Rendering a Human Touch to Smart Manufacturing

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If we can visualize physical processes on the manufacturing floor as living human beings, then much of the information-management practices of the healthcare may be applicable to the manufacturing sector as well. Such humane treatment of machines and manufacturing processes could be the next phase of Smart Manufacturing.

Throughout our life span, we invest an inordinate amount of time and effort on taking care of our health. For a fit and healthy lifestyle, we put in the effort to go the extra mile and adopt healthy habits. We get enrolled in fitness programs, look out for any undue changes, get any apparent symptoms diagnosed and administer medicines as per the illness identified. To prevent any possible ill-health, medical care starts with:

- Health Record Maintenance
- Routine Health Checkups
- Diagnostics
- Health or Medical Report
- Prognosis and Preventive Maintenance

Similarly, if we can visualize the physical processes on the manufacturing floor as living human beings then much of the information-management practices in the healthcare may be applicable to the manufacturing

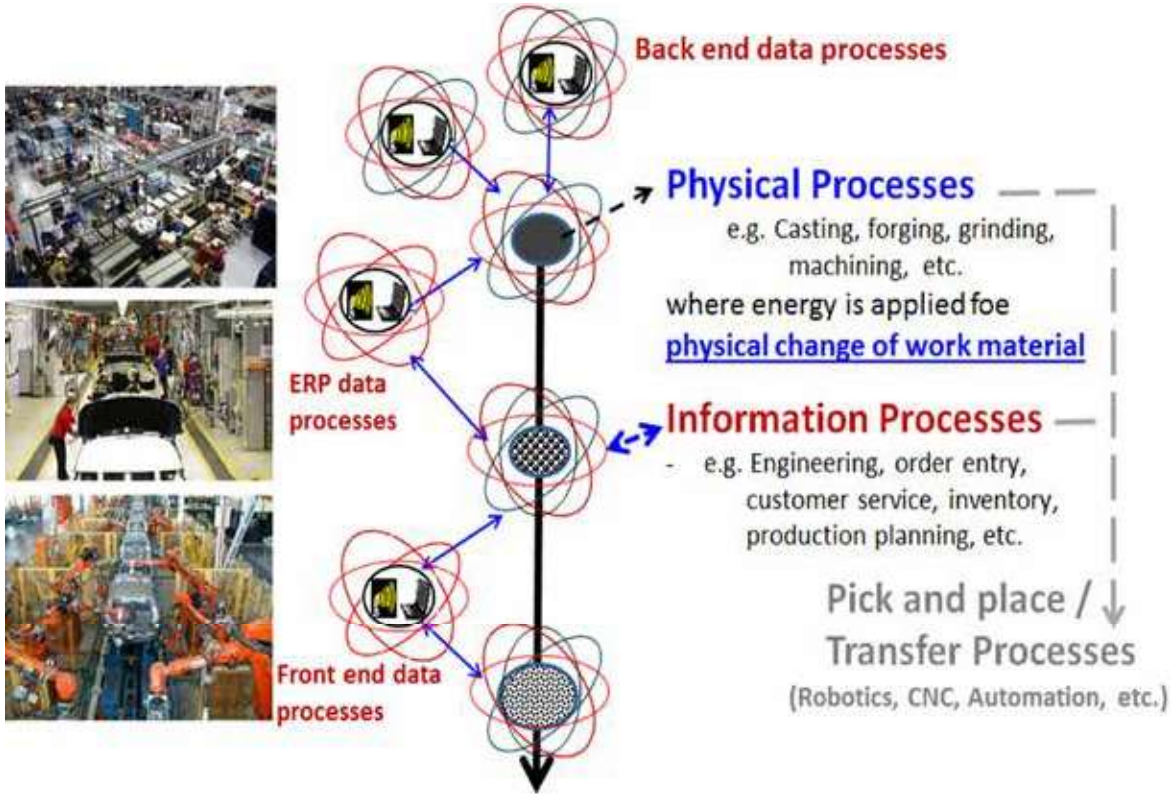

Fig. 1: Manufacturing: An organized use of physical and information processes

sector as well! Such humane treatment of machines and manufacturing processes could be the next phase of Smart Manufacturing.

WHAT IS MANUFACTURING?

Manufacturing is an organized collection and repetitive use of physical processes such as grinding, cutting, welding, ECM, EDM, thin film coating, forging, forming, heat treating, etc. together with a large number of Information Processes. In manufacturing, there are devices such as CNC systems, Robotics, Automation, etc. that intrinsically combine information / data manipulation together with physical activity.

It is the repetitive use of physical processes that distinguishes 'manufacturing' from research, design, product development, sales and marketing, etc.

Such use of physical processes requires a large array of Information Processes (relevant to Supply Chain, Logistics – inside and outside the manufacturing plant, Lean, Six Sigma, ERP, Order entry, Customer support, etc.) to create a product at the required quantity, quality, time and place. These are also described as 'Front end' or 'Back end' operations. This recurring activity invariably creates large sets of data / information. Much of the Smart Manufacturing attempts to exploit this data and its manipulation to gain efficiency and better economics in manufacturing.

PHYSICAL PROCESSES IN MANUFACTURING VS. HUMAN BEINGS

This approach to compare physical processes as living human beings may appear unconventional. It may not be seen favorably by some. However, our goal is to point out that much of the digital solutions and procedures already available in the healthcare sector may be readily applied to the manufacturing sector to advance Smart Manufacturing in leaps and bounds in a short period of time. All that is required is out-of-the-box thinking.

Every physical process used in manufacturing is also a system. It starts with the machine tool. When the new machine tool is shipped out of the machine tool company, the entire process can be documented as a system. In many respects, the 'System Document' generated when the process is installed corresponds to the 'birth certificate' of that manufacturing process.

Healthcare Management	Smart Manufacturing
Patient Record	System Document (See Fig. 3: STIMS Diagram)
Data from Routine Checkups	Process history, QC Data, Production Data
Vital Signals (Body temperature, Blood pressure, etc.)	In-process Signals (GrindTrak™ data: Grinding power consumed, MRR, etc.)
Advanced Diagnostics (EKG, MRI, CAT Scan, etc.)	Machine Tool Condition Monitoring (Vibration Signals, Acoustic Emission Signals, etc.)
Analysis and Treatment	Rule-based Algorithms and Problem-Solving
Medical Report	Manufacturing Process Health Check Report
Advanced Treatment (Level varies depending on Patient Record, Routine Checkup Data, Diagnostics and Health Check Report)	• Daily Production Management • Process Engineering / Problem Solving • Maintenance Protocol (Machine Tool age dependent) • Line-level Production Management • Plant Management • General Management
Data for Healthcare Management	Data for Prognosis and Performance Analysis (Across plants, locations, geography and other industries)

Fig. 2: Data Protocol for Smart Manufacturing (Analogous to Healthcare Data Management)

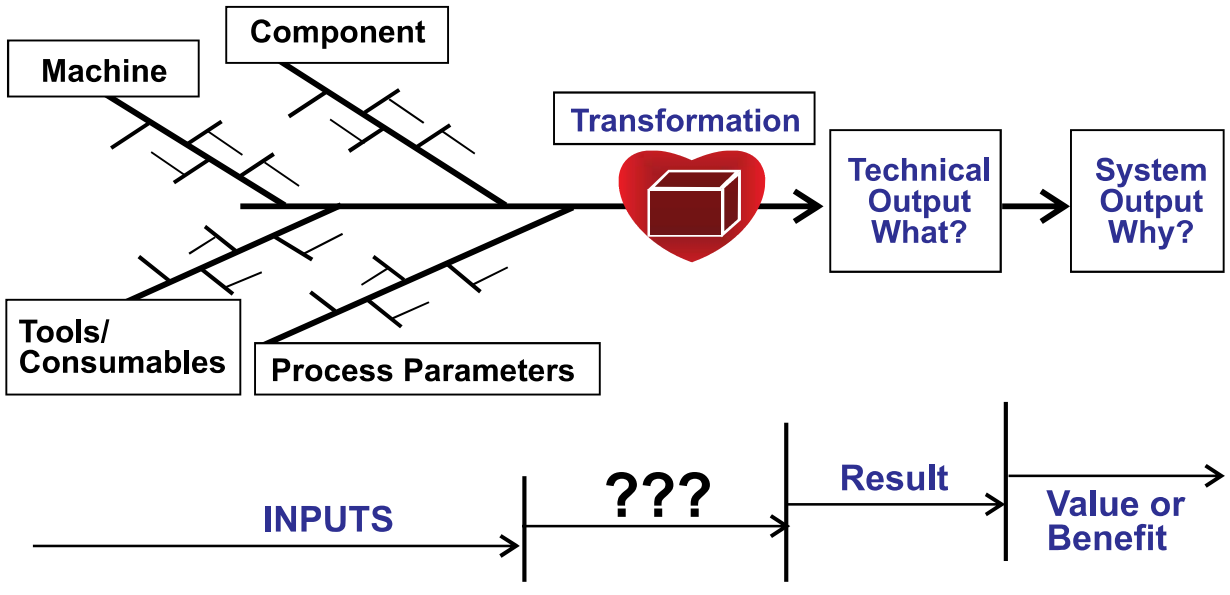

Fig. 3: STIMS Diagram: Treatment of the physical process in manufacturing as an Input / Transformation / Output System

System Document - Element	Source of Information or Data	
	Supplier	Manufacturer
Machine Tool	Machine Tool Supplier	• Purchasing Department • Advanced Process Engineering • Maintenance Department • Design Department
Tools / Consumables	Suppliers of: • Tools • Coolants • Jigs and Fixtures • Gauges • IT services	• Purchasing Department • Process Engineering • Tooling Department • Maintenance Department • ERP Data, SAP Data, etc.
Component	Raw Materials Supplier	• Purchasing Department • Design Data • ERP Data, SAP Data, etc.
Process Parameters	• Machine Tool Supplier • Tooling Supplier	• Process Engineering • Tooling Department • Maintenance Department • ERP Data, SAP Data, etc.
Transformation (In-Process Signals and Data)		
Technical Output	• Machine Tool Supplier • Tooling Supplier	• Production Engineering • Quality Control Department
System Output		Plant Management

Fig. 4: System Document – Digital data that represents the details of the physical process viewed as a system

Similarly, further comparing of the manufacturing process data to healthcare management is shown in the table (Fig 2).

Every physical process is also a 'live' unit, consuming energy and its use for transformation of raw material (or input) into a finished good (output). This input/transformation/output scheme of any physical manufacturing process – as a system – is illustrated in the STIMS (Science Based Technology, Innovation and Management Solutions) Diagram (Fig 3).

From the table in Fig 4, it is obvious that while relevant data exists to deal with the manufacturing process as a system, such data is today spread across various resources both inside the manufacturing company as well as with their many suppliers. Some of the information such as the System Outputs (e.g. Total Cost/Part) is not even documented at the unit process level. It should not come as a surprise to anyone that the 'Transformation' in most of the physical processes are treated as 'black box' without any relevant infor-mation pertaining to the in-process signals. These basic ailments must be addressed immediately to move towards new directions for a meaningful Smart Manufacturing.

A NEW BEGINNING

At MGT and AMTDC (Advanced Manufacturing Technology Development Centre), IIT Madras, initial efforts are underway to explore the above possibilities towards Smart Manufacturing as applicable to precision grinding processes. This endeavor with leadership from STIMS Institute may provide a new pathway in our quest for the 21st Century Smart Manufacturing.