



DRISHTIKON

A Perspective on Cyber Physical Systems

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Volume 1, Issue 1

Gazing through the CPS lens

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Cyber Physical System (CPS) is a manifestation of ubiquitous computing leading ultimately to the utopia of a connected world. The IITI DRISHTI CPS Foundation (hereafter referred to as DRISHTI CPS) is an endeavor at making this vision a reality. With the robust backing of the National Mission on Interdisciplinary Cyber Physical Systems (NM-ICPS), DRISHTI CPS is working along the specific vertical of simulation, modelling, and visualization of CPS. As we endeavor towards making a mark in this vast but important area, we feel a periodical bulletin will provide an appropriate avenue to disseminate our contributions and bring together a platform to converge and share views of academia, industry, students, start-ups and professionals for

an enriching perspective on CPS.

DRISHTIKON is the name we have chosen for this periodical as it is a compendium of perspectives on CPS. This first issue has opinions on CPS deployments across a wide breadth of domains including and not limited to CPS in manufacturing, prognostics and healthcare, the industry in general, and startups in particular. Interesting perspective on making the idea of CPS a success is also part of this issue.

We hope to provide a platform to converge and share views of academia, industry, students, start-ups and professionals for an enriching perspective on CPS besides sharing the happenings at DRISHTI CPS. Important inputs by way

of foreword by the Chairman, Hub Governing Body, and the Chairperson, Strategic Task Force set the tempo for an engrossing and enriching read. The bulletin is a key avenue leading to a confluence of thoughts and actions aimed for CPS technology development and sustaining a start-up ecosystem.

Editorial Team

Initiatives:

- Affiliate Programme
- Outreach and End Users Connect
- Technology Development
- Skill Centre
- Fellowships
- Intellectual Property Rights
- Startup Programme



Prof. Suhas S. Joshi is the Director of IIT Indore, and Chairperson of Hub Governing Body (HGB), and Board of Directors (BoDs) of IITI DRISHTI CPS Foundation.

Foreword by Chairperson, Hub Governing Body

We live in an interconnected world with the primary focus being on improving the quality of life and enhancing sustainability. While there are many facets of this interdependence, the most logical progression of the concept is to network machines through algorithms enabled by real time processing to improve functionality. This is the essence of Cyber Physical Systems (CPS) which encapsulate physical processes, connectivity, intelligence, autonomous decision making and control. CPS empowers us to envisage, design, develop and perpetuate smart systems in diverse fields resulting in the betterment of individuals and communities at large.

The National Mission on Interdisciplinary Cyber Physical Sys-

tems (NM-ICPS) is a very timely initiative to propel industrial and social systems to more responsive and efficient levels while complementing the 'Make in India', 'Skill India' and 'Startup India' initiatives of the Government of India. In line with the mission's objectives, IITI DRISHTI CPS Foundation, the Technology Innovation Hub (TIH) established at IIT Indore is working along the technology vertical of System Simulation, Modeling and Visualization. IITI DRISHTI CPS Foundation will serve as a catalyst for realizing the dream of innovation, technology development and entrepreneurship at IIT Indore.

CPS as a means for enabling translational research opens up

exciting opportunities for education and skill enhancement at multiple levels, and the IITI DRISHTI CPS Foundation will endeavour to support these. Further, the schemes of IITI DRISHTI CPS Foundation on technology development, skill enhancement, incubation and commercialization, are geared towards making the hyper-connected CPS vision a reality.

I congratulate the team for bringing out the inaugural issue of DRISHTIKON and look forward to many fruitful contributions from the industry and academia across the various avenues offered by IITI DRISHTI CPS Foundation.

Three opportunities to make CPS a reality

Vibhor Pandhare, Kennametal, Ohio, USA

The use of Artificial Intelligence (AI) in our daily life is not surprising anymore. From unlocking our phone to unlocking the mysteries of life beyond this planet, AI is becoming an essential aspect, if not existential. While many applications have seen success stories, like machine vision, some sectors are yet to normalize AI. The manufacturing sector is one such example. While having one of the greatest potential benefits, this sector has one of the least adoption rates today. And there is no single factor to blame. The foundation for deploying AI in manufacturing is provided by the data and logic coming via the Cyber-Physical Systems (CPS) technology.

Manufacturing happens in the physical space and the AI engine runs in the digital space. CPS provides all the elements of the transformation of the physical entities in manufacturing into their replicas in the digital space. CPS is not the Internet of Things – because, clearly, the physical entities on the shop floor are more than a 'thing'. It can be a half-a-million-dollar CNC machine that can do a few hundred types of operations, or it can be one of the thousand varieties of products made in the factory, or it can be the operator who forgets to record the scrap count once in a while maybe due to the extra workload. Essentially, manufacturing is complex and dynamic. If two

years of R&D by twelve engineers are needed to make the physical CNC machine serving a specific purpose, it is futile to attempt to create its realistic digital twin (DT) on an off-the-shelf digital solution by non-machining background people. Digital twins deserve the time, energy, and expertise equal to, if not more than, their physical twins in CPS. This is the first opportunity. Let's assume, on a good day, the CNC machine manufacturer itself creates and sells the digital twin at an affordable price to the factory. Yet, by itself, its use is limited. Because each of the thousand scheduled products can affect its behavior uniquely. How does the machine DT talk to the

"How does the machine DT talk to the product DT? Only the factory can make the product DT because it is proprietary information. But so is the information in the CNC machine DT."

product DT? Only the factory can make the product DT because it is proprietary information. But so is the information in the CNC machine DT. And if the factory has more than five types of machine manufacturers, do they all speak the same language? The challenges of scaling CPS are exponentially proportional to the number of proprietary stakeholders. Contextual open communication standards are the second opportunity. Further, not every

data point comes wrapped in a box of trust from a sensor or controller. It also comes from people. People are affordable, adjustable, and teachable. They get the product out of the factory and the revenue in. But this best friend can easily become the worst enemy. Humans talk the data language of inconsistency, missing values, and sometimes repulsion. Yet, they are a significant part of the data source and the actionable insight delivery for at least in

the near future. Unless they are educated in how AI can make their life easier and they are kept centric to the solution design, adoption will remain low. This is the third opportunity – management-driven changes based on user-centric design. Without these, the physical and the digital cannot unite in a factory CPS.

(Views expressed are personal)



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A cyber physical setting for social systems

Abhishek Srivastava, IIT Indore, Indore, India

Cyber Physical Systems (CPS) are leaving an indelible mark on processes around the world in a manner that is effectively changing the way we live our lives. Expectedly, the society that we live in is benefitting in more ways than one from the proliferation of CPS. In spite of this, there remains a vast pool of untapped potential for use and applications of CPS in our society. This especially holds true for the rural settings of our country which are connected through a healthy voice and data network and are waiting to use this for further satiation. A few applications of CPS in our society that immediately come to mind include medical applications, education, safety and security, agriculture. Perhaps the most impactful application of CPS is slated for the medical domain. It is not uncommon today for medical practitioners to utilise the ubiquity of cell phones to remotely provide consultations to patients. This is importantly not just restricted to discussing

the well being of patients but also utilising CPS tools and deployments to effectively assess the health parameters from a distance; more advanced work is towards the development of CPS mechanisms to facilitate medical interventions like operations and surgeries at remote locations. Education is another important domain expected to receive a robust fillip through CPS interventions. Distance teaching and learning is now commonplace and was very much the silver lining in the pandemic but even beyond this, virtual demonstrations, laboratories, experiments are gaps that CPS can appropriately bridge. The safety and security of society stands to gain from the advent of several CPS offerings. Advanced monitoring systems comprising sensors, cameras, actuators ensure that no part of the social infrastructure is in the blindspot and goes a long way in addressing our vulnerabilities as a society. In addition to this, applications like

traffic monitoring, collision detection and avoidance systems for the railways provide invaluable service to society. Finally, agriculture is an area that has the potential to reverse fortunes of nations at large and CPS enabled tools and infrastructure, like drones, soil monitoring, will go a long way in augmenting the yield. Drones provide mechanism for efficient and smart seed spraying over large tracts of land and also provide heat maps through appropriate sensors of the cultivated area and provide a quick picture of the health of the yield; CPS based soil monitoring systems provide significant impetus to fertiliser and pesticide spraying endeavours.

This is just the tip of the iceberg and comprises not more than a small sample of applications of CPS in society. The potential is immense and is waiting to be tapped.

(Views expressed are personal)



Dr. Abhishek Srivastava is working as a Professor in the Department of Computer Science and Engineering, IIT Indore, India.

Cyber Physical Systems in Manufacturing

Makarand S. Kulkarni, IIT Bombay, Mumbai, India

“The intelligence needs to be built through algorithms that not only learn from the process data that gets generated at a given process stage but also from upstream and downstream process stages to understand the dependencies between stages.”



Dr. Makarand S. Kulkarni is a Professor at the Department of Mechanical Engineering, IIT Bombay, India. Prof. Kulkarni is an affiliate member of IITI DRISHTI CPS Foundation.

The Internet has transformed the way machines, systems and people interact with each other through exchange of data and information. It has also served as a catalyst for other technological advancements that have directly or indirectly contributed or have the potential to do so in the near future. Cyber-Physical Systems (CPS) is one such advancement.

Even though the CPS concept finds its roots in the well-established field of embedded systems, there are fundamental differences between the traditional embedded systems and CPS. Unlike the traditional embedded systems, a CPS is a network of interacting digital counterparts of physical elements instead of standalone entities.

There are many definitions of CPS, including the one by the NSF (National Science Foundation, US), which defines CPS as

systems that integrate sensing, computation, control and networking into physical objects and infrastructure, connecting them to the Internet and to each other. Another definition that can be looked at is by NIST, which defines CPS as systems that comprise interacting digital, analog, physical, and human components engineered for function through integrated physics and logic.

Ignoring the differences in definitions, which are due to differences in the focus of such organizations and application areas, one can clearly see the common capabilities that are central to the CPS concept. A CPS is composed of digital versions of physical entities that are networked together and share the required data and information in real time to collaborate in decision making and execute functions in an effective and efficient manner.

Since developing a CPS will involve sensors, computation and control/actuation, it will require the use of Information Technology (IT) to get data from sensors to the processing unit for the purpose of computation and Operational Technology (OT) for optimal control/actuation. The combination of IT and OT along with associated requirement of low latency, security, privacy, safety, reliability etc. for the interconnected devices and infrastructures makes CPS development challenging.

In the Indian context, there is a huge potential for the development and use of CPS in areas of national importance like agriculture, health care, infrastructure management, defence, manufacturing etc.

In the context of manufacturing, some of the potential application of CPS could be as follows:

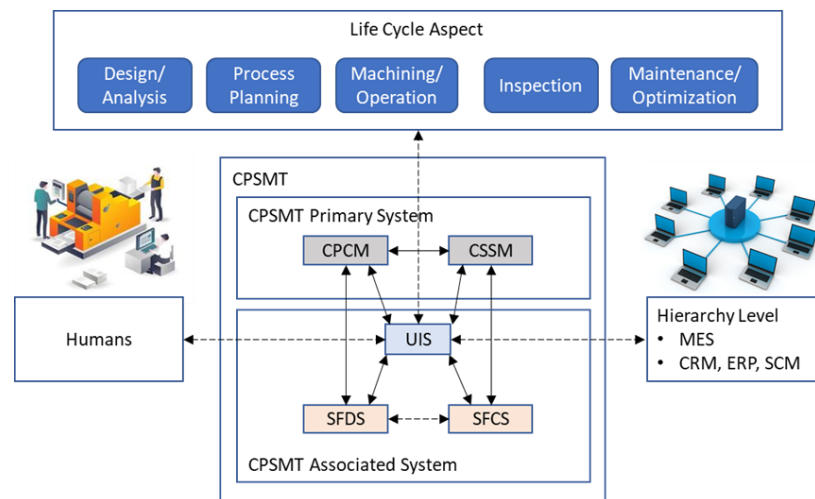


Figure 1: Reference Architecture of a Cyber Physically Controlled Smart Machine Tool System (CPSMT). CPCM: Cyber Physically Controlled Machine Tool, CSSM: Cyber Supporting System for Machine Tool, UIS: Unified Interface System, SFDS: Shop Floor Device System, SFCS: Shop Floor Control System, MES: manufacturing Execution System, CRM: Customer Relationship Management, ERP: Enterprise Resource Planning, SCM: Supply Chain Management.

Example 1: Intelligent control of industrial process and systems using embedded computing devices that are connected over a network, which can be considered as a seamless integration of computation and physical components, makes it an ideal candidate for CPS (figure 1). Industries like pharmaceutical, chemical, steel processing etc. can potentially benefit from such CPS applications. The intelligence needs to be built through algorithms that not only learn from the process data that gets generated at a given process stage but also from upstream and downstream

process stages to understand the dependencies but also from upstream and downstream process stages to understand the dependencies between stages.

Example 2: Real time monitoring and scheduling of networked equipment on the shop-floor for optimizing their production output, maintenance decisions and quality control plans. Integrating these individual shop-floor functions in a manner that the decisions turn out to be optimal is a challenging problem that can be addressed through AI and machine learning algorithms with access to real time production, equipment health

and process quality data. These CPS will also integrate with higher level systems like the MES and ERP.

With IT related costs continuously going down, there is an upsurge in the interest being shown for CPS by academia as well as industry. With such high level of interest, synergistic efforts by academia and industry can generate significant body of knowledge that will pave way for industrial implementations in Indian industries.

(Views expressed are personal)

CPS for Prognostics and Health Management

Prayag Gore, IMS Centre, University of Cincinnati, USA

Cyber Physical Systems (CPS) are popularly defined as integrations of physical processes in real world with the software algorithms in cyber space, connected by a network of sensors and actuators while being controlled by computer algorithms. In the field of Prognostics and Health Management (PHM), predictive maintenance can be achieved with the help of CPS. Continuously monitoring the

performance of a machine or an entire industrial process needs intelligent analysis of machine performance signals sourced either from sensors or controllers.

The onset of physical failure modes of critical components in a system is very difficult to observe directly. Often times, when such failure modes are observed, it's already late to implement any remedial action.

To meet this critical need, the cyberspace of CPS can be designed to host anomaly detection algorithms which constantly compare the signal signatures with healthy condition signal signatures and alert the user when a deviation is observed. For a multistage manufacturing system (figure 2), such predictions can result into zero breakdown time and root cause analysis of a particular failure.

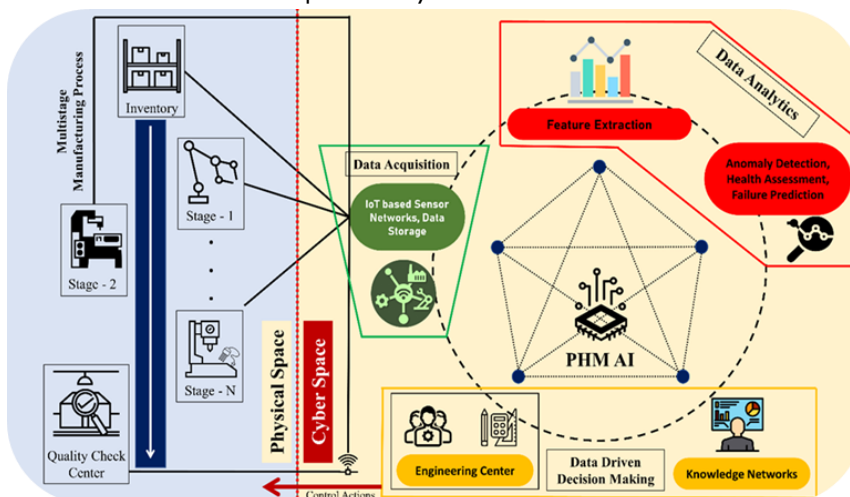


Figure 2: CPS architecture for multistage manufacturing process.

*“A calibrated digital twin
can be put through
harsh scenarios of fast
winds, storms,
earthquakes, etc. in form
of simulations.”*

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Mr. Prayag Gore is a Graduate Researcher at NSF Industry/University Cooperative Research Center for Intelligent Maintenance Systems (IMS), University of Cincinnati, USA

Digital twins form a subset of CPS and are extensively used in industrial systems to understand how a system works, monitor its performance and extract valuable insights about a system which can drive business decisions. Digital twins provide the ability to simulate different scenarios in cyber space and use the findings to make changes in the physical system. Let's take an example of the offshore wind turbines. Using sensors for simple physical properties like temperature and vibrations, the digital twins detect any aberration from normal performance in order to predict equipment health. A calibrated digital twin can be put through harsh scenarios of fast winds, storms, earthquakes, etc. in form of simulations. Insights from these simulations are used to boost

the performance and safeguard the equipment.

Another application of a CPS in the field of PHM is identifying new modes of failure which were previously unknown or unseen. Different states of a machine or a process are stored in the cyberspace as snapshots and compared after a fixed interval of time. These comparisons lead to identification of new failure modes which helps expand the knowledge network. An interesting example is the deployment of digital twin by Singapore city's municipal corporation. Being a coastal city, the digital twin was tested for various infrastructure failures in case of a Tsunami. The results were used to determine the exact locations of evacuation paths, water supply lines, building refuge shelters, etc.

The emergence of CPS has significantly impacted the field of PHM and will continue to do so for the foreseeable future. The ability to simulate different scenarios in cyberspace for a system that could go through them in physical space presents an opportunity to greatly increase the amount of data available for analysis. For predictive maintenance, more data is always welcomed and accurate data is most appreciated. As the cyber space in CPS comes closer and closer to modelling the physical space, this accuracy of available data will increase and PHM algorithms will work more effectively.

(Views expressed are personal)

Entrepreneurial journey: An alumni perspective

Gaurav Parchani, Dozee, Bengaluru, India

Entrepreneurship is a joyride with a fair share of ups and downs. While the destination or the target is very important one should enjoy this journey. My experience with building Dozee has been similar. While there's a long way to go, here's how it's been so far.

The start of this journey happens with a problem that one is passionate about. The problem is probably the most important part of entrepreneurship. The more interesting/ impactful/ significant the problem, the greater are the chances you'll be persistent with it even in the toughest of times. We were very passionate about creating a difference through technology

and ended up choosing a very hard market. Healthcare has lagged behind in tech adoption and infrastructure crunched environment. If we have to ensure quality healthcare to everyone, technology will play a massive role in bridging the gaps.

This was our motivation to build Dozee - a smart contactless remote patient monitor that automates and digitizes the vital parameter recording process, saving valuable nursing time. All of this data fuels our AI/ML solutions that add intelligence over this information for life saving early warning alerts and triaging solutions. Dozee is

being used in over 250+ hospitals and has monitored over 60,000+ patients with a significant portion during the pandemic in COVID wards.

Now Dozee converts any bed into a step down ICU for high risk patients creating a buffer between ICU and general ward beds. Dozee also powers remote monitoring and visibility to doctors for high risk patients discharged at home (figure 3). Developing and pushing these solutions out to the world was not easy, but was made possible by an amazing team and like minded partners that came together under one vision: "Saving lives through connected

"Now Dozee converts any bed into a step down ICU for high risk patients creating a buffer between ICU and general ward beds."

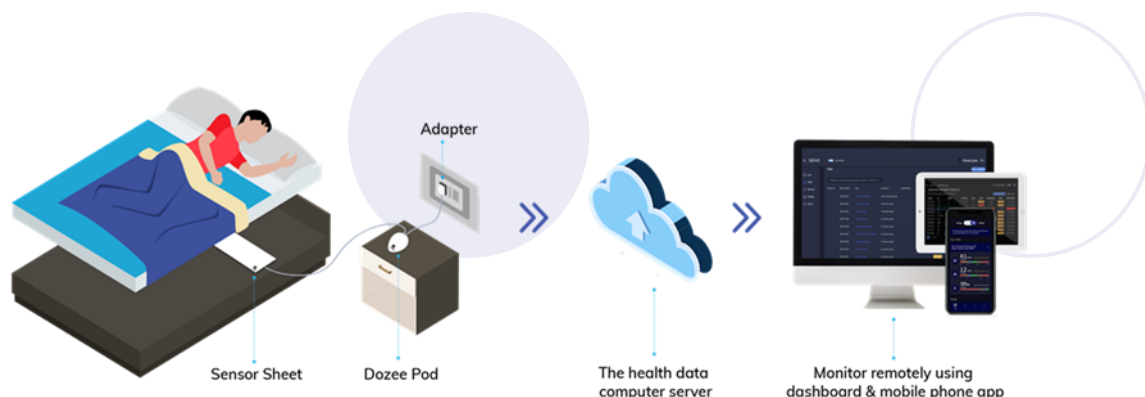


Figure 3: Dozee's vision of saving life through connected health.

health.”

To make sure quality healthcare is accessible to every citizen it will need nothing less than a revolution and India is at a perfect juncture to be the flagbearer of this revolution. India's scale is its largest challenge but it can be its biggest strength. We've proven this in the past: a national biometric registry for over a billion citizens, millions of peer to peer digital transactions enabled on UPI and more.

India has seen digital solutions creating tremendous impact in the physical space at scale.

There have been welcoming steps from the government on digital health including Ayushman Bharat Health Account (ABHA). We're in the middle of the development of the framework and policy for digital health with crucial areas like consent based interoperability of health data, the role of IoT in healthcare and more. Initiatives

like the National Mission on Interdisciplinary Cyber-Physical Systems are necessary to promote digital solutions in industries. The time for healthcare is now.

We've demonstrated repeatedly how solutions made for other countries may or may not work in India, but solutions made for Indian scale work everywhere.

(Views expressed are personal)



Mr. Gaurav Parchani is Co-founder and CTO of contactless health monitoring startup Dozee. Mr. Parchani is an alumnus of IIT Indore.

Smart Manufacturing: Accelerating the link between cyber and physical assets

Chandrashekar Bharathi, AceMicromatic MIT, AceMicromatic Group, India

In an era of transformation led by demography and choices, manufacturing industries face the opportunities and challenges of changeover from planned assembly operations to flexible demand linked production. This necessitates the ability to manufacture an item with a batch size of one, at the same cost and capital efficiency as that of items produced on a high-volume assembly line. Doing this requires a transition from “analog craftsmanship” to “digital craftsmanship” to react at the rate required, and to ensure efficiencies are created at scale. Cyber Physical Systems (CPS), which converges Computing, Commu-

nication and Control (figure 4a) can enable autonomous actions leading to reduced latencies for discovery, reaction, analysis, and “healing” (figure 4b).

CPS connects the entire manufacturing value chain, from incoming raw material supply to outbound logistics, and everything in between, to aid traceability and visibility. With this manufacturing spine digitized, companies would be in a position to achieve “vertical integration” (figure 4c) of all their key business processes, which in turn would yield processes that are faster, better, cheaper –

such as enabling highly decentralized decision, using knowledge-based, predictable, and resilient frameworks. Such vertically integrated companies may then participate efficiently and effectively in a network of customers and suppliers and tap into global opportunities.

To realize the benefits of CPS, Industry 4.0 or Smart Manufacturing concepts which leverage a 3-axis intersection of Business processes, Smart Initiatives and Enabling technologies need to be mapped out, for identifying business outcomes and tangible outputs. Getting information,

“Doing this requires a transition from “analog craftsmanship” to “digital craftsmanship” to react at the rate required, and to ensure efficiencies are created at scale”

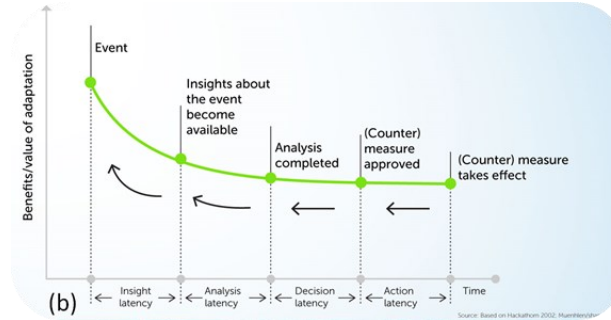
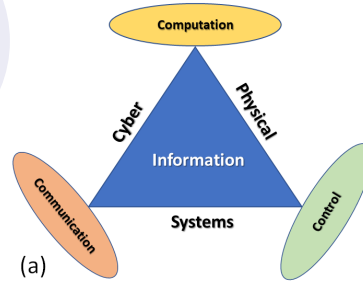


Figure 4: (a) CPS enabled convergence of Computing, Communication, and Control. (b) Latencies across business processes. (c) Vertical integration.



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digital workflows, metrics and KPIs in the hands of empowered blue- and white-collar workforce ensures autonomous, de-risked operations which can be scaled only limited by hard constraints such as availability of land or power.

Deploying this roadmap involves customer processes, technology development, service touch-points, academic research, management, and organizational frameworks, all acting in harmony. These are the purview of distributed entities, involving

industry, technology providers, academia, and training/skilling agencies. Ensuring viability through the lifecycle of such initiatives is best ensured by identifying which entity is best suited to delivering its core competence, working closely with each other. For instance, development of algorithms, mathematical models, proof of concepts may best be executed at research and academic institutes, with support from industry. Market development, customer interactions and produc-

tization at scale is best left to technology companies and industries, with domain support being given to academia. Skills development and training may be driven through government and private institutes leveraging emerging technologies. Such a well thought of deployment would ensure commercial viability, and a period of enduring development of the ecosystem, leading to transformation.

(Views expressed are personal)

‘Working towards our goals’ – Chairperson, Strategic Task Force

We are in a new era, where globalization and rapid evolution of digital technologies are bringing new changes to the society. There are growing uncertainties at all levels. At this hour, NM-ICPS is a stepping stone towards conceptualizing the Soci-

ety 5.0 through various innovative automated technologies compatible with new industry standard. IITI DRISHTI CPS Foundation, the Technology Innovation Hub(TIH) working on Interdisciplinary Cyber Physical System would explore its

various new research domains, the research outcomes, and technologies to be developed to fulfill the requirements of automation technologies leading to smart factories. This would offer industries the database knowledge, which would gener-

ate models that apply technology which aims at making more accurate and less uncertain decisions.

Strategic Task Force (STF) has been formed for better representation and implementation of the role DRISHTI CPS has been entrusted with, and for better synergy and fast tracking of programmes amongst the stakeholders. Role of STF to implement the programmes created under the umbrella of NM-ICPS is very crucial and challenging. The challenges in the research

domain of CPS is very significant, and there is ample opportunities for research and development of technology in this area. DRISHTI CPS's programme would be implemented through its various outreach programmes and would execute a time-bound plan to fulfill the National Mission. Research talent need to be encouraged to come up with proposals in collaboration with academia, research institutes and industries and also to have linkage with other hubs across the country

for a pragmatic approach to implement the Mission's goal. Framework for Grand Challenges in various areas of CPS is being planned for its future Road map. It is a pleasure to see the inaugural issue of 'DRISHTIKON' being published. I wish Team DRISHTI CPS great success ahead and excellent contribution towards the research, technology development and product realization in the areas of CPS.



Dr. Maitrayee Nanda, Chairperson STF, Ex Secretary AR & DB, DRDO, Ministry of Defence, Government of India

Happenings at IITI DRISHTI CPS Foundation

Streamlining of activities has paved the way for appropriate positioning of DRISHTI CPS towards its mandate as a TIH. In this context, technical initiatives to support CPS oriented endeavors have been launched. Also, a Memorandum of Understanding was signed by DRISHTI CPS with ProMFG to serve as its media partner. Perhaps most importantly, interactions with end users, both in the online and offline modes, have now begun at full swing. This has led to devising several important problem statements that are

publicly available on the website of DRISHTI CPS.

The number of affiliate members of DRISHTI CPS is 72 at the time of writing and the count is constantly updating. A comprehensive reconstitution of the Hub Governing Body (HGB) of and the Board of Directors (BoD) DRISHTI CPS was undertaken in line with NM-ICPS guidelines. In addition to this, DRISHTI CPS has initiated several programmes including and not limited to Fellowships, Affiliate, Technology Development, Skill Development, Out-

reach, and End User Connect, Startups, and Intellectual Property Rights have especially been harnessed as avenues to engage with dedicated focus groups for fulfilling the deliverables of TIH.

In all this, the STF has significantly contributed towards developing a framework for various schemes. Last but not the least is a recent and notable achievement wherein DRISHTI CPS was selected for the NVIDIA academic hardware grant for its Skill Centre.

"Skill Centre of IITI

DRISHTI CPS

Foundation was selected

for NVIDIA academic

hardware grant"

Affiliate Programme

The Affiliate programme is designed to be an underlying thread connecting several initiatives of DRISHTI CPS. Affiliates will play a crucial role by constituting a pool of active researchers and professionals in the relevant technology domain from India and abroad.

The different categories of affi-

ate of DRISHTI CPS include Student, Regular, Senior and Distinguished. Conducting skill courses, discounted registration or usage rates, peer-to-peer networking, and highlighting research group output are some of the benefits for becoming an affiliate of DRISHTI CPS. The affiliate count stands at 72

out of which 13 are student affiliates and 59 are regular affiliate members. DRISHTI CPS, through its affiliates, would continue to inspire the wider community through path breaking innovations.

Skill Centre of IITI DRISHTI CPS Foundation

“Learning should not stop with learning. Only a skilled person will grow in today’s world. This is applicable to both people and countries”, these were the words of the Honorable Prime Minister of India on the occasion of World Youth Skill Day 2021. Additionally, Shri Narendra Modi emphasized on the continuous and expedited efforts to skill, re-skill and up-skill especially in the current era of fast changing technologies. Cyber Physical systems and associated technologies can well be categorized as one of the most emerging areas that has got a significant presence in several industries within India. Realizing its importance, the DST has initiated

the NM-ICPS, whereby TIHs have been established at 25 institutes of national importance. IITI DRISHTI CPS Foundation is one such TIH with a primary focus on CPS under the vertical of Simulations, Modeling and Visualization.

DRISHTI CPS aims to provide an engaging environment to skill the youth of this country in addition to catalyzing employability via providing industry specific and need-based training. In this regard, a state-of-the-art skill center is being envisioned within the IIT Indore campus (see figure 5).

The planned skill center would

be a one-stop-shop for students both from within IIT Indore and outside to skill themselves and also tinker with their ideas through effective hands-on training. The center would also serve as a platform for industries to provide training to their employees and at the same time connect to experts in CPS via the affiliate programme of DRISHTI CPS. The carefully designed course curriculum offered at the skill center by experts will benefit students at all levels and also industry employees. These courses would not only provide the necessary skill accreditation but create next generation leaders in CPS.



Figure 5: Representation of the Skill Center at IITI DRISHTI CPS Foundation

Intellectual Property Rights Programme

Intellectual Property Rights (IPR) initiative of IITI DRISHTI CPS Foundation would assist students, faculty members and professionals in protecting and commercializing their innovations. A right balance between inventor friendly policy, single window reference system and fair distribution of returns along with flexible contracts and legal support are the hallmarks of

this initiative. The approach will be to steer the team to go beyond the laboratory scale prototype development i.e. field trials and associated refinement culminating in product development. This would be implemented by extending all possible technical support available at the hub. Needless to say, IITI DRISHTI CPS Foundation will back every supported endeavor

for commercialization by identifying appropriate end users. Recognizing IPR to be an important milestone of an entrepreneurial journey, the inter-linked programmes of IITI DRISHTI CPS Foundation would extend support for taking the invention further with maximum possible benefits for the inventors.

Technology Development Programme

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The Technology Development Program (TDP) of DRISHTI CPS serves as the foundation stone for realizing TIH objectives. Duration of TDP has been classified as short term (less than 12 months), medium term (12 to 24 months), and long term (more than 24 months) in terms of efforts towards prototype development. TDP will address specific gaps in system modeling, simulation and visualization aspects of CPS along with emphasis on the two technology verticals (industrial systems, and social systems). The return

on investment is the key yardstick at DRISHTI CPS for TDP.

An call for short term technology development proposals secured about 40 responses. Multi-stage evaluation of the proposals is underway, and final results are expected by the end of April 2022. TDP also serves as a link between affiliates and end users (industry, city administration, line ministries, public sector units, startup companies) through specific problem statements that are made available on the website. Any individual or group can submit potential

solutions to the listed problem statements of end users.

DRISHTI CPS is working towards recruiting scientific manpower which will be a resource for academia, startups, industries and MSMEs for technical assistance to CPS oriented problems. Call for proposals for medium and long term TDP will be announced soon.

Outreach and End Users Connect Programme

A sustained endeavor of the IITI DRISHTI CPS Foundation is towards making a mark in the society we live in. It is almost a norm for remarkable research ideas to get lost in high impact publications and never see the light of the day. At DRISHTI CPS we seek to turn this on its head and initiate ventures with the end user in mind. These may be solutions solicited by the industry or interventions aimed at a social cause, DRISHTI CPS will put its weight be-

hind their fruition and ultimate realization. Skill enhancement and trained manpower in CPS will be an added advantage for technological competence. With the above in mind, we invite all stakeholders to join us in this journey through the programmes described in this bulletin.

DRISHTI CPS was delighted to host and interact with Mr. Gopal Sharma, Head, Simulation, Production Modeling India (PMI) Private Limited, Nagpur, in March 2022. During his visit,

Mr. Sharma was briefed on the various initiatives of DRISHTI CPS and the possible avenues for collaboration. Mr. Sharma shared his experience on various projects at PMI. Apart from technology development, the issues being faced by startups in smart farming and agriculture sector were also discussed.



Left to right: Mr. Pradhumn Tiwari, Mr. Gopal Sharma, Prof. A. Kranti and Prof. Bhupesh Lad

Hub Governing Body, IITI DRISHTI CPS Foundation

Prof. S.S. Joshi

Chairperson, Director IIT Indore (Ex-Officio)

Prof. I.A. Palani

Dean R&D, IIT Indore (Ex-Officio)

Prof. B.K. Lad

Project Director and Member Secretary, IIT Indore

Dr. M. Nanda

Ex Secretary AR & DB, DRDO, Ministry of Defence, Government of India

Prof. U.S. Dixit

Professor, IIT Guwahati, Member

Prof. A.K. Darpe

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Managing Director, Cyber Infrastructure (P) Ltd, Indore, Member

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Area Vice President, India and South Pacific Rim, ANSYS Inc, Pune, Member

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Managing Director, Symphonia & Graphicus; Akshay Infrasy, Pvt. Ltd. Jaipur, Member

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IIT DRISHTI CPS Foundation, Convener (Ex-Officio)

'The Way Forward' – Project Director

It is rightly said: “*The moment you stop accepting challenges, is the moment you stop moving forward*”.

IITI DRISHTI CPS Foundation captures the essence of the above anonymous quote and has invested initial months on meticulously articulating its initiatives to serve as pillars of the technology innovation hub established at IIT Indore. These initiatives can be categorized into seven interlinked programmes: Affiliate, Technology Development, Fellowship, Intellectual Property Rights, Skill Centre, Outreach and End Users Connect and Start-up. These programmes are designed to be based on the product life cycle development, and have facilitated IITI DRISHTI CPS Foundation to move ahead with an accelerated pace.

The next step is the implementation for addressing the specific technology gaps which culminate into CPS prototypes and

products for industrial and societal needs. Solving the problem statements of the end users and skill enhancement will run in parallel with all other initiatives of the hub. The support to other academic institutions and start-up/spin-off is another major activity of IITI DRISHTI CPS Foundation. Results of fellowship awardees have been announced. The successful ideas for the short term technology development grant will be announced by the end of April 2022. Dedicated call for proposals to further engage end users is in the pipeline. Avenues for extending technical support to industry and academia is being planned to further enhance hub activities. The brainstorming discussions have resulted in the perfect balance between strong foundation and adaptability for ensuring return on investment.

I acknowledge the efforts made by faculty colleagues, and staff

members of IITI DRISHTI CPS Foundation who have been working tirelessly towards the objectives. The valuable input and support from the Mission Office at DST have been of immense help for the hub. Apart from disseminating information about Cyber Physical Systems through easy-to-understand articles by experts and professionals, DRISHTIKON will serve as a mirror and synergist for the activities of IITI DRISHTI CPS Foundation. Special thanks to IIT Indore, and members of Hub Governing Body and Board of Directors for motivating the team to excel.

With the dedicated efforts of team members along with support from IIT Indore and DST, IITI DRISHTI CPS Foundation is bound to flourish. We will remember to accept challenges, and move forwards.



Dr. Bhupesh Lad is working as a Professor in the Department of Mechanical Engineering, IIT Indore, India. Prof. Lad is the Project Director of IITI, and an affiliate member of IITI DRISHTI CPS Foundation.

Fellowships for students and doctoral scholars

DRISHTI CPS is committed to supporting the endeavours of young achievers at various levels of scholarship. The fellowship programme was instituted in line with this vision. Christened CHANAKYA Fellowships, as per the recommendations of the NM-ICPS, the fellowship programme is designed

to support undergraduate, masters', and Ph.D. students. Solicited fellowship applications comprise a comprehensive proposal on the project the student (s) intends to work on and includes among other things a clearly defined pathway to cater to end user requirements. The end user could be an industrial

establishment or a societal venture. The first round of fellowship awards have recently concluded. Many congratulations to the successful awardees, the details of which are given below.



CHANAKYA PhD Fellowship Awardee:

Mr. Jaideep Singh (PhD scholar, IIT Bombay) will develop a digital twin prototype with integrated real time decision support system for manufacturing.

CHANAKYA PG Fellowship Awardee:

Mr. Animesh Sharma (M.Tech. student, IIT Delhi) will work on the design and prototype of deep residual learning based channel estimation of 5G and beyond 5G networks.



CHANAKYA UG Fellowship Awardee:

Mr. Sharvil Joshi and Mr. Khushal Mittal (B.Tech. students, Acropolis Institute of Technology and Research, Indore) will work on the development of Sniper Robot- Eklavya.



About us: The Technology Innovation Hub (TIH) at IIT Indore was established under the aegis of the National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS). Christened DRISHTI CPS for **DRiving Innovation through Simulation Hub for Technologies in Interdisciplinary Cyber Physical Systems (DRISHTI CPS)**, the hub is invested in becoming a single stop shop for CPS design and modelling and their applications thereof. The overarching goal of DRISHTI CPS is to develop an ecosystem that will enable knowledge generation through basic and applied research and foster an interactive environment where innovative products can be developed through joint efforts of the industry and academia.

IITI DRISHTI CPS Foundation believes in strongly engaging with end users. Private industries, Public Sector Units (PSUs), Line Ministries, and City Administration continuously engage with DRISHTI CPS and provide their problem statements. The end users' problem statements are listed and continuously updated on our webpage. DRISHTI CPS is committed to supporting meritorious proposals from faculty members, students and researchers who wish to address these problems. A glimpse of a few sample problem statements is provided here.

Development of agile production scheduling algorithms and software for Smart Manufacturing

The task involves development of an automatic scheduling mechanism based on information about available machines, their capabilities, parts to be developed, and current loading status. In addition to this, the mechanism should also take into consideration constraints such as the penalty for not being able to ship, and other related impeding factors.

Development of digital twin framework for CNC machines

The main task at hand here is devising a clear definition of digital twins and its various applications for CNC turning, milling and grinding machines. This would be of great value to machine tool manufacturers. Further, use of digital twin in 3D visualization, performance estimation to more complex problems like design optimization or generative design are critical problem areas. These require modelling each subsystem, interactions between subsystems, FEA, FEM and determining the performance, performance prediction for various cutting conditions, theoretical prediction of failures, determining the theoretical life of components, and performing automated use case testing.

Welding Data Analytics

Looking for innovative solutions/approach to collect real time welding data (weld parameters) and run analytics to predict the quality of welding to reduce QA/inspection time. The data analytics running on the collected weld data may also be used for other predictions as applicable (say quality of welder impact of environment and weather).

Selection of System Integrator for Designing, Implementation and Maintenance of City Enterprise GIS Platform for ISCDL, Indore

Indore has a unique opportunity to address its three most pressing concerns: urban mobility, waste management and economic development through IoT and ICT platforms to target improved service delivery. The projects have been structured into Area Based Development and Pan City Configuration to address the needs of the entire population in an efficient manner. Indore Smart City has been envisaged and initiated the City Enterprise GIS Platform Project to address the above mentioned three most concerns. Various application and GPS solutions are required to be designed for addressing these concerns.

More details and problem statements are available on our webpage at:
<https://sites.google.com/iiti.ac.in/iiti-drishiti-cps-foundation/end-users-problems>



Contact us

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FOR CPS SOLUTIONS

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Media Partner



Connect | Collaborate | Transform

Connect with IITI DRISHTI CPS Foundation

The successful adoption of any technology by an end user is important for DRISHTI CPS. With this philosophy in mind, DRISHTI CPS is associating end users in its schemes from the very beginning. Industry, Public Sector Units, Government Or-

ganizations, Line Ministries and City Administration are few of the many end users for DRISHTI CPS.

End users bring rich experience, diverse scenarios and practical problems to the discussion

table. All of these are valuable inputs for the learning process, potential solutions and subsequent refinement in the development of a pragmatic and implementable technology solution.

Possibilities for End Users to collaborate with DRISHTI CPS

(1) List your CPS problem description or technology requirement on our webpage

End Users such as industries, MSMEs, PSUs, Government organizations, line ministries, state government departments, city administration, startup companies, NGOs can share their CPS oriented problem statements with us. A Non-Disclosure Agreement (NDA) between the selected teams and the participating end user may need to be signed before the commencement of the project. All possible options to file the patent will be explored and a mutually agreeable IPR agreement would be drawn up and signed.

(2) Extend support to our various initiatives through CSR and donations

DRISHTI CPS is a section 8 company (not for profit) eligible for receiving donation (under 80G) and receive funds under CSR initiatives of industry. We utilize such funds to support students, faculty members for research and development, establish R&D facilities, establish CPS bases at various locations in the country to disseminate the advantages of CPS technologies to society.

(3) Share your skilling/knowledge upgradation requirement for customized solutions

Skill development in CPS is a priority area for DRISHTI CPS. End Users are welcome to interact with our team and discuss the possibility of skill enhancement. Please visit Skill Development [webpage](#) for more details about the plans and activities of DRISHTI CPS.

(4) Reach out to the CPS community through DRISHTIKON

DRISHTIKON is planned as a biannual outreach bulletin of IITI DRISHTI CPS Foundation. The next issue is expected to be released in October 2022. The bulletin will be widely circulated and read across the country by the industrial and academic community. Please contact us to advertise in the second issue of this bulletin.

For more details on the above, write to us at oeup.drishticps@iiti.ac.in