## Understanding Machined to Think Exhibition Gallery at Nehru Science Centre

## Prelude

Today, we're at a juncture: Industry 4.0 is on the rise due to automation and the ubiquity of computing power and has spurred what many consider yet another Industrial Revolution. Over the course of the 18th and 19th centuries, the Industrial Revolution drove new manufacturing technology that would fuel the economic growth of significant parts of the globe and a new standard of living for centuries. Steam power, machines of all types, interchangeable parts, and innumerable other advancements offered manufacturers unparalleled levels of productivity — and profitability. Dubbed "Industry 4.0," this new era of manufacturing bears many similarities to earlier revolutions — new technology builds on that of the past to automate and streamline previously manual, fragmented workflow processes. If Industry 1.0 represented the rise of water and steam power, 2.0 the advent of electric power, and 3.0 computing capabilities, Industry 4.0 harnesses the inter-connectivity of machines, processes and products. But tangibly, how can these latest revolution power manufacturers as they strive to remain competitive and agile?

From Social media to the Internet of Things, digital fabrication to robotics, virtual reality to synthetic biology, new technologies are racing forward across the board. Together they are ripping up the rule book for people, firms and governments. Under the scope of this influence we stand on the brink of a technological revolution that will fundamentally alter the way we live, work and relate to one another. In its scope, scale and complexity the transformation is unlike anything humankind has experienced before. We do not know yet how it will unfold, but one thing is clear: the response to it must be integrated and comprehensive, involving all stakeholders of the global polity, from the public and private sectors to academia and civil society.

Each wave of new computational technology has tended to lead to new kinds of systems, new ways of creating tools, new forms of data, and so on, which have often overturned their predecessors. What has seemed to be evolution is, in some ways, a series of revolutions. But the development of computing technologies is more than a chain of innovation – a process that is been a hallmark of the physical technologies that shape our world. In computing, something richer is happening where new technologies emerge, not only by replacing predecessors, but also by enveloping them. Computing is creating platforms on which it reinvents itself, reaching up to the next platform. Arguably, the most dramatic of these innovations is the web. During the 1970s and 1980s, there were independent advances in the availability of cheap, fast computing, of affordable disk storage and of networking. Compute and storage were taken up in personal computers, which at that stage were standalone, used almost entirely for gaming and word processing. At the same time, networking technologies became pervasive in university computer science departments, where they enabled, for the first time, the collaborative development of software. This was the emergence of a culture of open-source development, in which widely spread communities not only used common operating systems, programming languages and tools, but collaboratively contributed to them. As networks spread, tools developed in one place could be rapidly promoted, shared and deployed elsewhere. This dramatically changed the notion of software ownership, of how software was designed and created, and of who controlled the environments we use. The networks themselves became more uniform and interlinked, creating the global internet, a digital traffic infrastructure. Increases in computing power meant there was spare capacity for providing services remotely. The falling cost of disk meant that system administrators could set aside storage to host repositories that could be accessed globally. The internet was thus used not just for email and chat forums but, increasingly, as an exchange mechanism for data and code. This was in strong contrast to the systems used in business at that time, which were customized, isolated, and rigid. With hindsight, the confluence of networking, compute and storage at the start of the 1990s, coupled with the open-source culture of sharing, seems almost miraculous. An environment ready for something remarkable, but without even a hint of what that thing might be.

Under this purview, Nehru Science Centre, therefore, through a newly curated and developed gallery, aptly titled “Machined to think”, hopes to provide a brief glimpse into the technologies that are destined to be pivotal for any nation.

Title: Glimpses of the Past
Mode of Display: Interactive Smart glass based projection

Today's electronic computers are recent inventions, stemming from work that began during World War II. Yet the most basic idea of computing—the notion of representing data in a physical object of some kind, and getting a result by manipulating the object in some way—is very old. In fact, it may be as old as humanity itself. Throughout the ancient world, people used devices such as notched bones, knotted twine, and the abacus to represent data and perform various sorts of calculations. During the sixteenth and seventeenth centuries, European mathematicians developed a series of calculators that used clockwork mechanisms and cranks. As the ancestors of today's electromechanical adding machines, these devices weren't computers in the modern sense. Merely they were calculators which could perform arithmetic functions with numbers, including addition, subtraction, multiplication, and division. By the middle of 16th century explorations of various continents and trading brought in the requirements of precise calculations of sea routes, accounting, etc. Mechanical devices, precursors of electronic calculators, were developed during this time to assist in such tedious and repetitive calculations like generating calendars of a year, taxing, trading.

The first computers were people. This was a job title given to people who did repetitive calculations for navigational tables, planetary positions and other such requirements. Hence, invention of devices for precise calculations and automation of certain tasks was the need of the hour and was achieved to a fairly good extent by the Jacquard Loom. The Jacquard loom invented by Joseph Marie Jacquard used punched cards to control a sequence of operations. A pattern of the loom's weave could be changed by changing the punched Cardin Scratch programming, the computer takes the blocks one by one and executes them. The loom too weaves line by line in a sequence the design on the punched card and perhaps that is what makes Jacquard Loom an important advancement towards automation.

Title: Timeline of Development
Mode of Display: Interactive Sliding Screen Overlay and Multi-touch Table with tag recognition

With the advent of vacuum tubes, the technology finally existed to create the first truly modern computer—and the demands of warfare created both the funding and the motivation. In World War II, the American military needed a faster method to calculate shell missile trajectories. The military asked Dr. John Mauchly (1907–1980) at the University of Pennsylvania to develop a machine for this purpose. Mauchly worked with a graduate student, J. Presper Eckert (1919–1995), to build the device. Although commissioned by the military for use in the war, the ENIAC (Electronic Numerical Integrator And Computer) was not completed until 1946, after the war had ended. Although it was used mainly to solve challenging math problems, ENIAC was a true programmable digital computer rather than an electronic calculator. One thousand times faster than any existing calculator, the ENIAC gripped the public's imagination after newspaper reports described it as an "Electronic Brain." The ENIAC took only 30 seconds to compute trajectories that would have required 40 hours of hand calculations.
The PC that's sitting on your desk is, in many respects, a direct descendent of ENIAC-inspired research, including the stored-program concept. Of course, your computer is thousands of times faster and thousands of times less expensive than its room-filling, electricity-guzzling predecessors. When we're talking about a PC, the "computer" is the microprocessor chip, which is about the size of a postage stamp and consumes less energy than one of the desk lamps in ENIAC's operating room. Until 1951, electronic computers were the exclusive possessions of scientists, engineers, and the military. No one had tried to create an electronic digital computer for business. Later in 1951, Eckert and Mauchly delivered the first UNIVAC to the U.S. Census Bureau when it gained fame correctly predicting the winner of the 1952 U.S. presidential election, Dwight Eisenhower. Since then, computers have been used to predict the winners in every presidential election.
First-generation computers were notoriously unreliable, largely because the vacuum tubes kept burning out. To keep the ENIAC running, for example, students with grocery carts full of tubes were on hand to change the dozens that would fail during an average session. But a 1947 Bell Laboratories invention, the transistor, changed the way computers were built, leading to the second generation of computer technology. Second-generation computers looked much more like the computers we use today. Although they still used punched cards for input, they had printers, tape storage, and disk storage. In contrast to the first-generation computer's reliance on cumbersome machine language, the second generation saw the development of the first high-level programming languages, which are much easier for people to understand and work with than machine languages. A leading second-generation computer was IBM's fully transistorized 1401, which brought the mainframe computer to an increasing number of businesses. In business computing, an important 1959 development was General Electric Corporation's Electronic Recording Machine Accounting (ERMA), the first technology that could read special characters. Banks needed this system to handle the growing deluge of checks. Because ERMA digitizes checking account information, it has helped to lay the foundation for electronic commerce (e-commerce). In 1963, an important development was the American Standard Code for Information

Interchange (ASCII), a character set that enables computers to exchange information and the first computer industry standard. Although ASCII didn't have much of an impact for 15 years, it would later help to demonstrate the importance of standardization to industry executives. In 1964, IBM announced a new line of computers called System/360 that changed the way people thought about computers. An entire line of compatible computers (computers that could use the same programs and peripherals), System/360 eliminated the distinction between computers designed primarily for business and those designed primarily for science.


Title: Behavioral Modeling
Mode of Display: Interactive Multi-touch Table with 3D Graphics

Behavioral models shows the dynamic behavior of the system as it's executing. They show what happens or what's supposed to happen when a system responds to an alarm. You can think of an alarm as being of two types:

1. Data: some data arrives that has to be processed by the system.
2. Events: some event happens that triggers system processing. Events may have associated data, but, this is not always the case.

Many business systems are data processing systems that are primarily driven by data. For example, a phone billing system will accept information about calls made by a customer, calculate the costs of these calls, and generate a bill. By contrast, real-time systems are often event driven with minimal data processing. For example, a landline phone switching system responds to events such as pressing on keys on a handset by capturing the phone number. The Model-driven Architecture and other model driven approaches advocate the primacy of models and model transformations in the software development process. Ultimately, the goal is to generate the complete software fully automatically from these models. To date, the fully automatic generation of the code from models is still a dream and, if it works at all, restricted to specific application areas. One of the main obstacles is the lack of adequate models for system behavior and model integration mechanisms. Behavior modeling attracts more attention as the research community understands that behavior modeling concepts are different from programming concepts. Modeling a complex system generally involves representing a combination of different types of behavior including internal system behavior, interaction with the environment, and collaboration between systems. Generally, different forms of model are needed for these different types of behavior and many different approaches to modeling behavior,

Title: Brain Machine Interface
Mode of Display: Controlling flight of an UAV using Concentration of mind

The brain is a very complex system. The frontal cortex, the region where most of our conscious thoughts and decisions are made, conducts much less than a tenth of the total activity in the brain. Planning, modeling of your surroundings, interpretation of sensory inputs up to and including our perception of reality, memory processing and storage and the basic drivers of our moods and emotions occur in many functional regions distributed around the brain, including the visual cortex at the rear, temporal cortex at the sides, parietal cortex behind the crown of our head and the limbic system deep inside the brain. Most of these deeper functions interact intimately with different parts of the cortex (the outer layer which is accessible to EEG measurements) however the interaction is quite complex and distributed. In order to map the true activity of the brain it is very important to measure signals from many different cortical structures located all around the brain surface.

Using Mind-wave sensor these EEG signals have been tracked and a Quad-copter is driven to maintain certain heights analogous to concentration of mind. Unmanned Aerial Vehicles better known as drones, have been used commercially since the early 1980s. Today, however, practical applications for drones are expanding faster than ever in a variety of industries, thanks to robust investments and the relaxing of some regulations governing their use. Responding to the rapidly evolving technology, companies are creating new business and operating models for UAVs. The total addressable value of drone-powered solutions in all applicable industries is significant—more than $127 billion, according to a recent surveys. Among the most promising areas is agriculture, where drones offer the potential for addressing several major challenges. With the world’s population projected to reach 9 billion people by 2050, experts expect agricultural consumption to increase by nearly 70 percent over the same time period. In addition, extreme weather events are on the rise, creating additional obstacles to productivity. Agricultural producers must embrace revolutionary strategies for producing food, increasing productivity, and making sustainability a priority. Drones are part of the solution, along with closer collaboration between governments, technology leaders, and industry.

Title: Supplemented Reality
Mode of Display: Large Format Full body immersive Augmented Reality Application

One of the great promises and at the same time one of the main focus areas in 4th Industrial Revolution is the bridging of digital, cyber, virtual and physical worlds, hence the focus on cyber-physical systems is prominent. Apart from the fact that this isn't just a technology issue, from the technological perspective one immediately thinks about the Internet of Things. However, virtual reality (VR) and augmented reality (AR) are certainly as important. Virtual reality and augmented reality are used in several sectors and contexts, from consumer applications to manufacturers. Yet, it's in manufacturing that augmented reality offers great value in myriad applications, in combination with several other technologies as per usual. The use of VR and AR in manufacturing and other industries for which the term Industry 4.0 gets used is not fiction. It happens as we speak and is poised to accelerate as the benefits become increasingly clear, offerings, hardware and applications mature and move to the next level and manufacturers increase their digital transformation efforts on the strategic and staged path towards the realization of Industry 4.0 and the digital transformation of manufacturing.

Virtual reality and augmented reality can play a role in the typical earlier stages where optimization and enhanced productivity in terms of quantity, quality, speed, flexibility are more important than later stages of innovation and genuine business transformation which can of course be set out as Industry 4.0 goals at the start, more about that in 'Finding the value in Industry 4.0'.Just think about how simulation models and the use of augmented reality can speed up the entire production chain, in combination with the right data, starting from the use of AR and VR in virtual design. Or about the use of augmented reality in maintenance. And then there is of course the possibility to put a virtual layer, based on the right data and information, on top of the 'reality' in all sorts of factory and industry environments, using devices such as AR/VR glasses/viewers. The latter is probably the best known illustration of how de facto virtual or cyber and physical meet.

Title: Integrals and Peripherals
Mode of Display: Object Referenced Touch Interactivity

The basic components of a personal computer are more or less the same today as they were in the 1990s. Well, perhaps "less" rather than "more." Parts still perform the same overall functions as they once did. The motherboard still serves as the computer's central hub, with everything connecting to it; the processor still follows instructions; RAM still stores data for quick access, and hard drives still store data long-term. The way those pieces are connected and how quickly they operate has changed tremendously, however. Many people who talk about improvements in computers reference Moore's Law, which essentially states the number of integrated circuits in microprocessors will double within every two years. The more integrated circuits, or transistors, a chip has, the faster it's going to be. But that's only one thing that makes computers faster and better. For example, the magnetic storage of hard drive disks has increased tremendously since the 1990s. We measure drives in terabytes when we used to measure them in megabytes. New interfaces for transmitting data also make a big difference. The Parallel ATA systems topped out at a speed of 133 MB per second, while Serial ATA, or SATA, currently supports up to 6 gigabits per second (768 megabytes).Recently, computers have begun to use solid state or flash memory technology to store data instead of hard drives, enabling computers to access data even faster. Since the rise of the smart-phone, computer hardware has gotten smaller than ever. But even in the smart-phones space, a lot of the same components are doing the same jobs they do in full-size computers. Laptops, desktops, smart-phones, and tablets: Their use cases couldn't be much different, could they? We use computers in more places and ways than ever before. But the internal components that make that possible are very similar. In most cases, they're just smaller. Intel manufactures ULV, or ultra-low voltage, processors for thin-and-light notebooks which run on less wattage than its regular laptop chips. Laptops also use smaller RAM and hard drives than desktops. Some laptop makers, like Apple, even solder solid state memory right onto the motherboard instead of including a hard drive, which saves even more space. Phones and tablets have to be incredibly compact. Instead of a motherboard, the heart of a mobile device is a system-on-a-chip, or SoC. The SoC integrates everything -- processor, graphics processor, RAM, interfaces like USB, interfaces for audio, and more -- onto a single board. Of course, touch devices include some hardware that desktop computers don't, like touch controllers for sensing our fingers. Instead of internal power supplies, laptops and mobile devices contain batteries.

But for the most part, they're all computers -- the hardware simply comes in different shapes and sizes.

Title: Data Center, the Future of Storage
Mode of Display: Double Layered Transparent screen overlay on Physical Model

Despite the fact that hardware is constantly getting smaller, faster and more powerful, we are an increasingly data-hungry species, and the demand for processing power, storage space and information in general is growing and constantly threatening to outstrip companies' abilities to deliver. Any entity that generates or uses data has the need for data centers on some level, including government agencies, educational bodies, telecommunications companies, financial institutions, retailers of all sizes, and the purveyors of online information and social networking services such as Google and Facebook. Lack of fast and reliable access to data can mean an inability to provide vital services or loss of customer satisfaction and revenue.

Amount of data being generated over a span of one year all over the globe measures in terms of Zeta Bytes and all these media need to be stored. And these days, more and more things are also moving into the cloud, meaning that rather than running or storing them on our own home or work computers, we are accessing them via the host servers of cloud providers. Many companies are also moving their professional applications to cloud services to cut back on the cost of running their own centralized computing networks and servers. The cloud doesn't mean that the applications and data are not housed on computing hardware. It just means that someone else maintains the hardware and software at remote locations where the clients and their customers can access them via the Internet. And those locations are data centers.

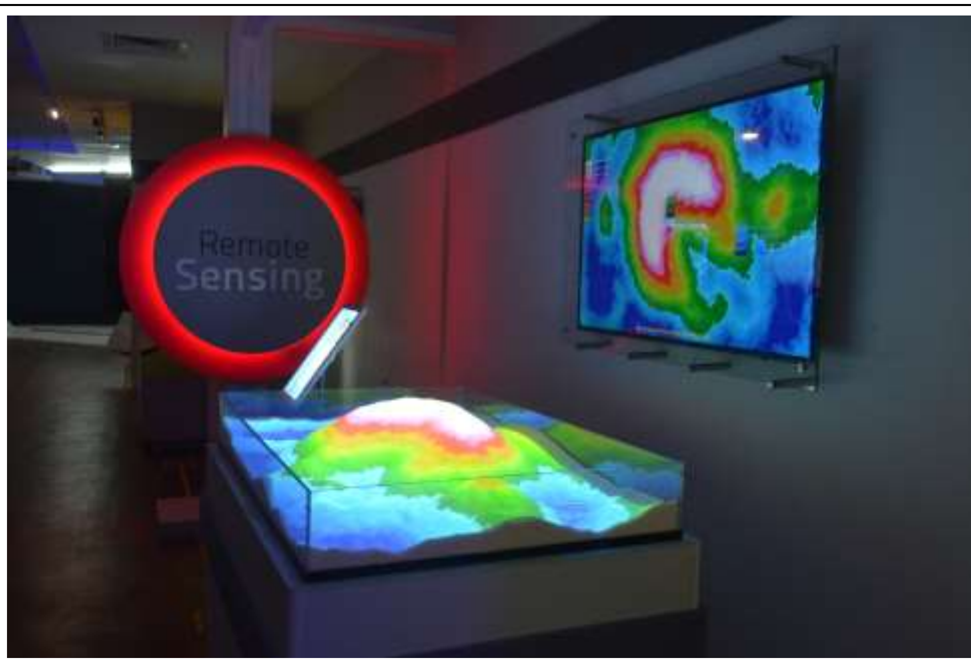
When we think of data centers, many of us envision huge warehouses full of racks of servers, blinking and humming away, wires running to and fro. And in some cases we'd be right. But they come in all shapes, sizes and configurations. They range from a few servers in a room to huge standalone structures measuring hundreds of thousands of square feet with tens of thousands of servers and other accompanying hardware. Their sizes and the types of equipment they contain vary depending upon the needs of the entity or entities they are supporting. There are various types including private cloud providers and public cloud providers like Amazon and Google, companies' private data centers and government data centers like those of various scientific research facilities.

Title: Remote Sensing
Mode of Display: Virtual Topographical Map using Projection mapping

This is a realistic ecosystem projected on top of a material surface emphasizing the variation in depth to recreate real-time model of a topological map which can reform according to the relief of the surface under consideration. However, the best part of the setup lies in its dynamic nature as it reforms the map as per changing topography. Hence it allows simulating any topography of need and thus analyzing the same as required.

Microsoft Kinect for windows is utilized here as a sensor to detect and scale a depth pattern in three dimension and thus to convey the data to a set of processing algorithms which determine the color of a layer relieved at certain height, to project it back on the same surface with the help of a standard LCD projector. Starting from Physical modeling of topography to its analysis featuring an immediate reformation of the modified point cloud helps in understanding realistic behavior of a system targeted for simulation. In due course of the analysis we will plunge deeper into the working of the system and see how the challenges involved were overcome.

As is mentioned above, it can be described as a topography simulator as a geographic map featuring changes in height in lands can be manipulated and presented at a smaller scale yet with considerable degree of accuracy. As the map portrays detailed and accurate graphic presentation of natural and geographical features of the land it can even be generalized as a smaller scale chronographic map simulator where larger part of the ground is covered with reference to the elevation of the region.



Title: The Cuber
Mode of Display: Rubik Cube solving Robot with 4 Axes Rotation

An essential facet of Industry 4.0 is autonomous production methods powered by a concept referred to as the “Internet of Things”— the idea that by harnessing a connected mesh of objects, devices and computers machines can communicate with each other. And autonomous robots are a seminal example across countless industries, including manufacturing. By connecting to a central server or database, the actions of robots can be coordinated and automated to a greater extent than ever before. They can complete tasks intelligently, with minimal human input. Materials can be transported across the factory floor via autonomous mobile robots (AMRs), avoiding obstacles, coordinating with fleet-mates, and identifying where pickups and drop-offs are needed in real-time. Because they’re connected digitally, their physical movements are as well. And since AMRs receive work signals from real-time production systems and manufacturing execution systems, assembly and production employees can focus on actual assembly and production — not the minutiae of internal logistics.

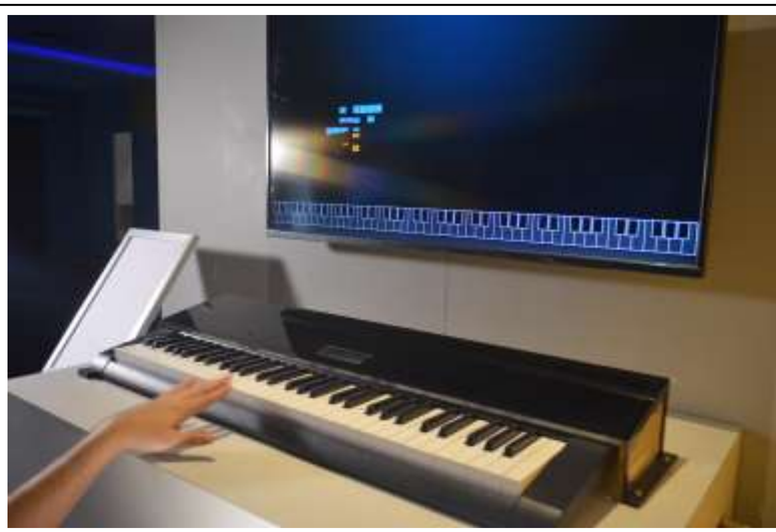
Industry 4.0 goes beyond the typical idea of machine-to-machine communication. Facility components typically not regarded as “machines” can be wired up as well, and treated as “machines” within the factory’s digital ecosystem. For manufacturers, this is a tremendous opportunity. Manufacturers should be attentive to the automation opportunities and research the enabling technology necessary to integrate automation into a well-tuned operation. The simplest example related to autonomous mobile robots could be opening doors. Doors that might have been opened and closed by a person during the transport of components and even completed products, must now be “connected,” allowing robots to communicate with them and automatically open them as they transport the goods. Where previously, factory employees might usher palettes into elevators to move materials between manufacturing floors, with autonomous mobile robots, those elevators can now connect via wireless connections and open automatically when the AMR approaches. Robots can now be fully integrated with the facility’s systems, including fire alarms — and respond to emergency situations.

Title: Artificial Intelligence
Mode of Display: AI driven application responding to a Human Piano Player

Current Industry 4.0 and smart manufacturing developments clearly point to the adoption of artificial intelligence (AI). And yet few AI developments have led to the creation of smart manufacturing applications. Head to Wikipedia and a basic definition of AI reveals five steps to achieving real intelligence – from simple reflex agents leading up to the more advanced type of AI: learning agents. I think most readers would agree that current systems are at the lowest level of AI and we have a long way to go to get to level five – fully contextualized decision making.

People have the wonderful ability to make decisions by taking account of a massive range of variables, which can be instinctive, learned and factual. A simple example: before going out we might check the weather forecast before deciding to take an umbrella with us. When we think this through, we not only consider factors such as how heavy the rain might be and how hard the wind might blow, but also how long we might be outside, and whether we trust the forecast or care if we get wet. Only time will tell if computers can match the way we think. Google AI just won a GO games series against the world champion by replaying and learning from old games. Yet not one of Google's stated aims for AI relates to industrial applications. Why? Is it just too hard? On the shop floor, most processes are close to unique, or have few similarities worldwide (at the plant cell level). At the minute, this could mean that an investment in AI is hard to justify. But there are signs of AI being tested in shop floor environments.

Some software, published recently, follows the same principles as Google AI: it learns best practices by following the decisions made by operators. It runs in the background, unobtrusively, and correlates the operator actions to product quality and productivity. It's not only cool, but I think it's the way forward to capture valuable knowledge easily and effectively in times when we lose shop floor expertise when skilled operators retire or leave.



Title: Internet of Things
Mode of Display: IoT Inspired Smart phone control of RGB LEDs

It’s important to mention that the smart devices won’t all be smart-phones, PCs and tablets, but will include wearable technology, web enabled TV, white goods, cars and so on – all connected in a gigantic web of communications. In industry, the phenomenon has several names: the Industrial Internet of Things, Industry 4.0 and Connected Enterprise. Beyond futuristic tags, all these concepts reflect the same reality: the need to optimize production through connectivity and an increased flow of data.
Only fifteen years ago, an industrial plant operated on three separate levels. You had the plant processes or operational technology (OT), the IT layer and in between stood the grey area of middleware - connecting management systems to the shop floor. The problem in most enterprises was that the commercial and production systems were entirely separate, often as a deliberate policy. Trying to connect them was difficult not only because of the divergence in the technology, but also the limited collaboration between different parts of the organization. For these reasons successful implementation of middleware was rare.
Fast forward to today’s smart factory floor that uses the almost ubiquitous Ethernet to make communications as smooth as possible. Supporting the new generation of networking technologies is an increased flow of data, collected and analyzed in real-time. However, data is only useful when you can decipher and display it. The next step to industry nirvana is using relevant data for better decisions and predictive analysis, in which the system itself can detect issues and recommend solutions.
Smart manufacturing is based on a common, secure network infrastructure that allows a dialogue – or even better, convergence - between operational and information technology.

Title: Predictive Analytics

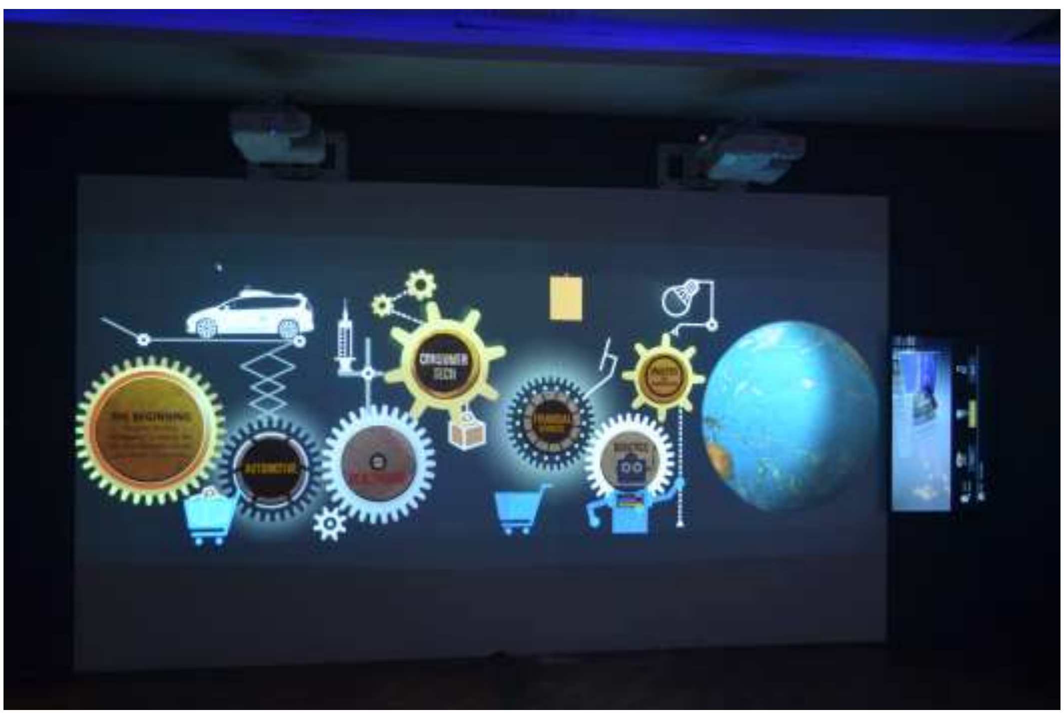
Mode of Display: Playing Card based prediction game and Multimedia

Under Industry 4.0, big data analytics is useful in predictive manufacturing and is a major theme for industrial technology development. To assist manufacturers in maintaining a competitive edge in operational management control and in improving their production efficiency and yield rates, Industries have developed a big data analytics solution with integrated ensemble learning capability. An advanced machine learning algorithm analyzes process data collected from production systems to provide early warning for anomalies and system failures and to predict product quality. An accuracy of up to 100% and false alarm rates of less than 6.58% have been achieved in the prediction of next-run failure of components along the line. The algorithm also achieves 100% accuracy and 3.51% false alarm rate in predicting the quality (Go/No Go) of the work-piece next in line. This intelligent solution for the manufacturing sector can nurture information service providers' capacities in big data analytics. It is also suitable for the epitaxial process and a wide range of semiconductor and machining applications.

Title: Social Connection
Mode of Display: Interactive Projection Mapping

Thanks to constant progress in science, we are living in a rapidly evolving world where new trends and technologies are developed daily. This has an impact on many different areas that impact on society in general, one of which is the whole field of industry and education. Especially in recent years, much progress has been made in this area, leading to some people talking about the fourth industrial revolution. This exhibit discusses this new revolution, also known as Industry 4.0, addressing the introduction of modern communication and computing technologies to maximize interoperability across all the different existing systems. Every day we are more connected and able to communicate and interact in real time between educational and industrial systems. This exhibit discusses about technologies that support this new industrial revolution and discuss impacts, possibilities, needs and adaptation. These changes are important steps to meet the growing demand for highly customized products and services, improving resource efficiency and higher throughput.

The Industry 4.0 revolution takes into account important aspects from the technological, industrial and social point of view. The so-called Cyber Physical Systems (CPS) are becoming increasingly important in this context, that is, the networking of embedded systems that interact with both other similar devices and with the others over the Internet. CPS is an evolution of embedded systems because it requires the devices beyond the capacity of processing, communication capacity and an interaction with systems and a corresponding in the virtual world, making the device can be visualized as a virtual tool.



Title: Bioinformatics
Mode of Display: Full body interactive with gesture recognition based presentation

A vast array of technologies is rapidly developing and converging to fundamentally change how research is performed, and who is able to perform it. Gene editing, DNA synthesis, artificial intelligence, automation, cloud-computing, and others are all contributing to the growing intelligence and connectivity of laboratories. It is currently possible to perform a growing number of research tasks automatically and remotely with a few clicks of the mouse. And with the barriers of entry to synthetic biology tools decreasing, they will no doubt be subject to automation as well, and may even be coupled with artificial intelligence to optimize the power of genetic engineering. While this may be a boon for the development of novel vaccines and therapeutics by parties that have traditionally not had access to the necessary tools, it also opens the risk of nefarious use to engineer or edit biological agents or toxins. While there have been attempts at governance to limit the avenues by which a bad actor may gain access to the pathogens or tools to create biological weapons, the ever-increasing pace of innovation has left gaps that may be exploited. Fortunately, investment in technologies such as artificial intelligence and sequencing may also function as the best defence against the growing threat of misuse of biological agents.

Use and deployment of advanced sensors and actuators for detection of maladies in Neurological cases and their rehabilitation happen to be another promising field gaining prominence in the given context. An example of such attempt may be sighted with the use of sensors capable of recording and comparing human walk cycles leading to gait analysis and thus helping early detection of physical and or, mental disabilities for a countable number of cases.

Title: Synthetic Vision
Mode of Display: Flip Book and Virtual Reality using Oculus

Industry 4.0 is one of a number of different terms for the current trend of automation and data exchange and analytics in manufacturing technologies. It includes the Internet of Things and cloud computing strategies to link systems and devices together. Industry 4.0 creates what some refer to as a "smart or digital factory". Internet of Things adds to that by linking the products we use every day, so that operating data can be used to fine tune manufacturing and servicing activities. In Industry 4.0, the connected ecosystem of the Internet of Things, will be able to help provide manufacturers and consumers alike with increased automation, improved communication and monitoring, along with self-diagnosis and new levels of analysis to provide a truly productive future. Factories will become increasingly automated and self-monitoring as the machines within are given the ability to analyse and communicate with each other and their human co-workers, delivering much smoother processes, and freeing up workers for other tasks. Until recently, the only way to gain detailed information about the status of products and industrial equipment was to be in physical proximity and have the ability to inspect it. Today, increased computing power and connectivity are making it possible to virtualise this task by creating and maintaining a digital representation, or “digital twin”, of any piece of real equipment, and thus of any product and industrial plant.

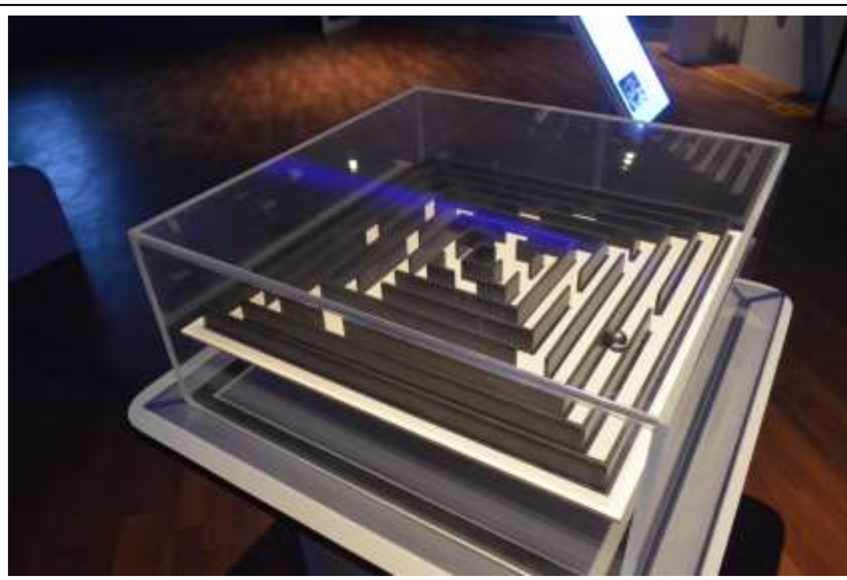
A Digital Twin is a digital model that has the ability to update and change as its physical counterparts’ change. The digital twin is constantly learning and updating itself from multiple sources to represent the real-time status. It can also integrate historical data from past machine usage to factor into its digital model. The ultimate vision for the digital twin is to create, test, build, operate and service products and industrial equipment in a virtual environment. Only when we get it to where it performs to our requirements do we physically manufacture it. We then want that physical build to tie back to its digital twin through sensors so that the digital twin contains all the information that we have available to enable operators to “interact” with the physical build.

Title: Gestural Maze
Mode of Display: Hand Gesture Controlled Maze Game

Gesture control has already begun to have a significant impact on the computing industry with users being able to input text into their devices mid-air, audiences interacting with presentations, and service robots that use image processing to be gesture control enabled. As the concepts of an always-on world, ubiquitous computing and the much vaunted “Internet of Things” gain mileage, so does the search for an intuitive, unobtrusive user interface. One only has to look as far back as the proliferation of touch interfaces to understand the consumer appeal of improved UIs. Enabled through a variety of methods - cameras, 3D sensors and wearable devices - gesture control is also driving emergent technologies such as Augmented Reality (AR) and wearable computing. And with recent technological developments ironing out kinks rapidly accelerating the progress of the technology, gesture control is currently the most intuitive human-machine interface available to manufacturers, users and developers.

Wearable devices perhaps create the most opportunity for industry adoption of gesture control as professionals are no longer restricted by the need to be near a stationary computing device. For instance, surgeons can use gesture control to flick through X-ray reports, diagnosis details and patient profiles through during procedures. Another instance could be engineers controlling various moving parts of a machine during maintenance and repair. Combined with augmented reality, gesture control also offers great opportunities for training and education. Students can now design, model and manipulate 3D objects onscreen under the guidance of their tutor, allowing educators to combine theory with practice.

Retailers have the opportunity to supercharge their quest to create immersive consumer experiences. Augmented reality experiences combined with gesture control can lead to focused, personalized campaigns unlike anything previously possible. Furthermore, with recent developments in robotics allowing human beings and robots to collaborate in the workplace, gesture-controlled robots would allow for increased efficiency, productivity and safety in industrial scenarios.



Title: Dynamic Canvas of Wood

Mode of Display: Canvas made of Wooden Pegs rotating centrally to form meaningful Images

Assemblages of cylindrical, centrally mounted wooden pegs exhibit fascinating collective motion when energized by electrical pulses of predefined duration to make them rotate on their axes. The behavior range from coherent synchronous motion to phase separation and dynamic self assembly. Although such centrally oriented assembly of wooden pegs individually demonstrating circular motion, is easy to comprehend, understanding their collective behavior remains elusive. To further elucidate the effect of such behaviors performed in groups, all cylindrical pegs were chamfered at certain angle while their faces are illuminated using directional lights to illustrate their behavior with ease. An image processing engine used on top of that to provide exciting signals to individual elements to rotate at certain angles to give rise to a meaningful image. Although in most of the approaches demonstrating flocking behavior, individual elements are displaced in the spatial field, here in this case the same is obtained with the help of their rotational behavior. Hence following are the basic three ways how such collective behavior of flocking is satisfied in the given Context:

a. Separation: Angular displacement of neighboring agents demonstrating short range repulsion

b. Alignment: Similar angular orientation of agents corresponding to a heading element

c. Cohesion: Similar Rotational angle of individual agents towards average angle of neighbors

In the given context of Industry 4.0, since sentinel of technologies are going play a key role, communication and integrity among them would be essential. Flocking, being a definitive answer to such phenomena of integration, may find a place in the sectors of industrial automation.

Title: Alan Turing
Mode of Display: Mannequin

Alan Turing was clearly a man ahead of his time. In 1950, at the dawn of computing, he was already grappling with the question: "Can machines think?" This was at a time when the first general purpose computers had only just been built. The term artificial intelligence had not even been coined. John McCarthy would come up with the term in 1956, two years after Alan Turing's untimely death. Yet his ideas proved both to have a profound influence over the new field of AI, and to cause a schism amongst its practitioners. One of Turing's lasting legacies to AI, and not necessarily a good one, is his approach to the problem of thinking machines. He wrote: "I have no very convincing arguments of a positive nature to support my views." Instead, he turned the tables on those who might be skeptical about the idea of machines thinking, unleashing his formidable intellect on a range of possible objections, from religion to consciousness. With so little known about where computing was heading at this time, the approach made sense. He asserted correctly that "conjectures are of great importance since they suggest useful lines of research". But 62 years on, now that we have advanced computers to test, it seems wrong that some proponents of AI still demand the onus be put on skeptics to prove the idea of an intelligent machine impossible.

In fact, Turing well understood the need for empirical evidence, proposing what has become known as the Turing Test to determine if a machine was capable of thinking. The test was an adaptation of a Victorian-style competition called the imitation game. The first version of the game he explained involved no computer intelligence whatsoever. Imagine three rooms, each connected via computer screen and keyboard to the others. In one room sits a man, in the second a woman, and in the third sits a person - call him or her the "judge". The judge's job is to decide which of the two people talking to him through the computer is the man. The man will attempt to help the judge, offering whatever evidence he can (the computer terminals are used so that physical clues cannot be used) to prove his man-hood. The woman's job is to trick the judge, so she will attempt to deceive him, and counteract her opponent's claims, in hopes that the judge will erroneously identify her as the male. What does any of this have to do with machine intelligence? Turing then proposed a modification of the game, in which instead of a man and a woman as contestants, there was a human, of either gender, and a computer at the other terminal. Now the judge's job is to decide which of the contestants is human, and which the machine. Turing proposed that if, under these conditions, a judge were less than 50% accurate, that is, if a judge is as likely to pick either human or computer, then the computer must be a passable simulation of a human being and hence, intelligent. The game has been recently modified so that there is only one contestant, and the judge's job is not to choose between two contestants, but simply to decide whether the single contestant is human or machine.

The AI aristocracy strongly supported the contest until it became clear how badly the machines were performing. Now, even after so many years, no machine has come even close to winning. Despite the failure of machines to deceive us into believing they are human, Turing would be excited by the remarkable progress of AI. It is flourishing in so many spheres of activity, from robots investigating the progress of climate change to computers running the world's finances.