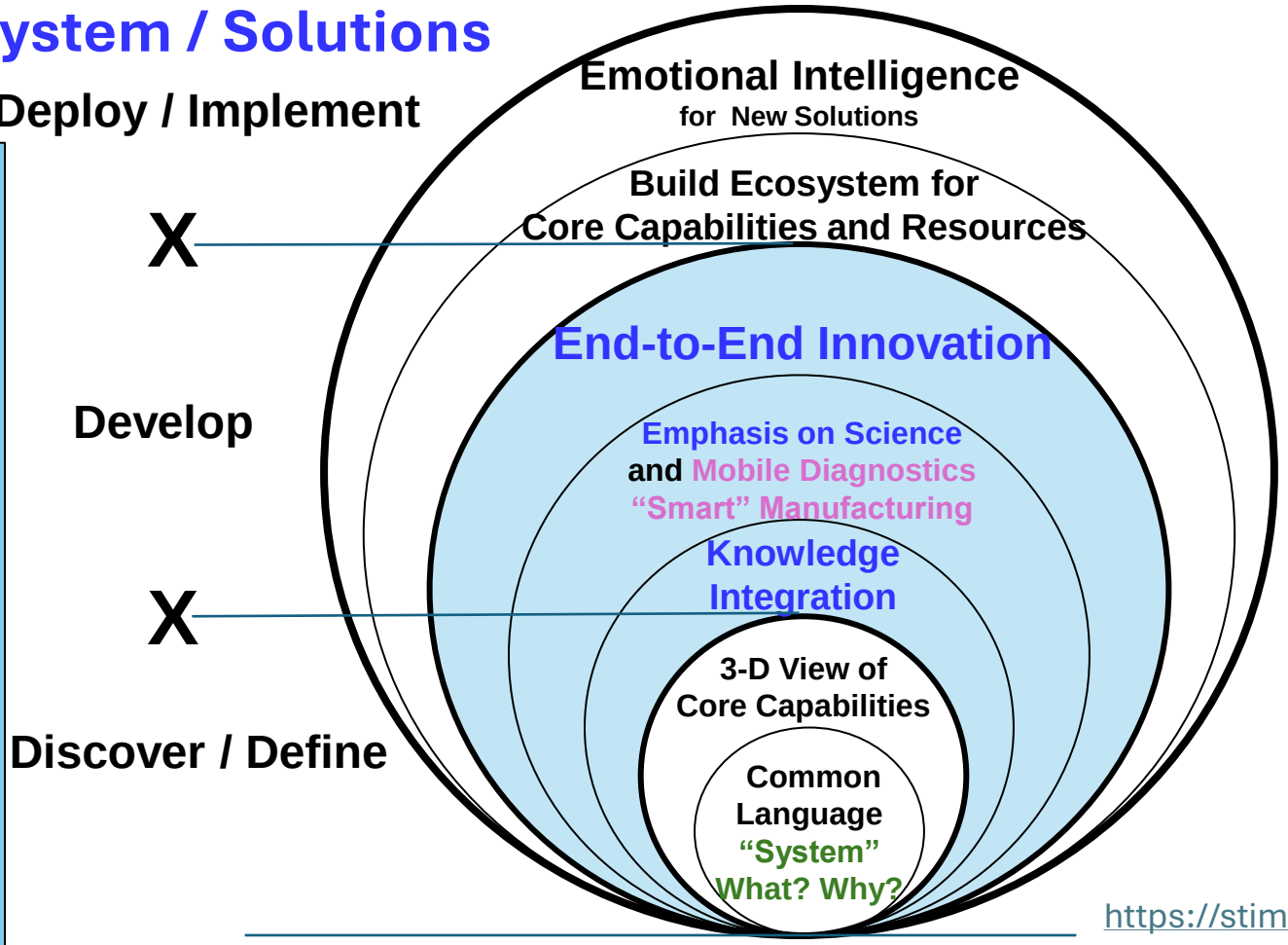
Transformational Skills

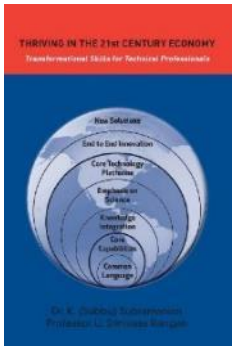
Core Capabilities in 3D :

People:
- Knowledge,
- Experience,
- People Skills

Project:
- Science,
- Engineering,
- Management

Enterprise:
- Technology - Solution (STIMS)
- Digital Tech.
- Finance / Market drivers.





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Thank You!

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