

The System Approach

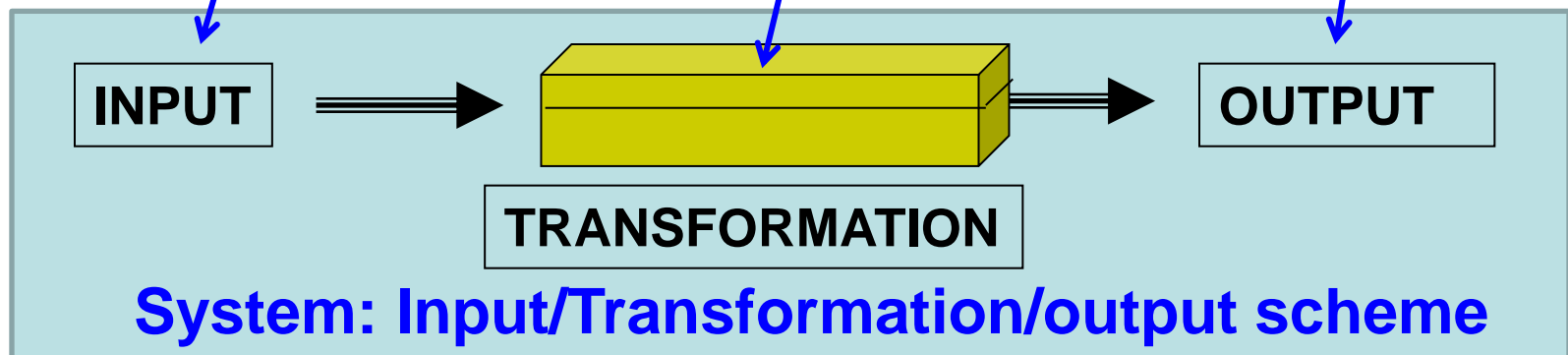
What is a “System”?

A system is a collection of parts, which interact with each other to function as a whole. --- Draper Kauffman, “Systems Thinking”

A system is a perceived whole, whose elements “hang together” because they continually affect each other over time and operate toward a common purpose.

--- Peter Senge, “Fifth Discipline”

A system is a network of interdependent components that work together to try to accomplish the aim of the system. A system must have an aim (goal). Without aim there is no system. --- W. Edwards Deming, “The New Economics”

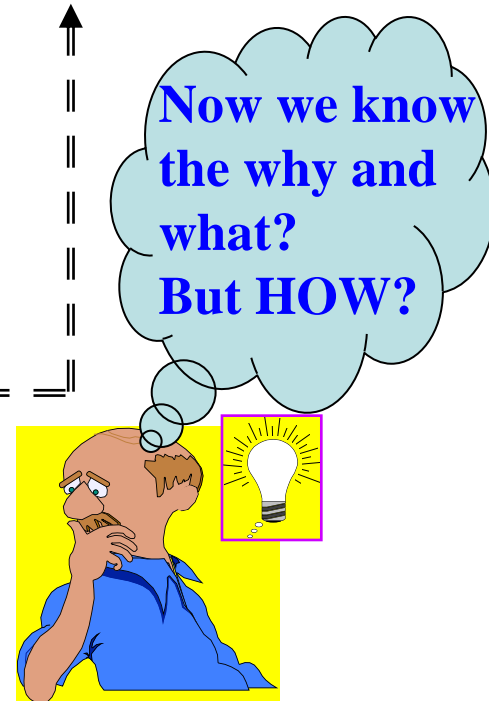
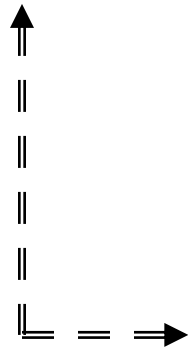
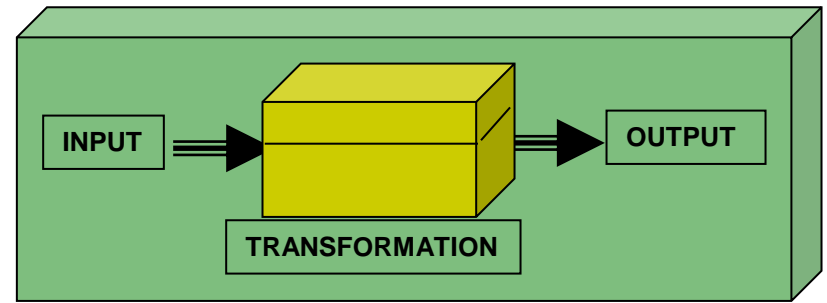


What is a Solution?

“input/transformation/output” system leading to added value to those who are willing to pay for such value addition!

What is the Need ?

- Create and implement New Solutions
- Replicate known solutions in larger quantities

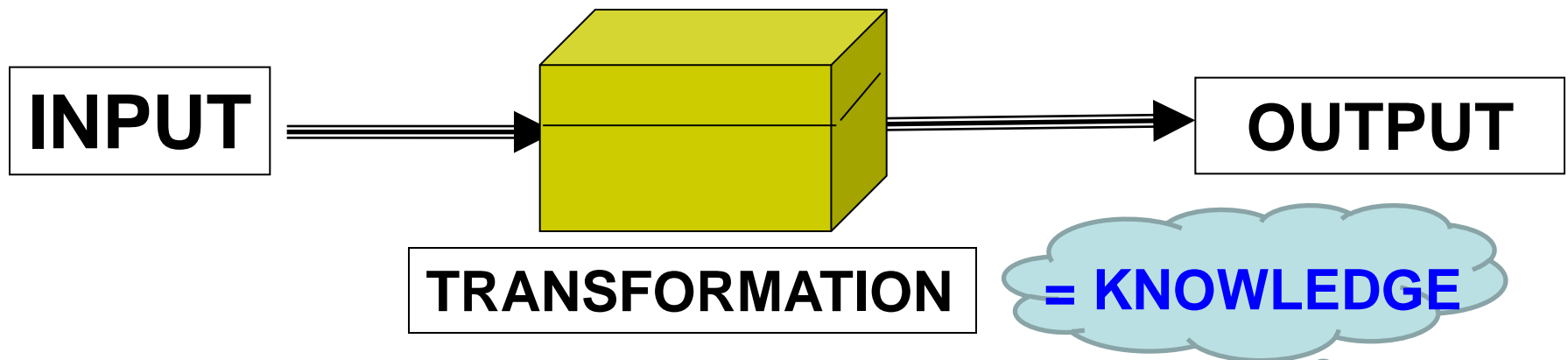


What is a Solution? What is the Need?

What is a Solution?

Solution:

“input/transformation/output” System,
leading to added value with reward for such value addition!



Solution: **KNOWLEDGE** and its **USE!**
SYSTEM THINKING.

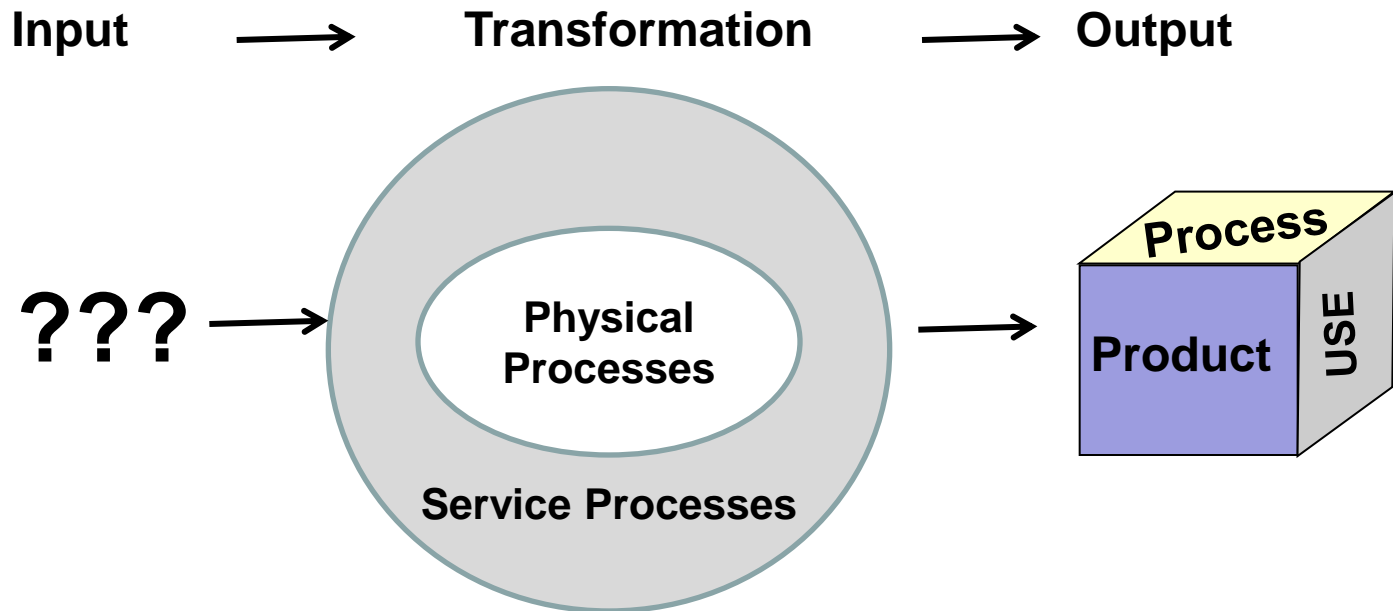
Dr. K. (Subbu) Subramanian

STIMS Institute (*Science Based Technology Innovation and Management Solutions*)

SubbuKDG@gmail.com



Manufacturing: A collection of Physical Processes and Service Processes.



Service Processes: Anything to do with Information and logistics
That collect process, analyze and disseminate
information and decision making

Physical Processes: Where physical change happens on the work material
(e.g.): Cutting, grinding, EDM, ECM, Welding, Forming, Forging,

Physical and Service Processes - Features

Process Category	Description	Characteristic Features
Physical Processes	Domain specific activities; directly impacted by technical professionals and their academic/sector specific skills	<ul style="list-style-type: none">• Physical sciences intensive• Physical goods and inventory• Relatively low end-user contact• Capital/investment intensive• Long development and implementation cycle
Service Processes	Domain neutral Information and logistics activities; impacted by IT applications solutions	<ul style="list-style-type: none">• IT applications intensive• Information and database• Active end user contact• Network and connectivity• Relatively short development and shorter implementation cycle

Quantum Improvement in Service Processes are Already Taking Place

Traditional vs. World Class

	Today ?	World Class (10 tears ago)	Traditional
Set-up Time		< 10 minutes Down to 1 minute	2- 4 hours 20 - 30 minutes
Quality		1,500 ppm, 0.15% 300 ppm, 0.3%	3 - 5% inside the Co.- 2 - 5% warranty cost 15 - 25% of sales (true cost of quality)
Plant or Space Utilization		> 50%	25 - 30%
Work as a Function of Touch Time Value added Time/Total Time		25 - 30%	2 - 4%
Material Velocity (Turns)		> 100 (3 days)	2 - 4 (3 months)
Flexibility Number of SKUs Manufactured/Setup		270 parts/machine tool	25 parts/machine tool
Distance a Part Travel through the Plant (From Receiving to Shipping Deck)		300 feet	> 1 mile (up to 2 or 3 miles)
Reliability of the System or Equipment		90 - 95%	65 - 75%

Tools: Lean, Six Sigma, ERP, BPOs, Outsourcing,

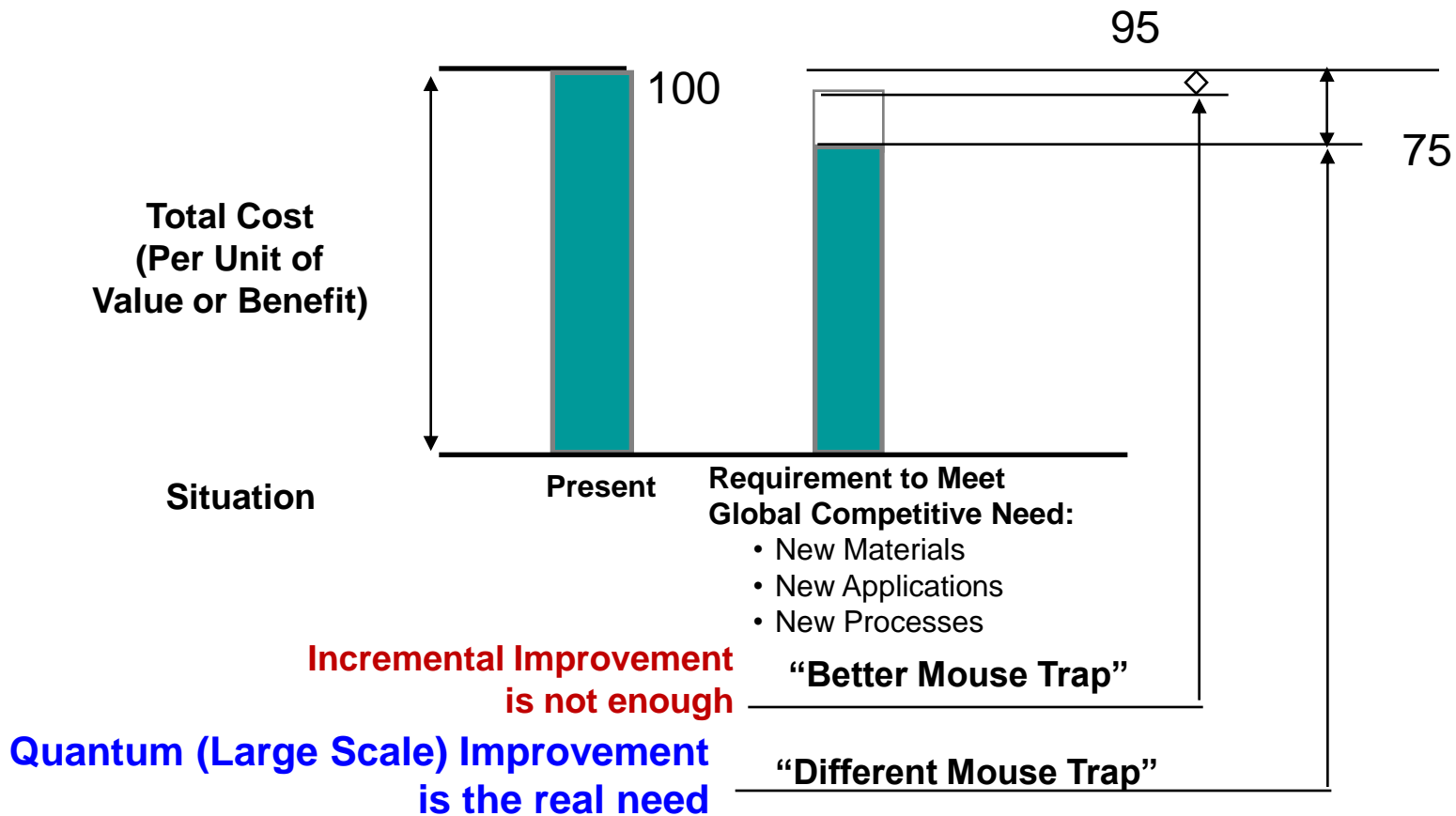
Dr. K. (Subbu) Subramanian

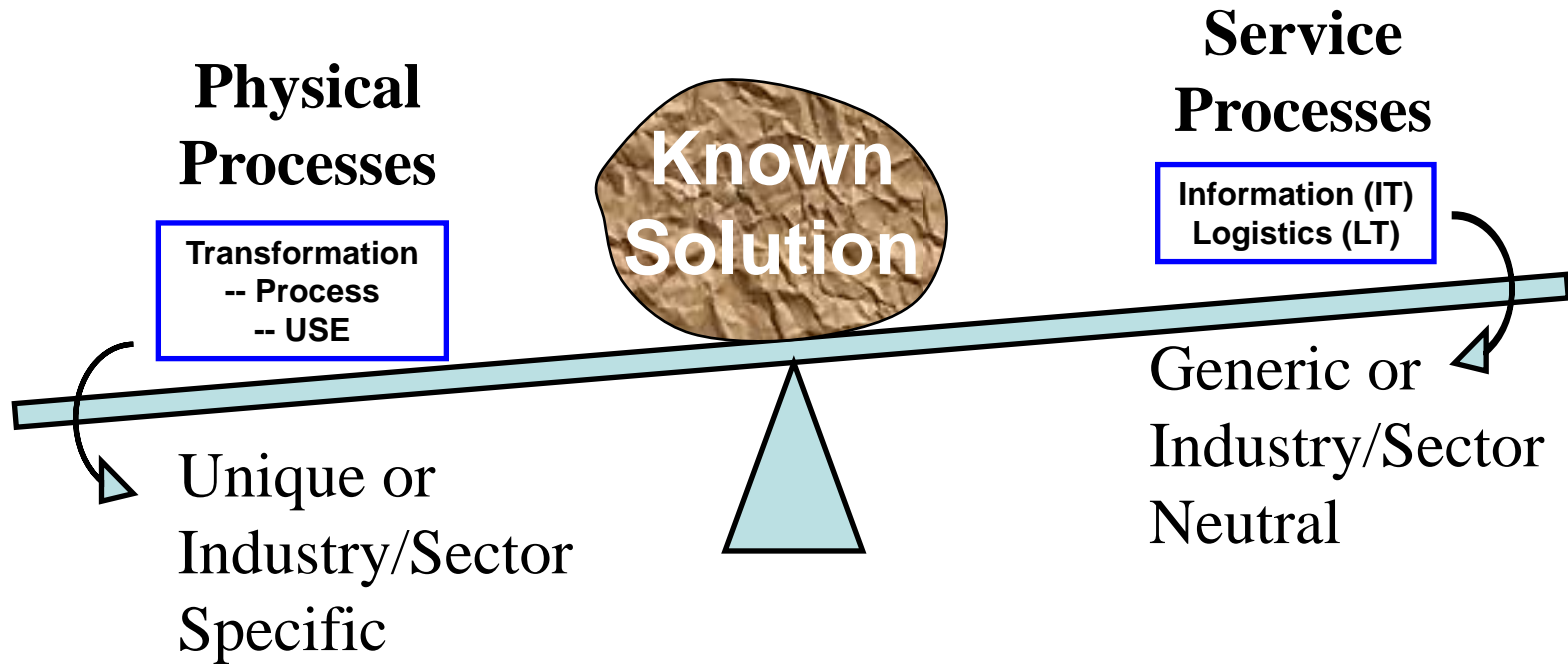
STIMS Institute (*Science Based Technology Innovation and Management Solutions*)

SubbuKDG@gmail.com

Manufacturing Processes

What is the Need?



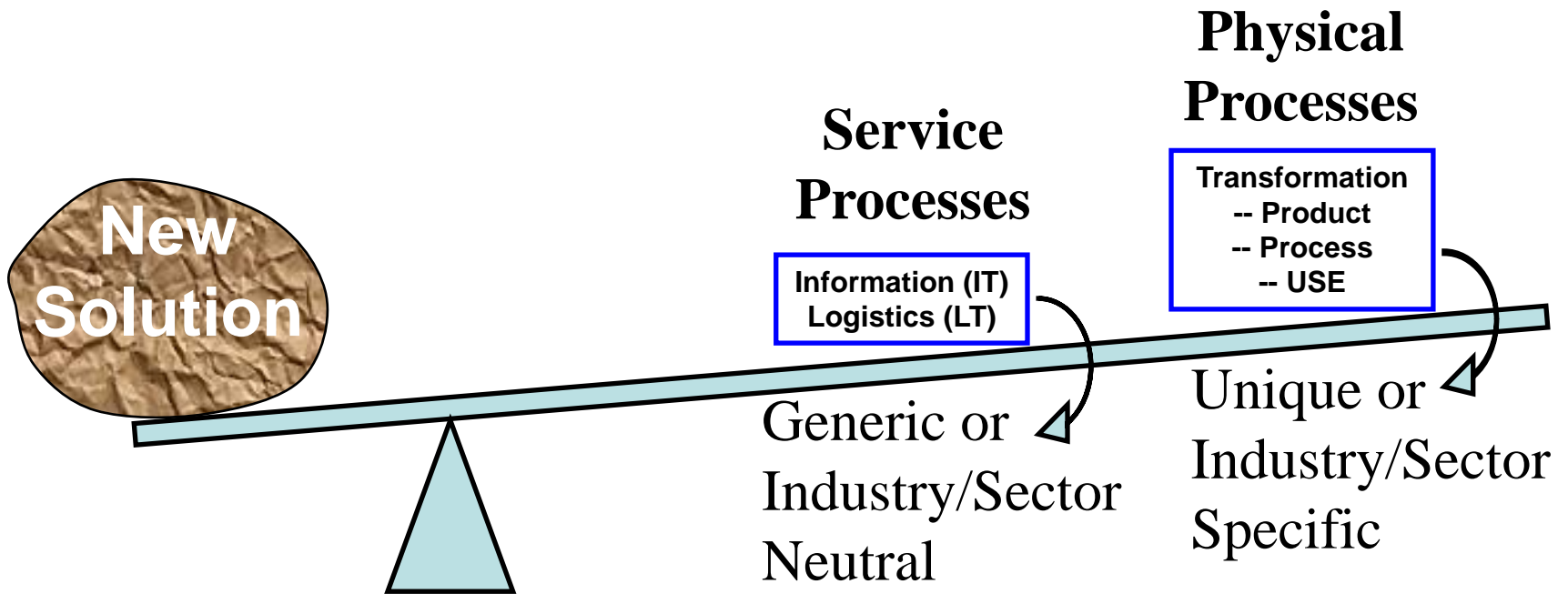


Model for end of 20th Century manufacturing

Dr. K. (Subbu) Subramanian

STIMS Institute (*Science Based Technology Innovation and Management Solutions*)

SubbuKDG@gmail.com



Model for Advanced Manufacturing for the 21st Century.

Dr. K. (Subbu) Subramanian

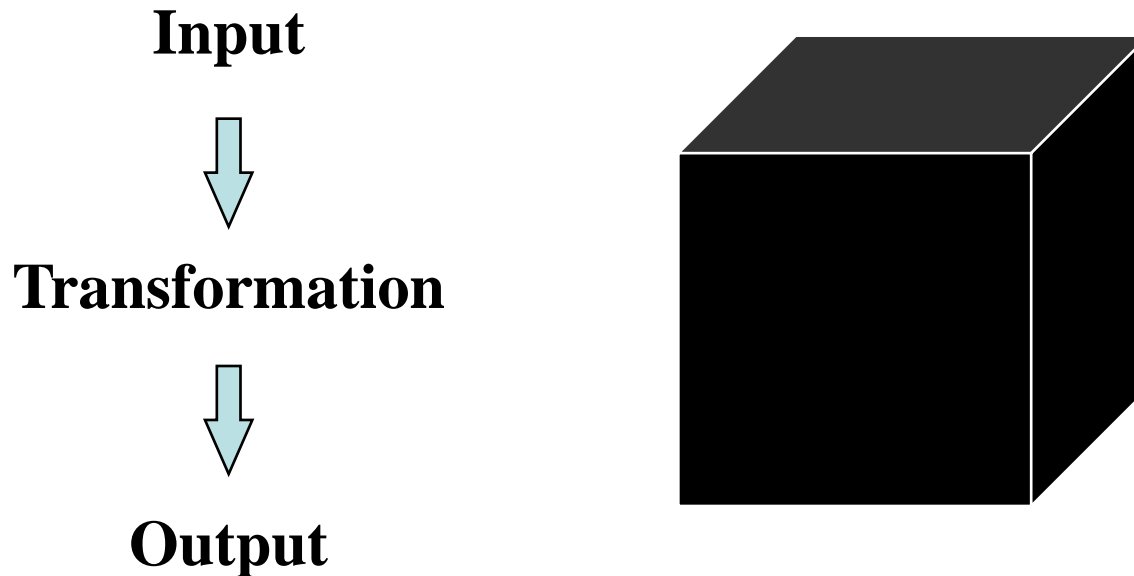
STIMS Institute (*Science Based Technology Innovation and Management Solutions*)

SubbuKDG@gmail.com

System Thinking

Manufacturing Process

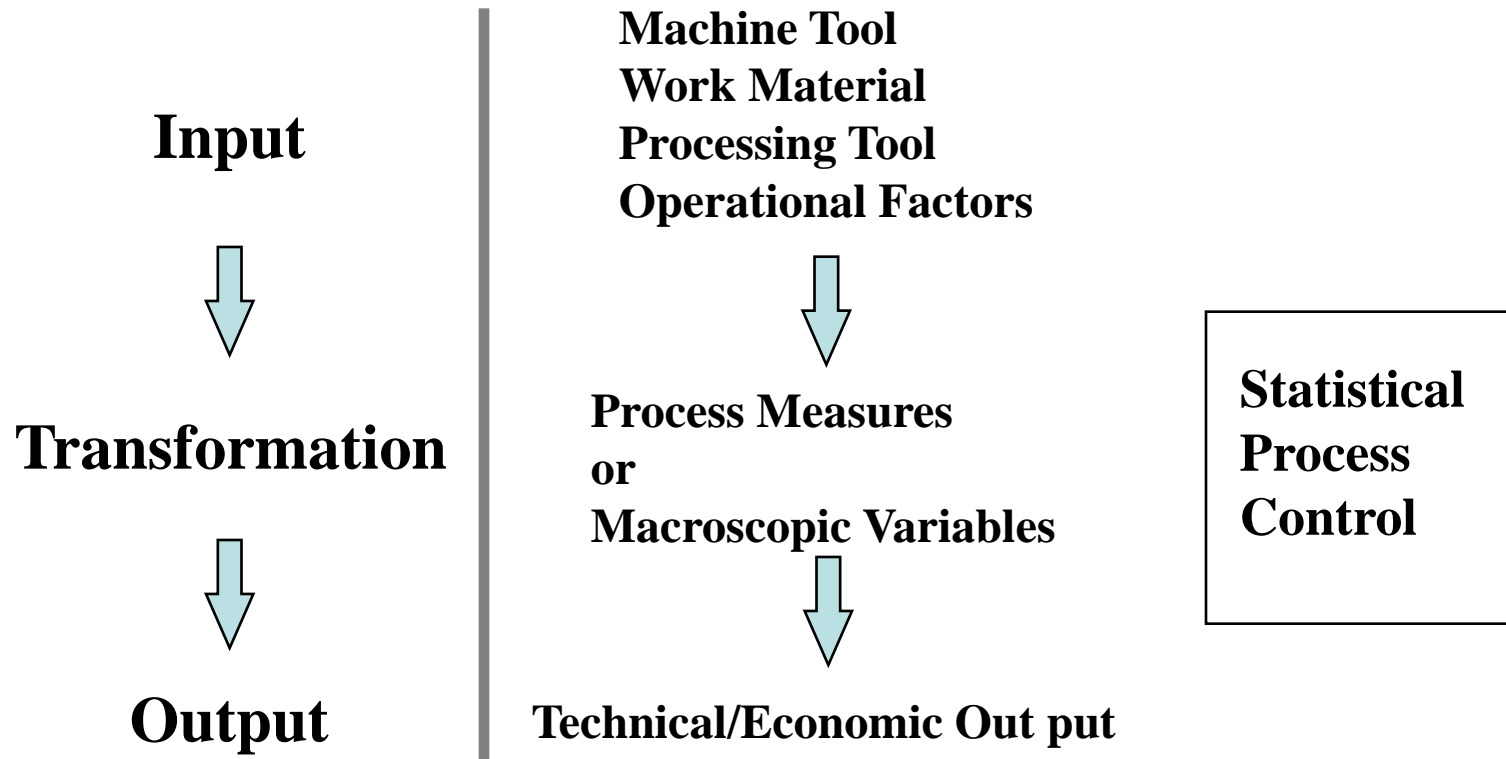
- It is not a “Black Box”



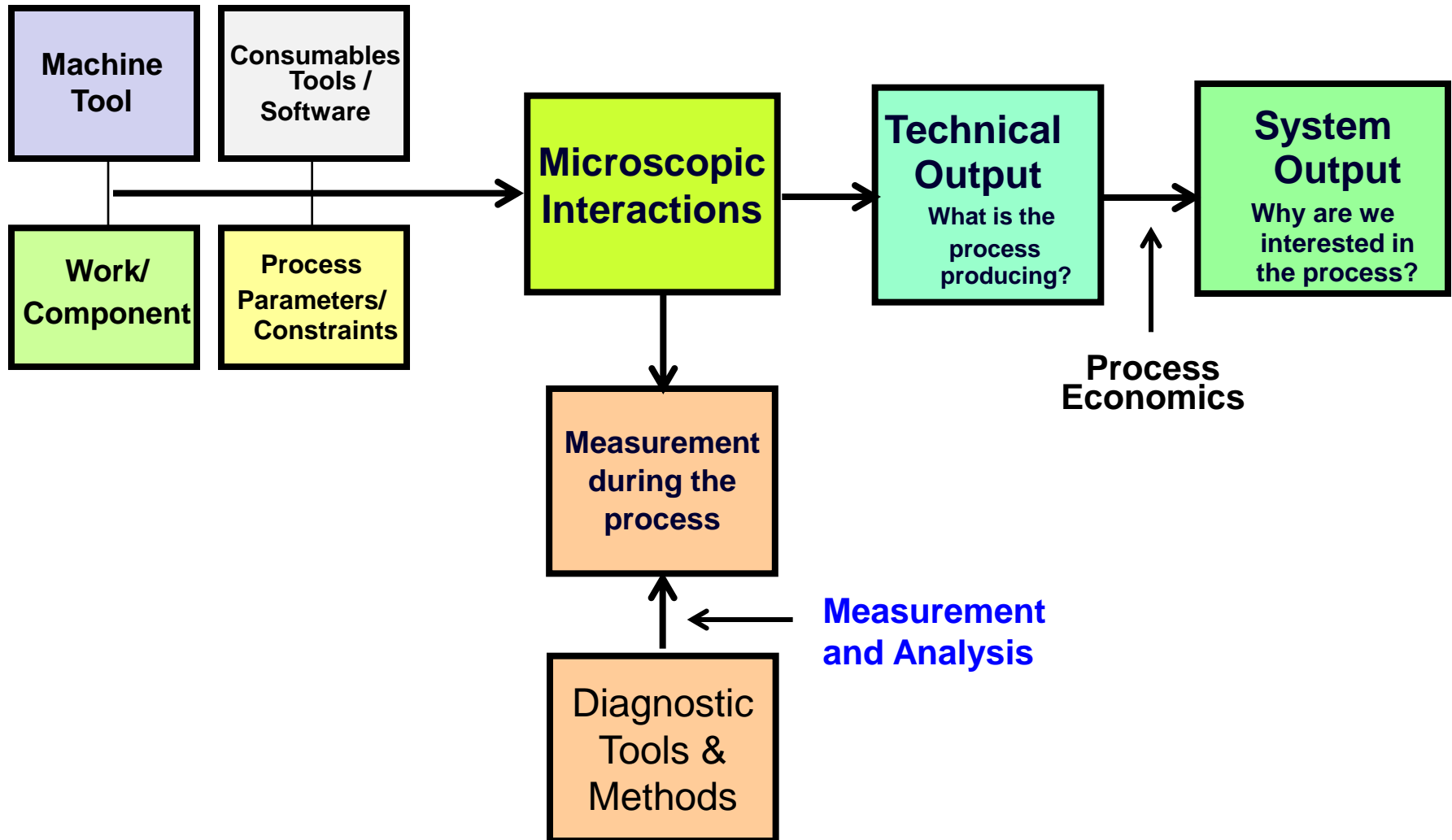
System Thinking

Manufacturing Process

- It is not just a Statistical Process

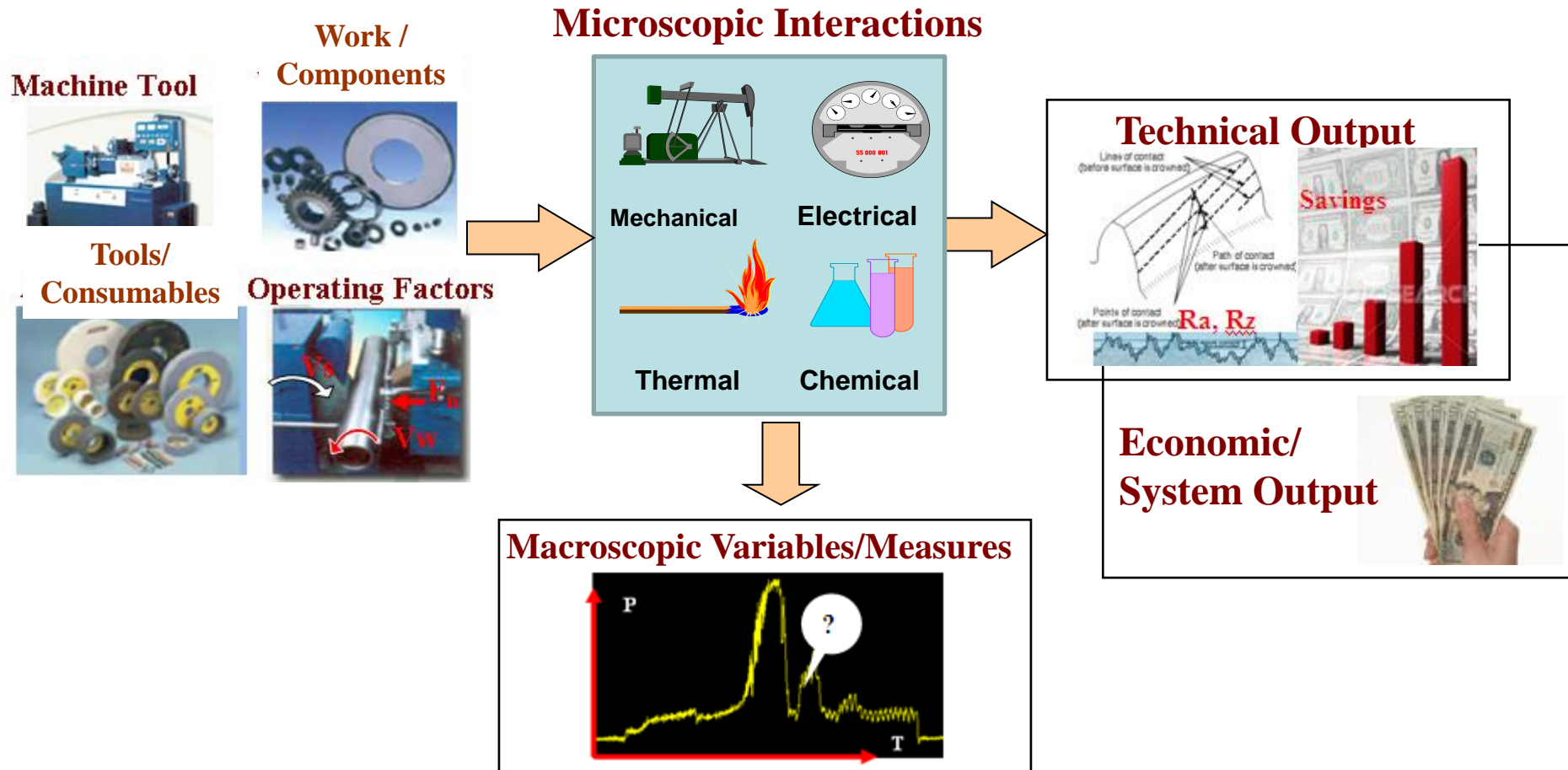


The “System Approach”



Manufacturing Process: It is a “System”

Input \longrightarrow Transformation \longrightarrow Output

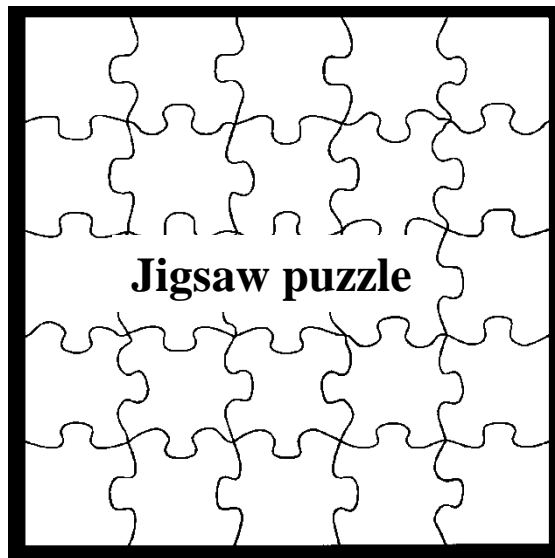


Dr. K. (Subbu) Subramanian

STIMS Institute (Science Based Technology Innovation and Management Solutions)

SubbuKDG@gmail.com

Why do we need The System Approach ?



Process Solution is a puzzle and requires either...

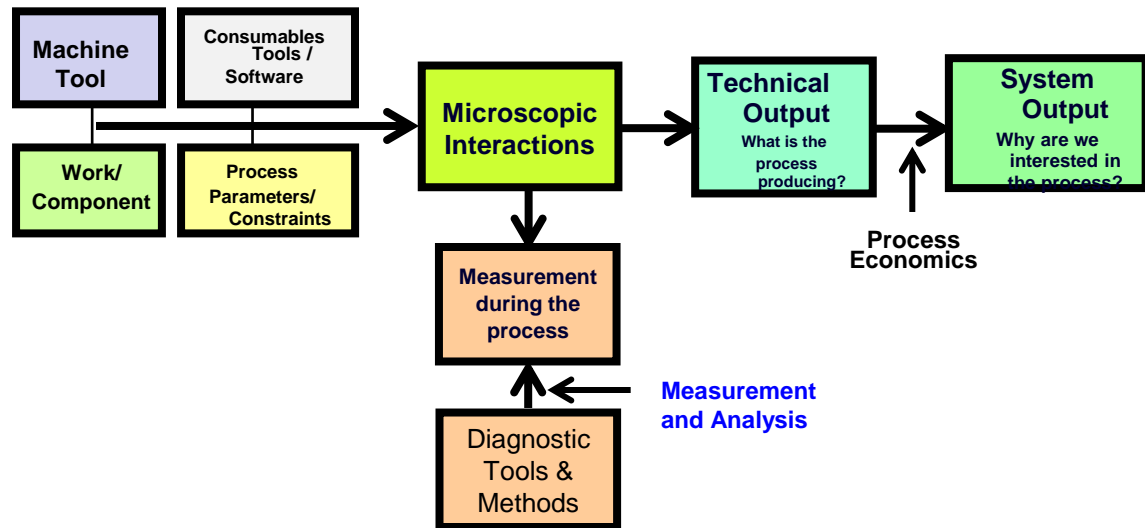
> One person with many years of experience with many companies, products and applications.

There are few people like this.

> Or, many people, each with a little knowledge, to fit together and solve the “puzzle” – the problem. This is very difficult and inefficient.

> So what do we do?

SubbuKDG@gmail.com

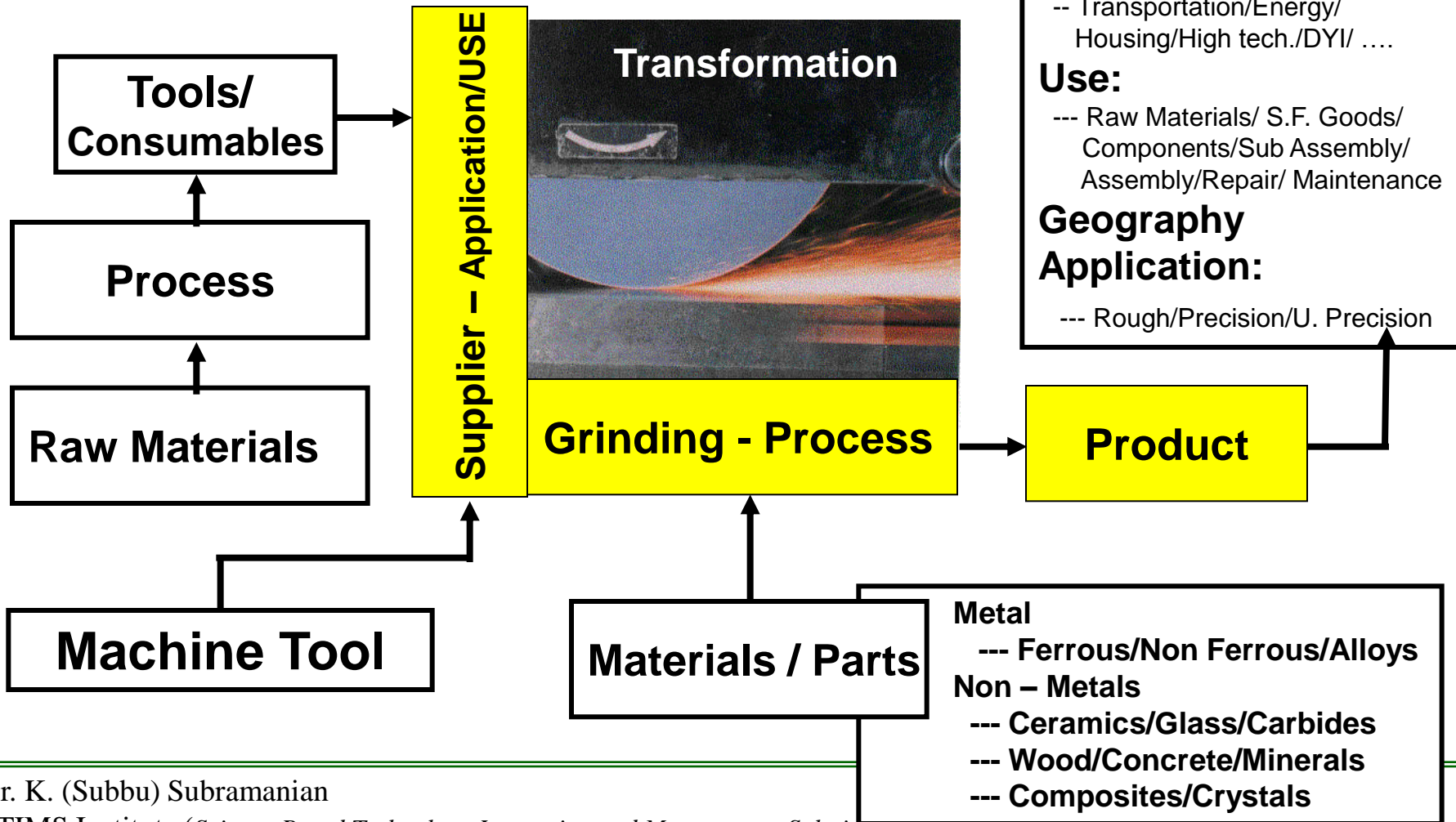


Use the System Approach

- Every person has the same information
- Everyone’s knowledge is integrated into a common framework
- **Awareness:** Fill all the boxes as much as we can. Then ask questions where the box is empty
- **Analysis:** Which question to be asked and in what order?

The System Approach: Integrating the Knowledge of every one involved in the Process (e.g): Grinding Process

End User



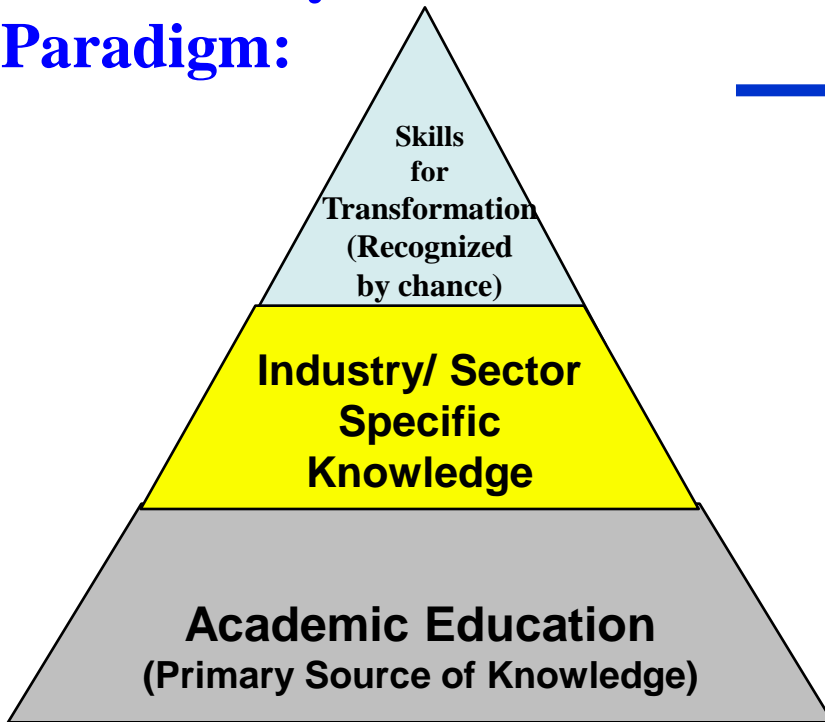
Dr. K. (Subbu) Subramanian

STIMS Institute (*Science Based Technology Innovation and Management Solutions*)

SubbuKDG@gmail.com

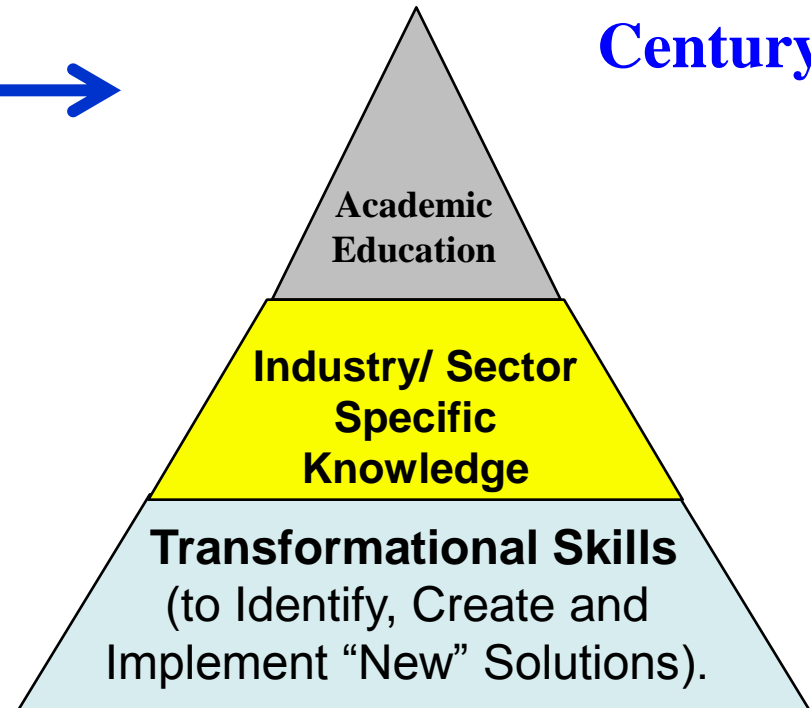
Sources of “Knowledge”

**20st Century
Paradigm:**



20th Century Paradigm

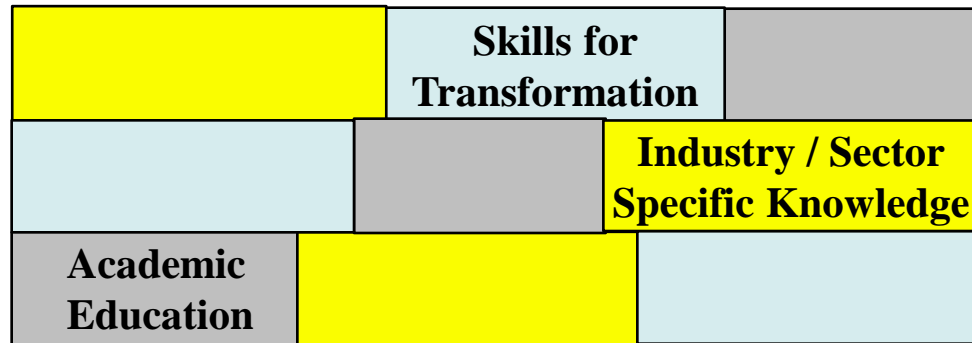
**End of 20th
Century**



End of 20th Century

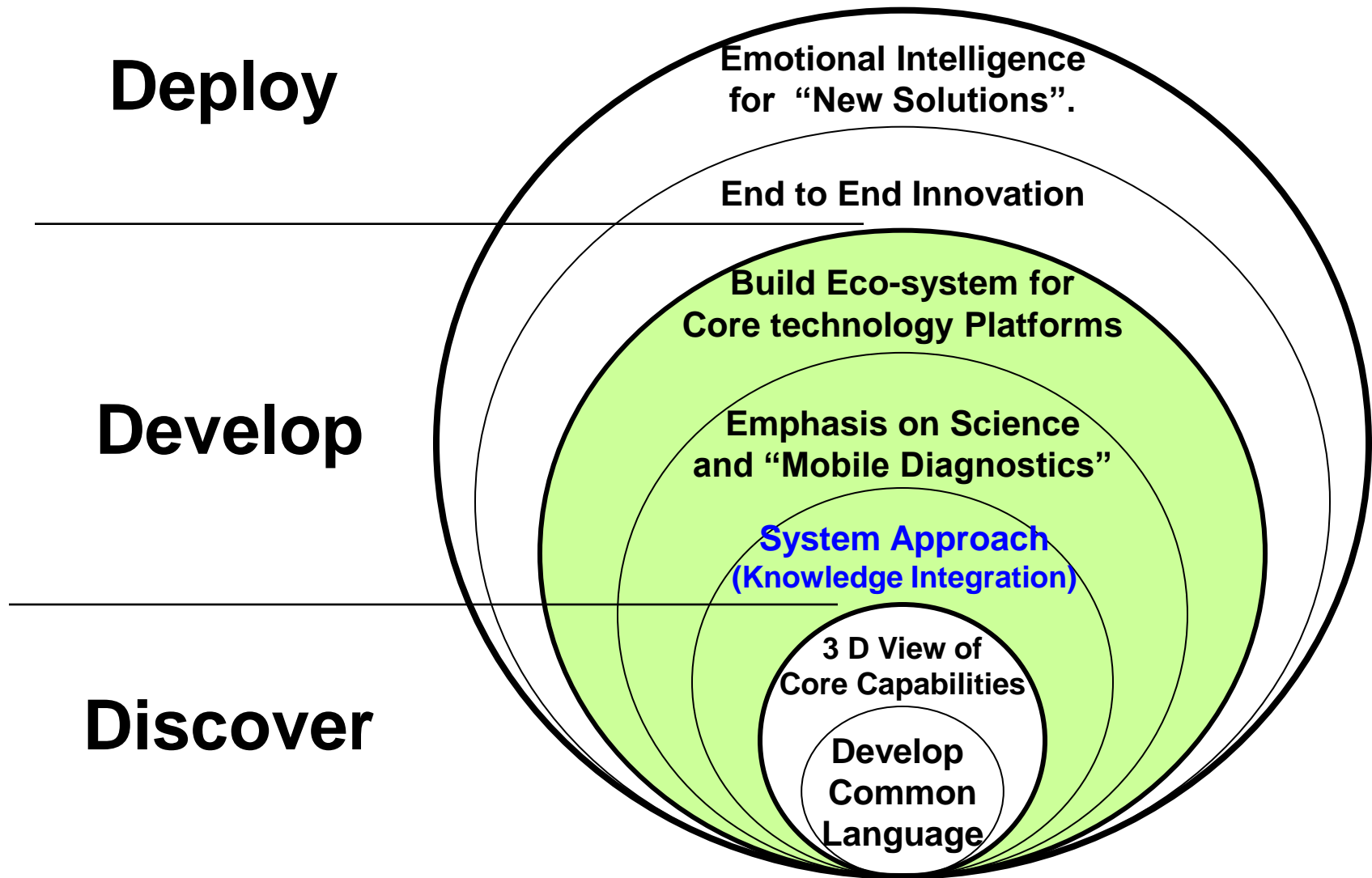
Sources of Knowledge and their order – 20th Century

Ordering of “Knowledge” required for success in the 21st Century



- **Building blocks to be used in an inter-dependent manner;**
- **Knowledge Integration in all three building blocks as needed.**
- **Use resources available from any where**
- **Generate impact across the globe.**

Transformational Skills for 21st century Technical Professionals.



Dr. K. (Subbu) Subramanian

STIMS Institute (*Science Based Technology Innovation and Management Solutions*)

SubbuKDG@gmail.com

Transformational Skills required for success in the 21st Century

- **Identify “New” Solutions :**

- Develop a “Common Language”
- 3D View of Core Capabilities

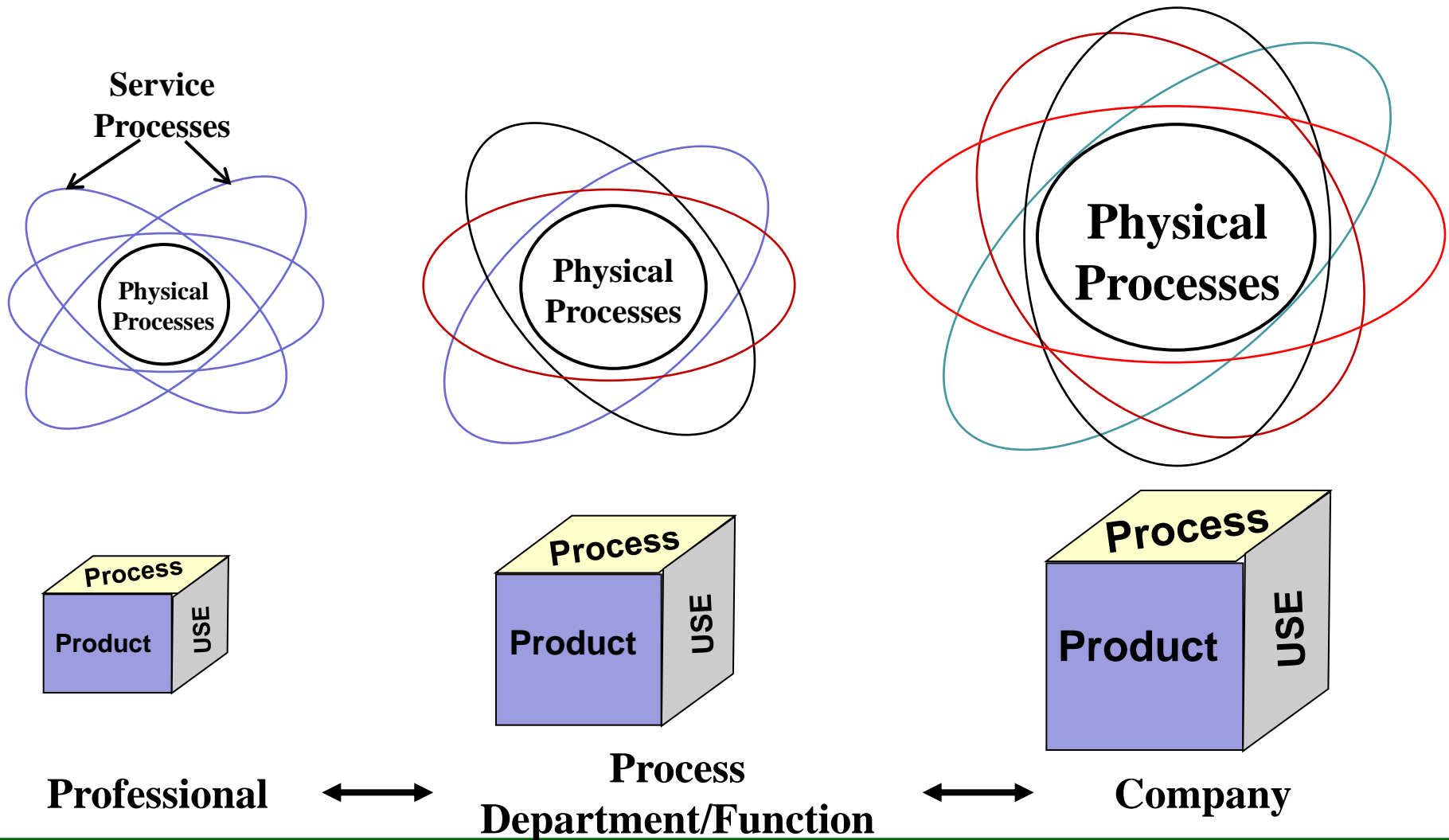
- **Develop “New “ Solutions - Knowledge Integration:**

- The System Approach
 - relentlessly ask the question “Why?” and also find the answers.
(the next wave after Lean and Six Sigma)
- Scientific reasoning and use of Mobile Diagnostic Tools
- Integration of knowledge from all sources from across the globe

- **Implement “New Solutions”:**

- Innovation Culture : End to End Innovation
- Emotional Intelligence of Leadership, Innovation and Entrepreneurship.

Solution: with a nucleus composed of “Physical Processes” integrally linked with a collection of service processes



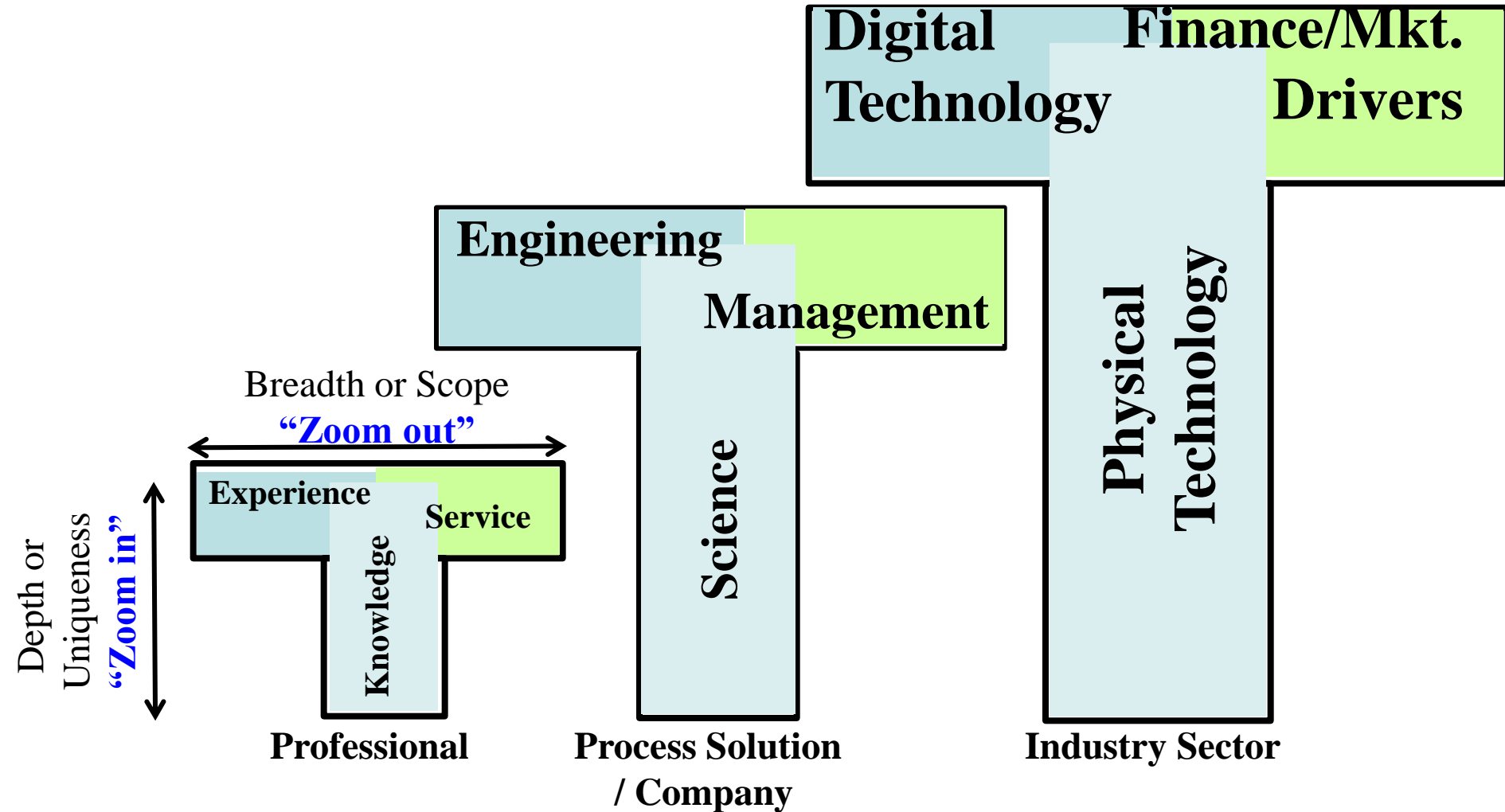
Dr. K. (Subbu) Subramanian

STIMS Institute (*Science Based Technology Innovation and Management Solutions*)

SubbuKDG@gmail.com

The System Approach:

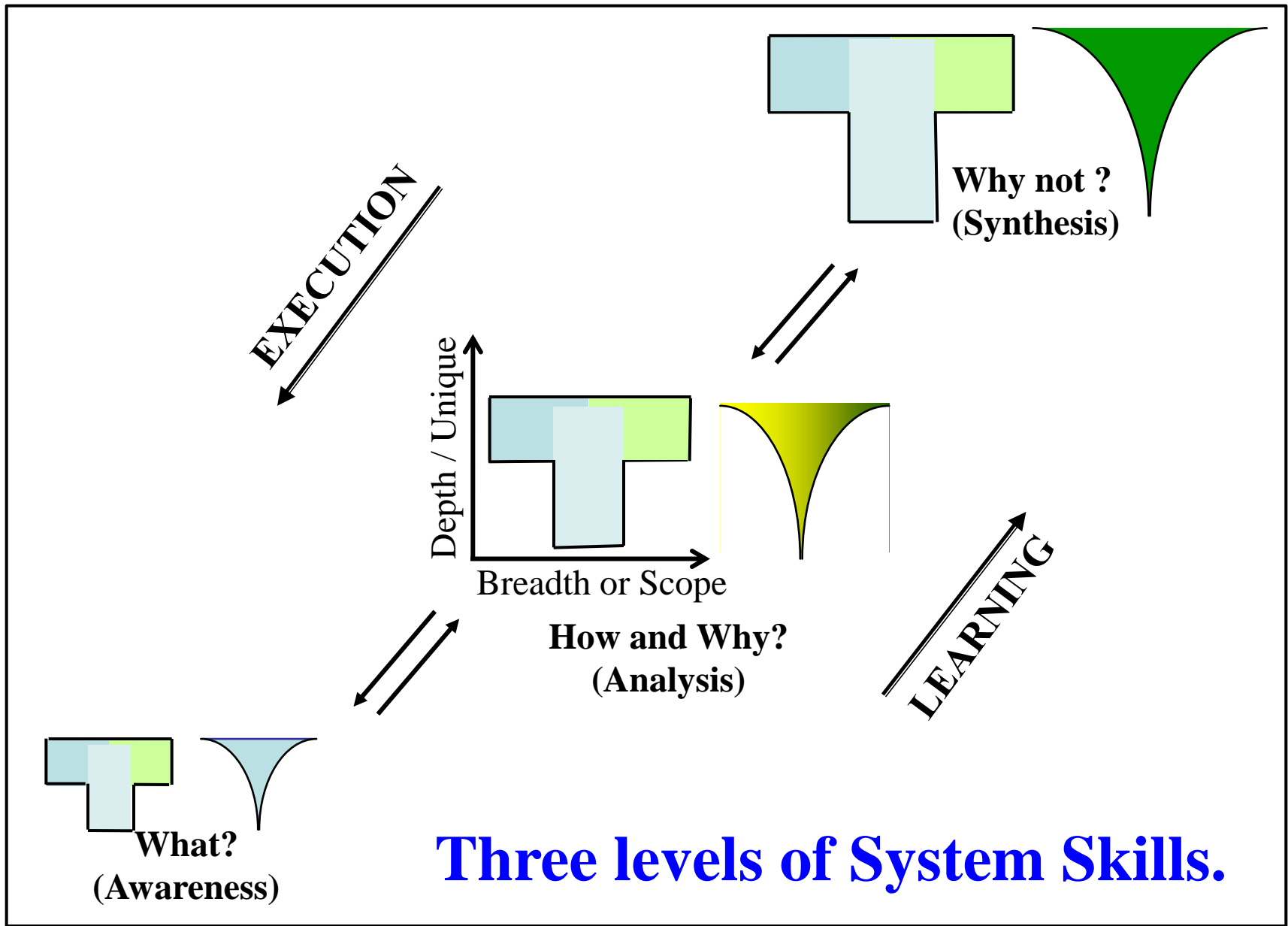
Alignment of core capabilities at each level.



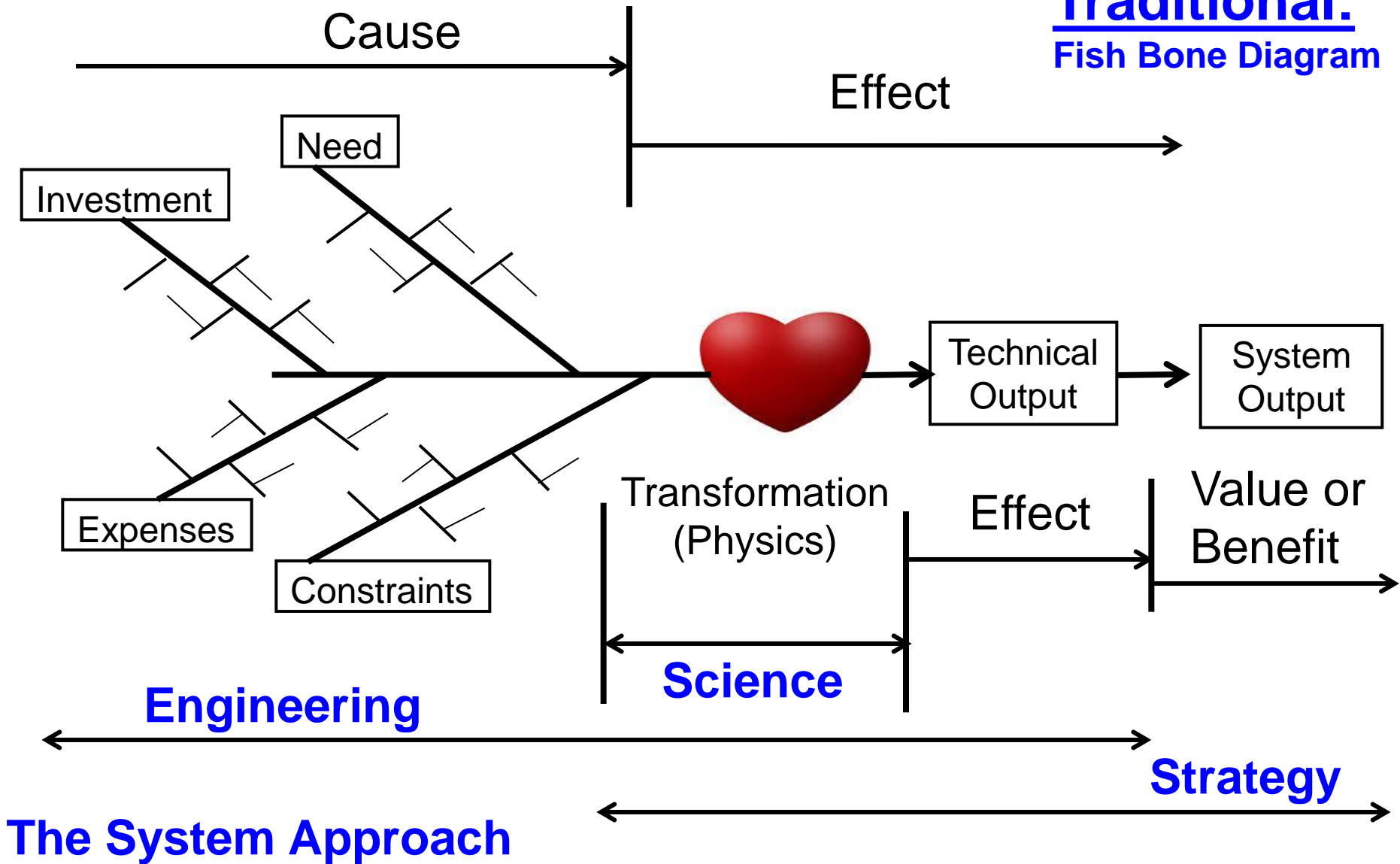
Dr. K. (Subbu) Subramanian

STIMS Institute (*Science Based Technology Innovation and Management Solutions*)

SubbuKDG@gmail.com

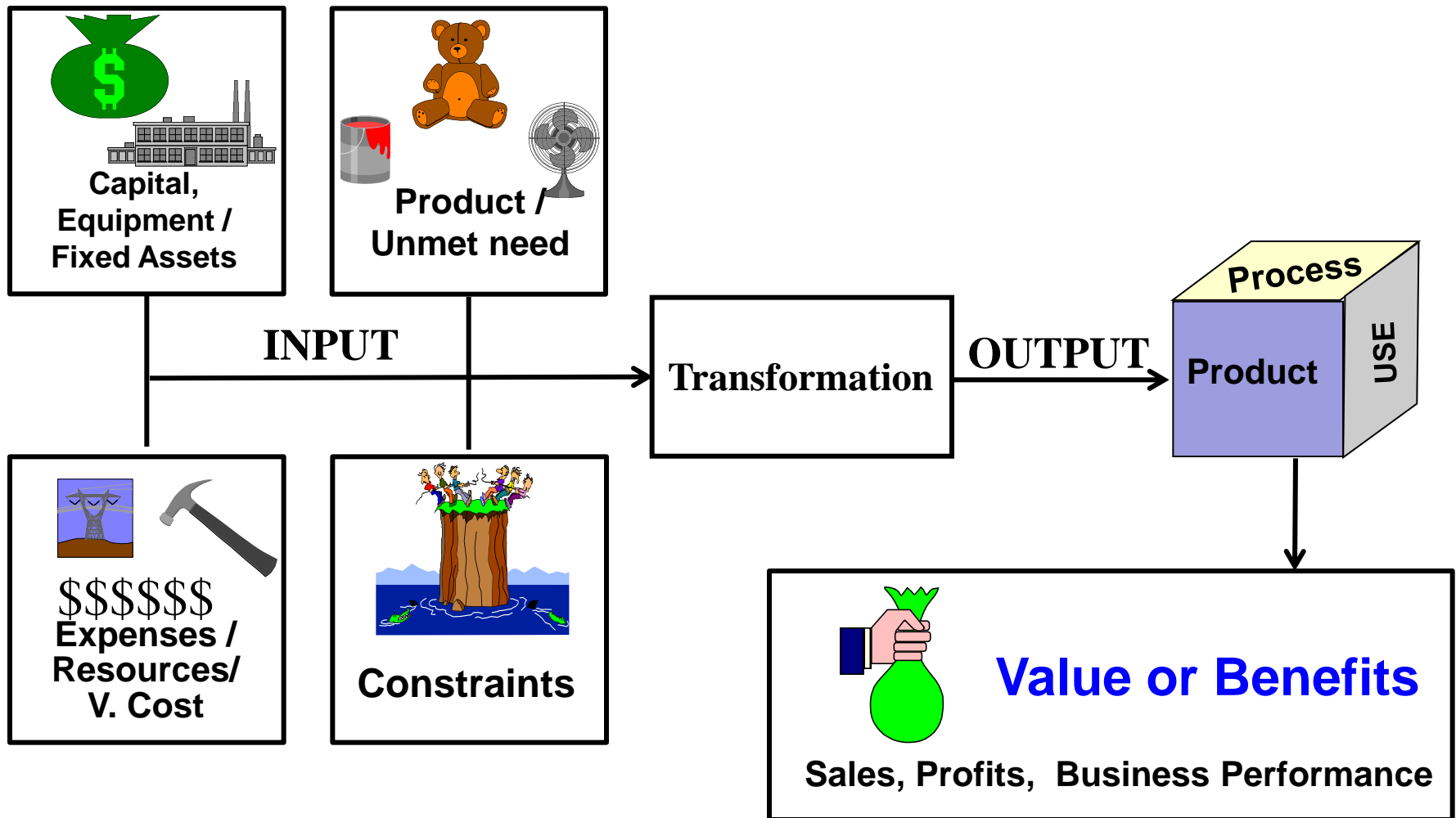


Traditional: Fish Bone Diagram



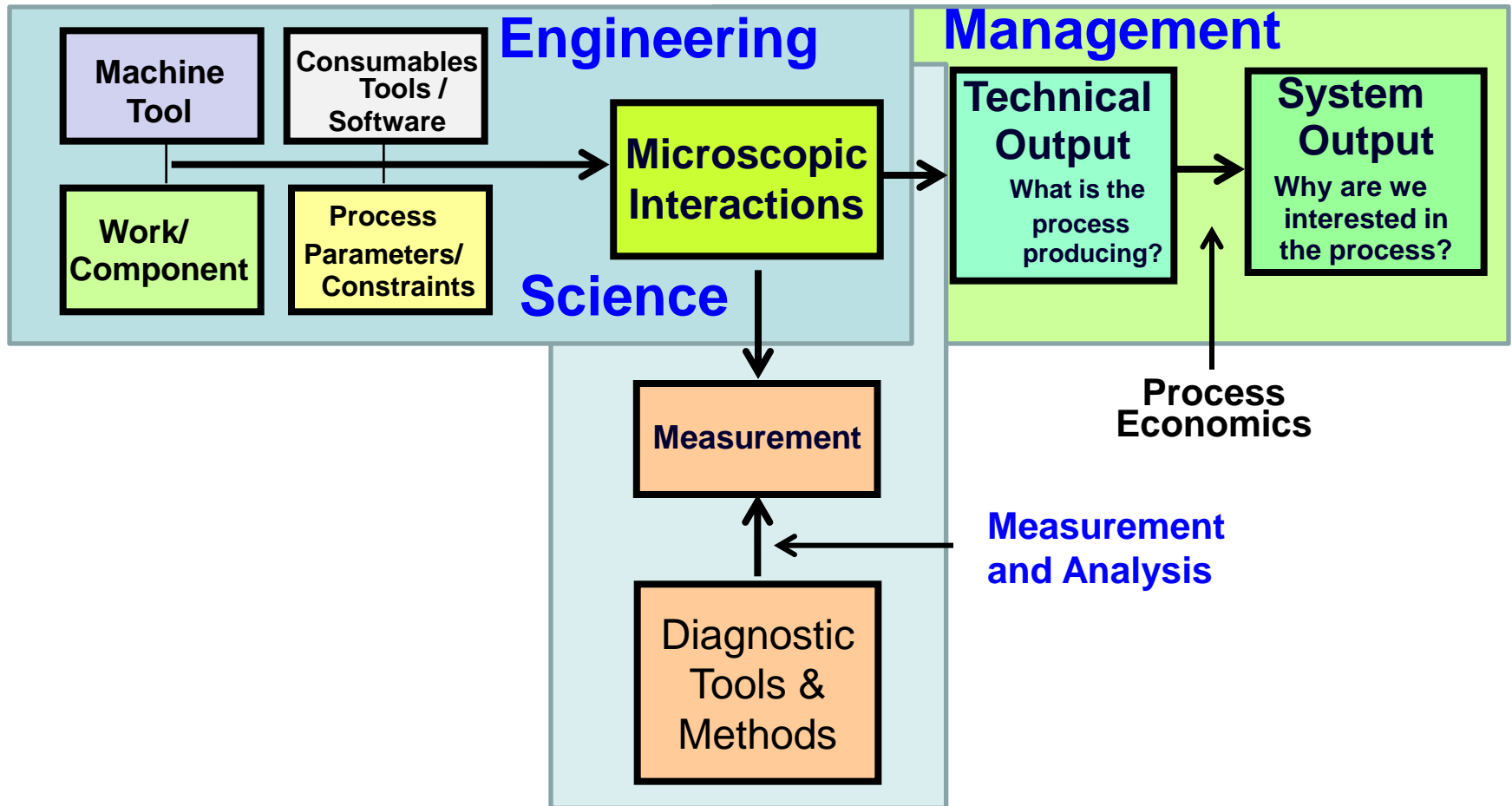
The System Approach

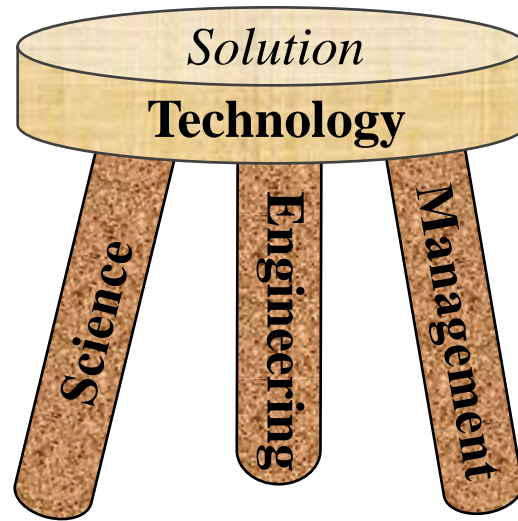
The System Approach: There are four input categories leading to the transformation and the outputs.



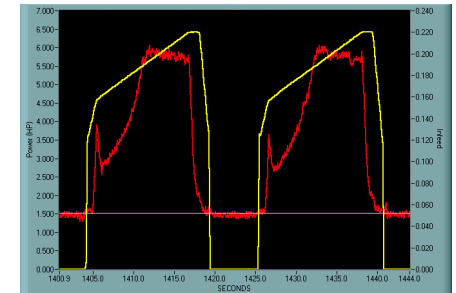
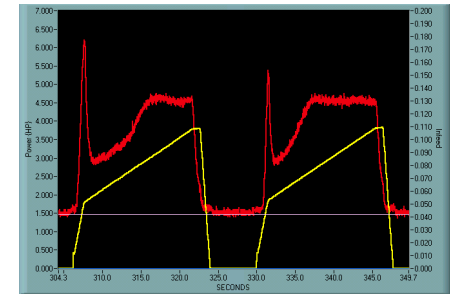
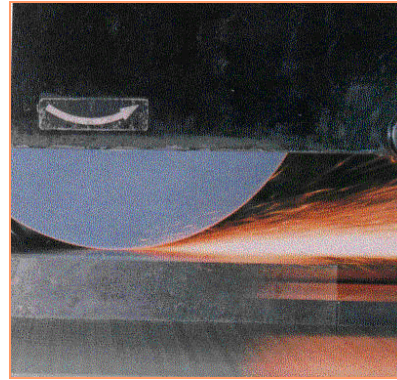
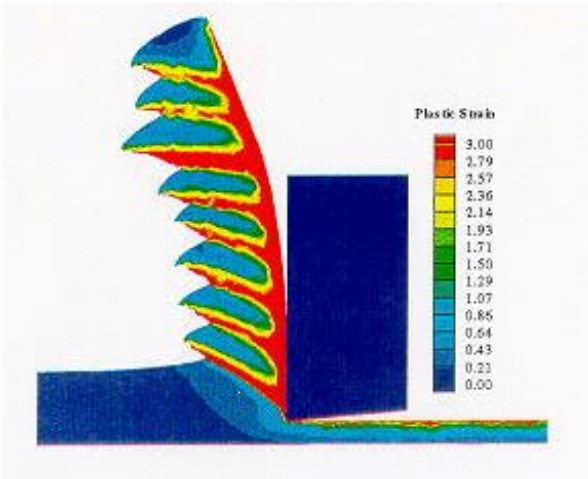
Technology = Knowledge and its Integration !

= “Science” + “Engineering” + “Management” (Operations + Strategy)





**Technology: integration of
Science, Engineering and Management,
leading to new solution.**



Science: Understanding the “Transformation”

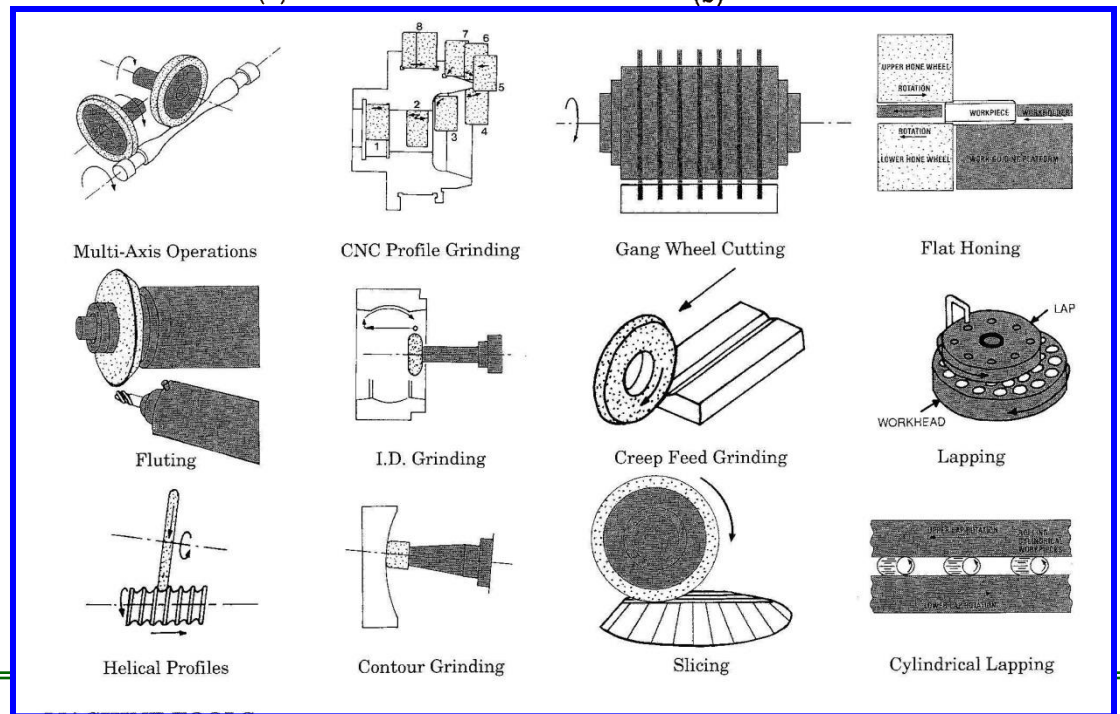
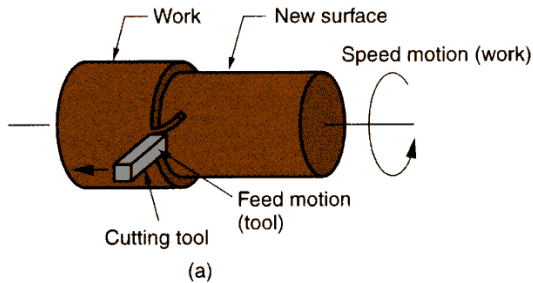
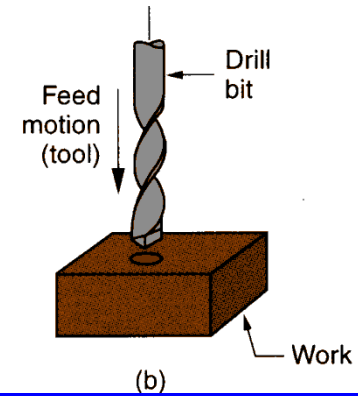
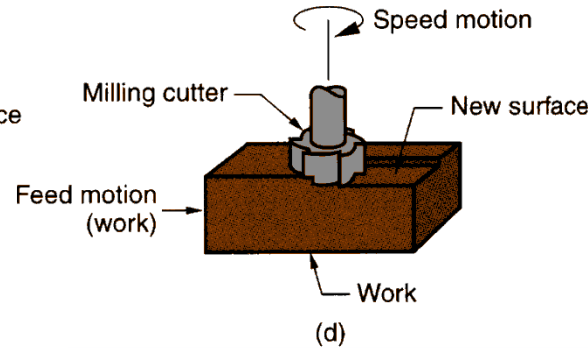
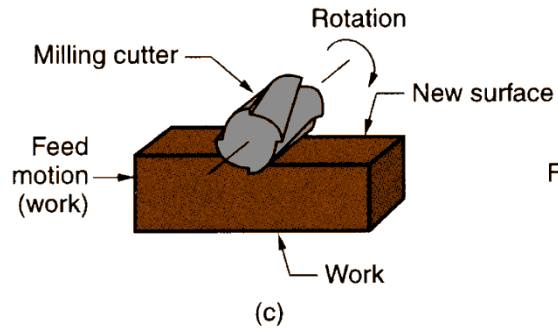
- What really happens during the “Process”?
- Microscopic Interactions:
 - They represent the “Physical Science”
 - They can not be “seen”
 - They can be measured, analyzed and inferred

Dr. K. (Subbu) Subramanian

STIMS Institute (*Science Based Technology Innovation and Management Solutions*)

SubbuKDG@gmail.com

Engineering: Application of the “Transformation”



Dr. K. (Subbu) Subramanian

STIMS Institute (*Science Based Technology Innovation and Management Solutions*)

SubbuKDG@gmail.com

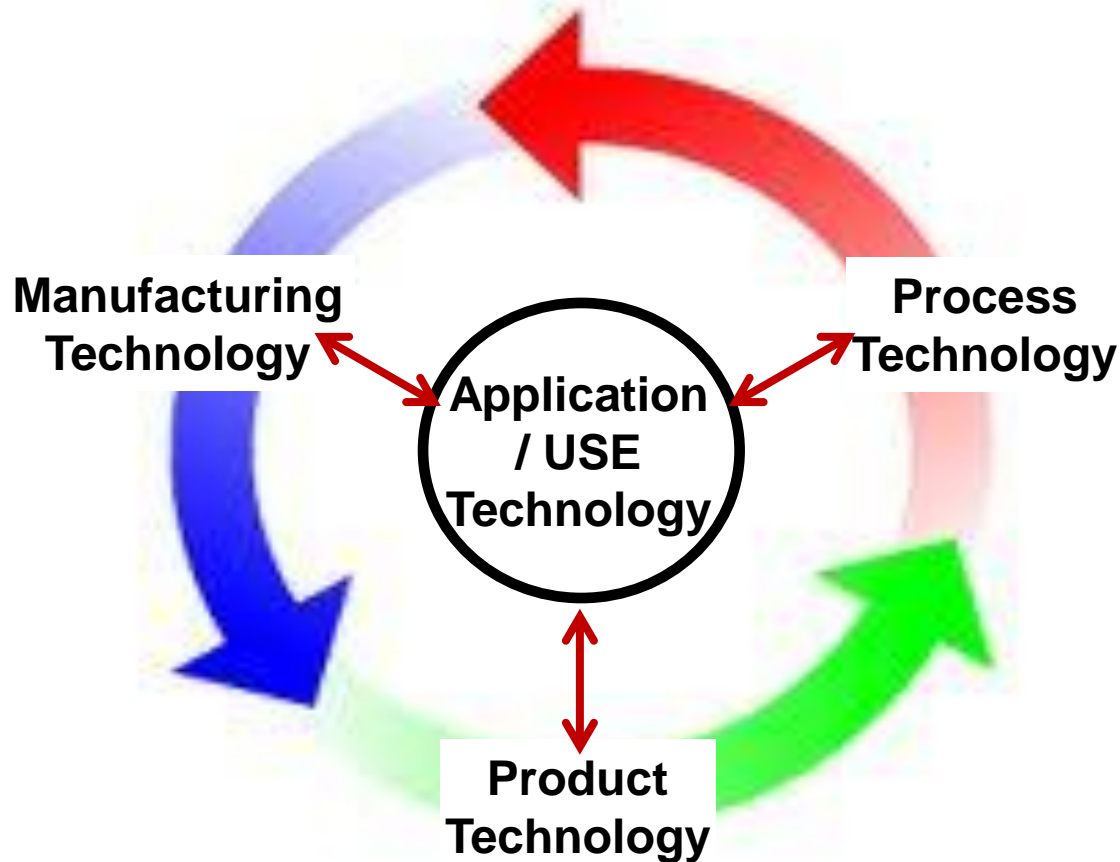
What is “management” ?



Your Education:

The system Approach for Grinding Processes;

Can be used in every aspect of the job in the company



Management
(Strategy)

1. Establish the System
Outputs: Why?
Identify the stakeholders, their
benefits, and priorities

+
Management
(Operations)

6. Document the New
Solution (How?) With
improvements in the technical
and system outputs

2. Document the process as
Input/Transformation/
Output System: What?

and

Engineering

5. Implement the changes
(How?) Simultaneously
needed in all four input groups
to influence the transformation

3. Establish the Technical
Outputs: What do we want
from the process?

+
Science

4. Diagnose and Interpret:
Obtain the “vital signs”; what do
they infer about the transformation
(core capabilities): Why?

The System Approach - Implementation Methodology

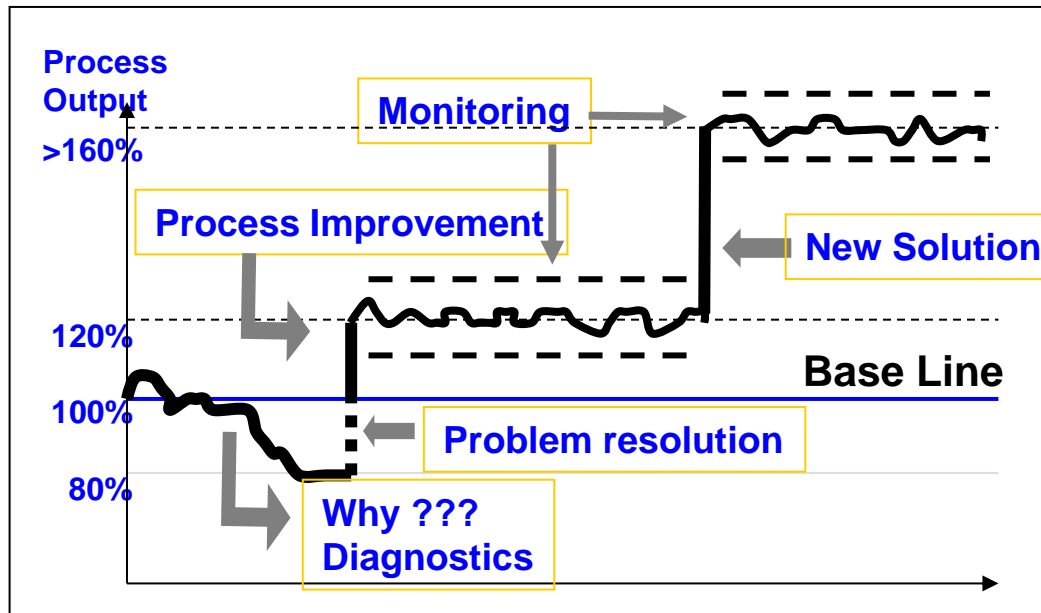
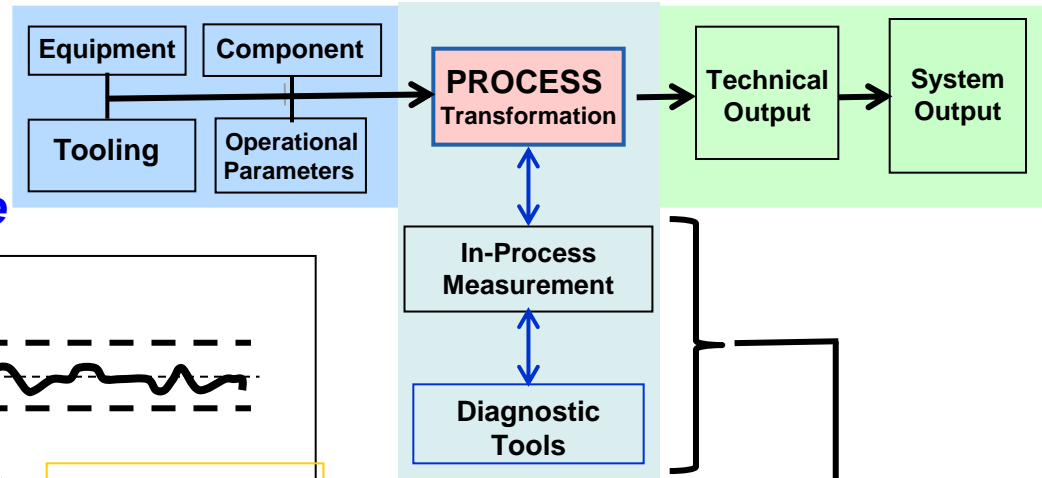
Dr. K. (Subbu) Subramanian

STIMS Institute (*Science Based Technology Innovation and Management Solutions*)

SubbuKDG@gmail.com

Five Steps in the Scientific Approach to Problem Solving:

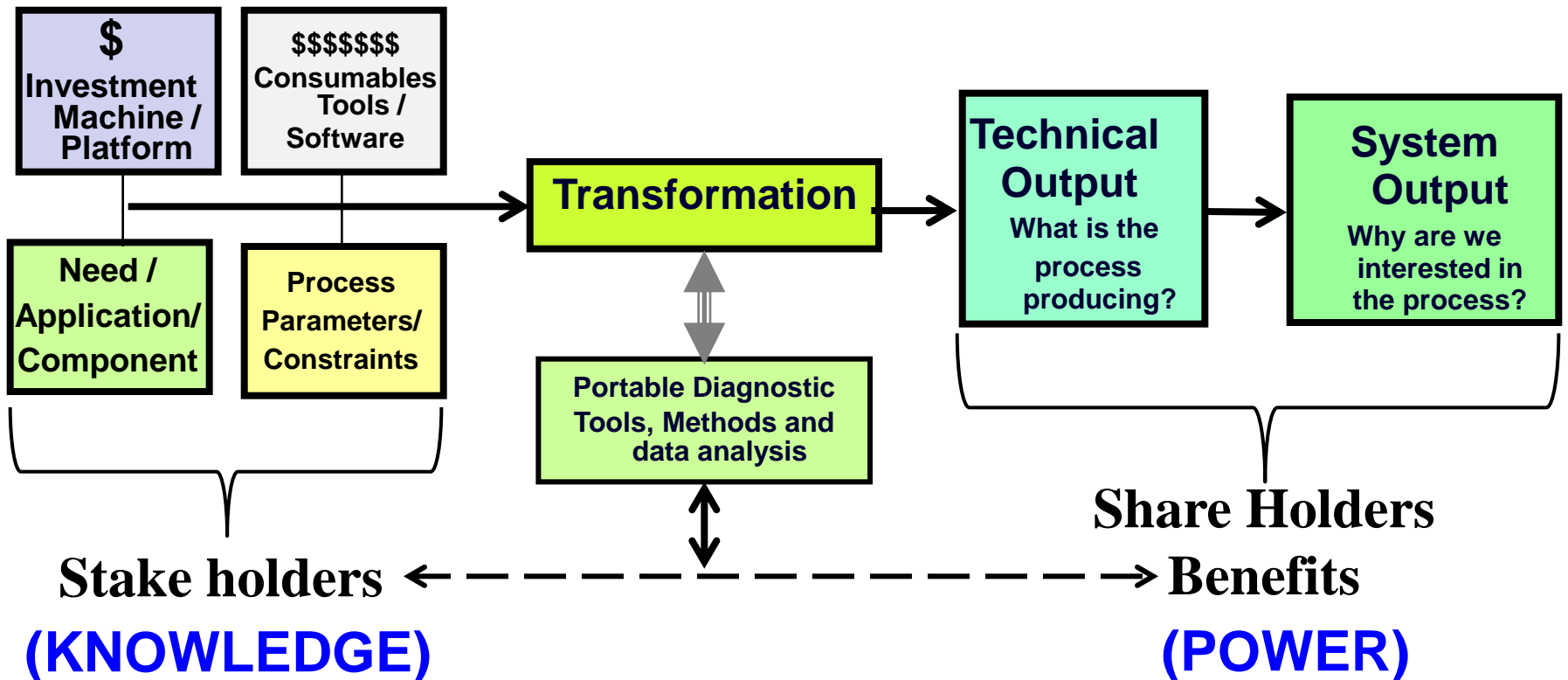
- Diagnostics
- Problem Solving
- Process Improvement
- Process Maintenance
- New Solution or Step Change



**Progressive Impact of “Science”
Backed Up by Diagnostic Tools**

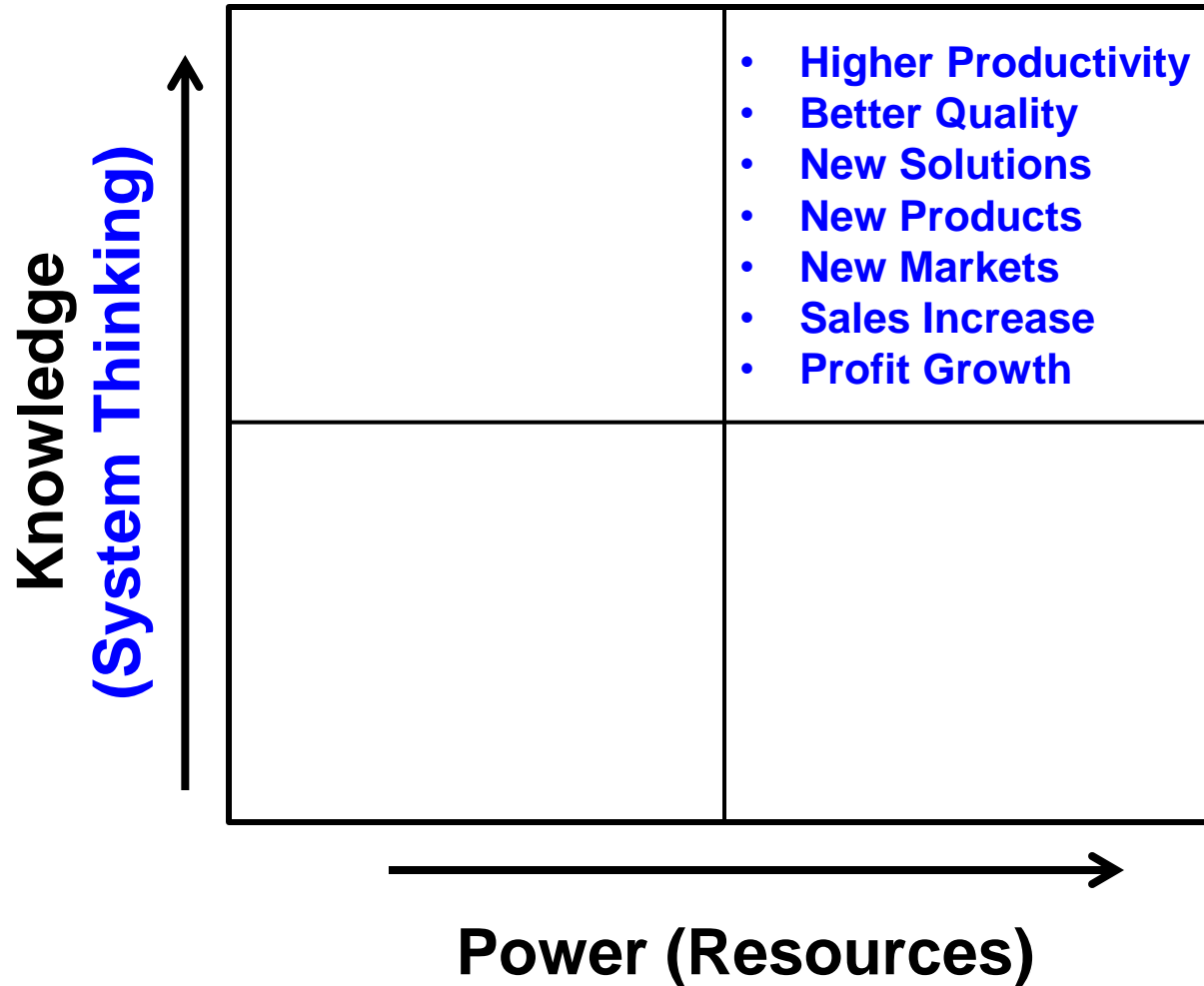
Knowledge Integration (1) : Sharing the power to gain new Knowledge.

You can't get something for "nothing"!



Knowledge Integration (2) :

Using the power together with new Knowledge.



The System Approach – Summary

- **Every process represents a Input/ Transformation /Output system.**
 - **We need to define the “context” of the system to further develop solutions based on that.**
- **The outputs of any system can be identified in two Categories:**
 - **Technical Output: “What” is the Solution? What are the deliverables?**
 - **System Output: “Why” are we interested in the solution?
Why these deliverables?**
- **The inputs to the system can be grouped under four distinct categories:**
 - **Machine Tool, Abrasives, coolants and other consumables, Work Material or components to be finished and Operational parameters**
 - **All inputs to the system are channeled through these four input categories**
- **All those who contribute to the inputs:**
 - **Also seek/gain their benefits through the “system outputs”!**
 - **They are also the sources of knowledge pertaining to the system.**
 - **Weakness in knowledge or contribution in any of these four input categories ultimately affects the system / solution outputs.**
- **The system is configured or designed to transform/modify or change the input into the outputs, to achieve the finished parts of required quality, productivity, cost and performance.**

Transformation or Microscopic Interactions

- Is not a black box or “statistical”
- It is the effect or interactions, which occur when the inputs are brought together.
- Represents the “Phenomena” of nature, which are “subtle” and intangible
- BUT, they can be inferred through:
 - Changes in inputs and their effect
 - Changes in outputs
 - Measurements or data obtained in real time (when the transformation happens)
 - Interpretation of the real time signals and inferences based on them
- They are useful to understand the effect of changes in inputs and their result as seen in the outputs in a deterministic manner . This knowledge on the cause and effect as influenced by the transformation is called “**Science**”.
- Application of the Transformation or microscopic interactions through proper integration of the relevant inputs across the four input categories to obtain the required technical outputs is called “**Engineering**”.
- Establishing which transformation to use and why (Strategy) and how to execute that efficiently, economically and in a timely manner (Operations) is called “**Management**”.
- The System Approach is a frame work or methodology to integrate the Science, Engineering and Management aspects of any Input/Transformation/Output system.
- Hence the System Approach enables the engineer to span wide (zoom out) to address the engineering and management aspects and also dive deep (zoom in) on the scientific aspects of the problem or solution as required.

The System Approach – Summary

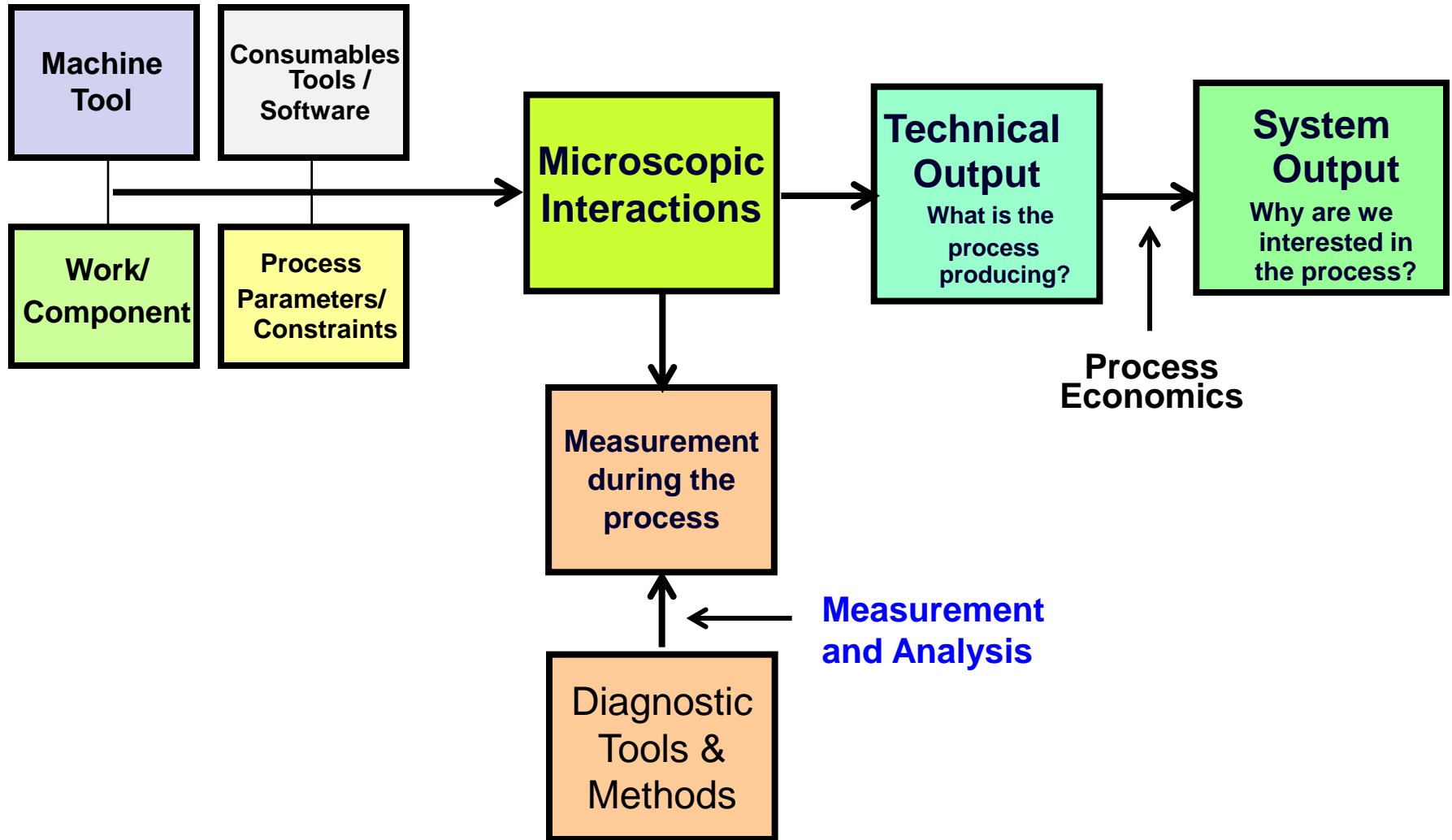
- When all input groups are changed simultaneously for the same effect on the “transformation,” – the science - the output is always “quantum” or large scale in nature, (i.e.), *the whole is larger than the mere sum of its parts.*
- When the input groups are changed or altered individually (one at a time and over a period of time), even for the same effect on the transformation, the output is generally incremental in nature.
 - In this case, the conflicting effects of the input groups and their variability over time, sometimes cancel each other, resulting in minimal net gain.
 - This is the serious underlying risk in all our efforts toward continuous improvement.
- Signals pertaining to the “Transformation” represent the vital signs of the system / process or the solution. They are collected as in-process data. Digital Tools are very useful to collect and process such in-process data.
- Power of Digital data: Mine, Model, Experiment, Decide, Predict
- Data and analysis of signals pertaining to the Transformation can be used for:
 - Diagnostics
 - Problem Solving
 - Process Improvement
 - Process Maintenance
 - New Solution or Step Change

The System Approach – Summary

Data and analysis of signals pertaining to the Transformation can be used for:

- **Collect and compare base line information**
Feature recognition
- **Resolve Process problems.**
- **Estimation of the capability of the equipment and other inputs to the system:**
Stiffness, Accuracy, Precision, Process capability,...
- **Analysis / Performance comparison:**
Over time
Across machines or across systems.
Across plants or locations
Analytics
Data Science
- **Development of New Products (R&D)**
- **Implementing “New “ Products and Processes**
- **Complaint Investigations**
Reduce learning time
Reduce credits or warranty costs
Reduce set up and debugging efforts.

The “System Approach”



Thank You!