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Higher Education Practice as a Response to Societal Needs: Policy Change in Credit System for Digitally Transforming Society

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Abstract

This paper traces the evolution of Higher Education as a response to societal needs. Using the basic fundamentals of retrospective and inductive grounded theory research, it takes the descriptive approach to examine curricular, delivery and assessment modifications in Higher Education through the Industrial Eras to address the changing needs. It then analyses the current state of society undergoing digital transformation, specifically, industry and workplace transformation, and puts forth the view that gaps have arisen in the incumbent Higher Education Teaching-Learning organization that have to be addressed to meet the requirements of the knowledge- and information-driven digital society and economy. The paper proposes a new Teaching-Learning organization framework to address the gaps and shows the necessity to modify the prevalent Lecture-Tutorial-Practicum credit structure to close the gaps and concludes by briefly explaining how it was incorporated into the university's academic policy.

Keywords: Higher Education; Academic Credit System; Academic Policy; Teaching Learning Organization; Digital Transformation; Knowledge Economy

Introduction

The symbiotic relationship between science, with its discoveries in materials science, biomaterials, energy storage and alternate energy sources, and technology led to exponential growth in computing power coupled with miniaturization; and faster, cheaper and more efficient digital technologies. This led to the next level of industrialization, Industry 4.0, with focus on autonomous cyberphysical systems relying on technologies such as Artificial Intelligence and IoT (Internet of Things) aggravating the dilemmas of higher education further.

Digital technologies have not only impacted the industrial production and supply chain processes but also the way businesses operate giving rise to platform-based networked business models, organization and digital economy. The platform-based networked business relies on asset sharing rather than asset building, are easy to scale due to the very nature of being digital, allow platform users to add value to the product offering due to being networked. The platform-based networked nature also allows addressing the intangible needs of humans for socialization and self-expression with users themselves leading and co-creating assets (Libert et al., 2016). The platform-based networked organization and digital economy requires skills and attitudes beyond traditional skills of domain knowledge acquisition and application that Higher Education stresses on imparting.

This paper examines the progression and practices of Higher Education through the industrial eras to the current digitally transforming society. Drawing on the basic principles of retrospective and grounded theory research, it adopts a descriptive approach to examine the progression and practices of Higher Education through the industrial eras to the currently digitally transforming society to inductively arrive at theoretical frameworks. It studies relevant research articles including comprehensive reviews, policy documents, government reports and initiatives, and institutional reports to identify factors for evolving HE structure and function. It observes that the three perspectives of aspirational needs of society, workforce needs of the industry and governments' desire for economic and social development have played a role. Based on the findings, it states that HE structure and organisation have to be changed to meet gaps that have arisen in order to satisfy the needs of the rapidly changing industry and concludes by proposing a new teaching learning organization framework and modification to the academic credit structure.

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Origin of University System

The first university in the western world is said to be the University of Bologna established in the city of Bologna in Italy in the 11th century. It offered Canon and Civil Law as branches of study as required by the church and the courts of rulers, the two being the entities that dictated the charter of the universities. Gradually, several universities were established in different parts of Europe offering more branches of study such as medicine, law, theology and the liberal arts (University of Bologna | History & Development, 2024; Grendler, P. F., 1999; de la Croix, David & Vitale, Mara., 2020; Carpentier, V., 2019). The end of the 18th century saw a continuing separation from religious studies leading to the formation of what was termed as modern universities with Halle being the first modern university in Europe, founded in 1694. Most German and American universities modelled themselves along the lines of Halle. In the later 18th and 19th centuries, universities began to emphasize academic freedom, empirical experimentation, rigour and objectivity leading to displacement of religion as a driving force (University | Definition, Origin, History, & Facts, 2024; Rudy, W., 1984). The focus shifted to discovering the workings of nature and organizing the newly discovered knowledge so as to transfer to the following generations as it was deemed essential for improvement of the human mind and the society as a whole. The teaching was organised in classrooms and laboratories and in the form of lectures, readings and experiments (Mandke, V. V., 1989; Dove et al., 1985; Shipman, M. D., 1971).

Thus, it can be seen that the early universities offered religious, legal, liberal arts and scientific education as the perception of the goal of a university was to preserve religious and cultural beliefs, pursue research, and discovery of new knowledge for the sake of knowledge itself. They did not see it their role to link with other vocational needs of society or link scientific research with vocational improvements. Students desirous of pursuing vocations in religion, law, arts and science, and often supported by guardians, attended universities.

Industrial Era and Higher Education

While prior to the Industrial Revolution 1.0 and 2.0, cottage industry was the norm for production, the invention of capital-intensive machines to aid production led to the formation of proto-versions of the modern-day factories. The machines required specialized skills to operate, necessitating training for the same. This led to an important distinction for education. While earlier, the interest and responsibility for training and education lay with the individuals and their parents, now the employers too had to take an active part in education and training as they had a stake in creating the necessary labour force for their establishments. Another distinction was the growing perception of the nature of the skills themselves. These skills were viewed as belonging to two categories – factory-specific and generic skills that were applicable to all establishments, punctuality and obedience being a few. Generic skill development was addressed in Sunday schools while the factory-specific skill development took place on the job in the establishments themselves (Mokyr, J., 2001; Kapás, J., 2009).

Another aspect pointed out by Mokyr (2001) is that knowledge and skills had to be transmitted not only across a generation but also from generation to generation. In the pre-Industrial era, homes themselves served this purpose with the relatively static knowledge and skills being passed from parents to children or in some cases under external apprenticeship. But in the Industrial era, especially with machines and production processes undergoing rapid improvement, knowledge was no longer static but changed and grew. Applying knowledge from one domain to another too had its gains. The factory itself served as an educational setup for inter-generational knowledge transfer with new employees learning under more experienced ones. The knowledge also was beginning to get documented in the form of manuals and handbooks which employees were expected to read and understand. But with technological advances, it became increasingly costly for individual employees to re-train themselves repeatedly and this role of retraining was undertaken by the factory in the form of group training. Also, all knowledge was not amenable to codification and hence learning under more experienced employees or experts was still needed. Technology advancement in the form of development of machines, the production processes and business skills for running factories relied on individual inventive and innovative capabilities. These developments too took place outside of the formal university system which continued in the domains of theology, arts and humanities (Carpentier, V., 2019).

While the seeds and similarity with the requirements of the current digital society can be seen – industry-specific information, communication and computer skills and generic skills such as creativity, analytical thinking, communication and collaboration, universities did not consider it their charter to contribute to the industry; and employee training skills did not need higher education intervention.

As industrialization progressed, electrification of industry and advances in transportation required a higher degree of knowledge and skills. Both governments and society realized the need for universities to make a greater contribution to industrialization. This led to stratification of higher education institutions into classical and technical universities as well as the emergence of research universities based on the Humboldtian model and Enlightenment (Carpentier, V., 2019). The two World Wars saw Higher Education institutions contributing to the war efforts of their respective countries and their agendas, both technologically and ideologically. It brought into focus the role of Higher Education in achieving technological prowess.

Introduction of the Elective System and Credit Hours

Another seminal development in Higher Education was the introduction of the elective system which allowed offering of multiple courses to students to choose from. This necessitated a means to quantify the education process. The academic credit system was introduced that defined learning in terms of teacher-student contact hours. The credit system facilitated offering of large numbers of courses as well as student mobility by making it easy and simple to manage both. The credit hour was used as a unit in academic administration too and was soon applied to tuition fees, salaries, facilities and programs of study (Heffernan, J. M., 1973).

While the credit system had its merits in academic and fiscal management of education, simultaneously, the credit system's disadvantages were being recognized (Ehrlich, T., 2003), the chief being:

- Learning needs another unit of its own to measure learning outcomes rather as time was not a suitable unit
- Dividing the curriculum into courses results in the student exiting the course of study with a fragmented rather than an integrated understanding of the subjects
- Drives students to earn credits rather than understanding the subjects
- Time as a unit of learning attainment stifles originality
- It makes education mechanical whereas education is a dynamic process
- Any innovation in pedagogy would disrupt the class schedule which was based on fixed lecture and practical hours

- Credit hours assigned to practicum and seminars do not reflect the actual time spent by the student outside the lab or classroom

Further, several studies showed that students learn equally well in independent study and other alternative learning settings with lesser contact hours (Heffernan, J. M., 1973; Harris, J., 2002). These studies and observations indicate that the credit system would need modification to adapt to the newer ways of learning that are aligned to the way the human brain thinks, works and creates.

Knowledge Era and Higher Education Progress

The invention of the semiconductor-based transistor saw the beginning of the next phase of industrialization. From there on the progression from discrete electronics to integrated electronics, microprocessors, computers, modems and the internet saw a complex relationship amongst basic scientific research, industrial research and production, professional bodies and the governments. It can be seen that while in the beginning technology and science advanced parallelly, each not in communication with the other, the rise of technical and research universities brought technology in closer contact with science. The rapid advances in technology, in particular digital technologies, can be attributed to technology drawing its basis from science and also straddling between science and economics, thus leading to economic advancement (Mandke, V. V., 1989). Higher Education came to be viewed as a vehicle for economic growth for its role in providing trained workforce to manage increasing needs of the industry. This view led governments, desirous of economic growth, as well as the society wishing to improve its monetary condition and status, to drive higher education leading to rapid establishment of a large number of higher education institutions including polytechnics, technical and teacher education institutions leading to what was termed as “massification” of higher education which was quickly adopted by most countries across the world (Carpentier, V., 2019).

Another level of cohesion and cooperation amongst higher education institutions can be seen in Europe which was brought about by the establishment of bodies such as ERASMUS (European Community Action Scheme for Mobility of University Students) and OECD (Organisation for Economic Co-operation and Development) as well as the Bologna Process. ERASMUS began with an initial focus on higher education and student mobility across European nations. Its scope has expanded to include Education, Training, Youth and Sport at all levels. OECD’s charter has been to advise governments on policies for sustainable and inclusive development. With education being one of its focus areas, it is known for its worldwide school student assessment called PISA (Programme for International Student Assessment) which moves away from rote-based recall to application and solving problems of the real world as educational attainment indicating how education should be reorganised to deliver higher order thinking outcomes. To make European higher education “attractive and competitive worldwide”, the Bologna Process attempts to bring unity to the higher education systems followed across Europe - uniform quality of education, shared and reciprocal recognition of qualifications amongst others.

The Ongoing Debate of Higher Education Purpose

It can be seen that while the government's efforts have led to the establishment of a large number of institutions in a short span of time as well as addressed the workforce requirements of the growing knowledge economy and industry, it stands the risk of making higher education increasingly bureaucratic as well as making grassroot level innovation difficult to implement and scale. Further, the schism due to stratification into technical and traditional HE universities with growing focus on job-readiness of the former, brought forth the debate regarding the purpose of higher education – should its role be that of serving the labour needs of the industry or should it continue to honour its original purpose of development of humanity through pursuit of knowledge – this question becoming particularly important in the context of the growing importance in the knowledge era and economy. The Bologna Process and the OECD framework of higher education emphasise on generating workforce for the industry intensifying job competition through additional qualifications and certifications acquisition leading to a divide between higher and lower qualified personnel (Kromydas, T. 2017).

The difference between instrumental and intrinsic notions that exist with respect to the purpose of education is brought out in (Kromydas, T. 2017) and the author puts forth the view that the two notions though appearing to be irreconcilable can be seen to be amalgamated in some prevalent higher education systems and put forth a hybrid model. The instrumental view sees education, especially higher education, through the lens of the human capital theory and regards higher education an investment of time and money that will in turn fetch higher returns in the labour market. On the other, the intrinsic view sees the purpose of higher education to provide knowledge and skills that enables humans to be able to make choices about their lives.

A chief criticism of the instrumental view is that it places the purpose, content, delivery and assessment in the hands of the industry and market players with short-term objectives while relegating the students, parents and teachers as mere actors. Further the social and economic inequalities continue to remain despite the promise of economic progress. The Hybrid model approach proposes a true knowledge-based economy where "knowledge is not subdued to economic reasoning…, where economy would become a means rather than an ultimate goal for human development and social progress".

The instrumental view of higher education also leads increasingly to 'corporatizing' of higher education that emphasis on job-readiness and revenue accruement. This is moving away from the view of higher education creating responsible individuals who apply knowledge to solve societal challenges, climate change being one of them. Higher education should move away from the narrow notions of job-readiness and instead create an environment where students "only consume knowledge, but also produce, challenge and reformulate it, connecting their learning with their already diverse lived experiences." Thus "students become 'job ready' to challenge the status quo and collectively negotiate a better world for themselves and their peers as they graduate (Douglass, J. A., 2010)."

A harmonization of the intrinsic and instrumental notions can be seen in the emerging American model of the public research university which gives equal importance to teaching, research, and societal service, in particular, supporting the needs of the regional economic players and engaging with the local community. A broader view of human capital is proposed which includes cultural, economic and educational, social, cognitive and aspiration capital (Cornelius-Bell et al., 2023).

To summarize, till the early 20^{th} century, industrialization required knowledge and skills of not very high order and unidimensional in nature for fulfilling the production needs of factories. From the 1950s onwards when governments stepped to expand higher education reach leading to increased enrolments and creation of technicians, engineers and other graduates, "linear manpower planning models assuming perfect labour markets characterized by codified view of orthodoxies of knowledge and skills was used as the basis" (Mandke, V. V., 1989).

This assumption led to no demands being made on higher education curricula to address the development of cognitive abilities of analysis and synthesis needed for students to become problem solvers who can go on to contribute to technology innovation which was being increasingly perceived by the industry but not articulated. Higher education itself had taken the industry for granted and assumed that it would readily absorb students who had been trained academically which worked well in the initial stages where technology was still developing. By the 1970s, when technology began to develop rapidly leveraging advances in science, the semiconductor transistor being one example, the mismatch between workforce requirements and supply from HEs began to surface. With rapid technological progress and increasing reliance on knowledge as the driving force of progress, the mismatch presented itself as uncertainty in the future demand leading to "simultaneous shortages of new skills and surpluses of many obsolescent skills" This led to challenge the belief that increased educational expenditure and enrolments lead to economic development since the higher education system had only increased in number but not in nature to meet the demands of a different kind of workforce that can handle not only the rapidly changing technology but also contribute to the change thus transforming the society as a whole. (Mandke, V. V., 1989).

Digital Economy and New Learning Processes

Digital technologies have led to the phenomenon of Digital Transformation. Kraus et al. (2021) review and attempt to classify research work published on digital transformation and lists some definitions of digital transformation as reported in literature. While most definitions pertain to industry and organization transformation, two definitions attempt to capture the overall effect of digital transformation – "Digital transformation comprises the changes associated with the application of digital technology in all aspects of human society - Stolterman et al. (2004, p. 689)" and "Digital transformation is the use of information and communication technology, not when trivial automation is performed, but in the case where fundamentally new capabilities are created in business, public government, and in the lives of people and society - Martin (2008, p. 130)". This paper takes the same view but is also cognizant of the variations as well as interdependencies when viewed sector-wise. Thus, Digital Transformation encompasses the transformation of the entire society as a result of adopting digital technologies in research, industry, governance, commerce, health, education and entertainment leading to digital economy. ERASMUS renamed ERASMUS+ as of 2021, has included Digital Transformation as one of its priorities.

To characterize the changes occurring in the digital economy and society from the industry's perspective, two terminologies are being used – VUCA (Volatility, Uncertainty, Complexity, Ambiguity) and BANI (Brittle, Anxious, Nonlinear, Incomprehensible). The VUCA framework has been borrowed from the military world and applied to the business world impacted by digital technologies. It has been used to give an understandable picture of the business environment and thus arrive at business strategies to handle the situation at hand (Bennett 2024). BANI was proposed to describe the current state of the world grappling with nonlinear situations such as the pandemic, climate change and geopolitical tensions which the VUCA framework could not depict adequately (Cascio, 2022; Kraaijenbrink, 2024). The Gartner Hype Cycle provides a mechanism to view graphically the life cycle of a technology/allied industry from proof of concept/adoption to obsolescence states. It attempts to help businesses to understand technology from the business angle and reduce technology investment risks (Gartner. (n.d.); Steinert & Leifer, 2010).

Higher education institutions can use the VUCA/BANI frameworks and tools such as the Gartner Hype Cycle to prepare itself and students for the changing world and workplace. Bushuyev et al. (2023) propose applying project management principles, models and practices for "innovative development of educational systems" that can respond to the BANI environment. They list ten competencies required to function in a BANI environment and suggest adoption of scenario building and simulations as means to enable students and other stakeholders to understand and develop skills to work in a BANI environment. They also propose principles of effective project management including Agile methodology to manage the "innovative development of educational systems." They conclude that such a development practice is expected to promote active learning, help teachers become facilitators, build collaborations with external stakeholders and develop all the necessary skills and attitudes for the BANI world.

In this context, the paper proposes that our digitally connected world can be viewed as a complex system that is interconnected with multiple feedback loops, interdependent, nonlinear, adaptive, and open system thus requiring a different teaching-learning organization to prepare the students for the world of futures'. Vermunt, J. and Verschaffel, L., (2000) describe a model of teaching – "process-oriented teaching" that is based on the "interplay between learning and teaching" and enabling new knowledge acquisition by learners. We take the view of new knowledge creation through a "connectomnal complex network" based on 'process-oriented teaching-learning' in which instruction is perceived as an interplay between teacher and learner. In 'interplaying' each student plays multifarious roles, namely, researcher; technology user; technology expert; observer understanding of learning practice; seeker of support from team and peers to restructure these perceptions if another way of perceiving is more fruitful; environment changer; and self-directed learner. The teacher too enacts multiple roles, namely, a mentor; goal-setter and questioner; strategist; positive T-L environment builder; catalyst for controlling between constructive and destructive conflict in learner's thought building, between learner's external and internal regulation, between teaching and learning strategies; situation builder; context provider; monitoring for enhanced performance; stake holders group builder; and T-L process integrity assurer. Thus, the student can said to come in "m" multifarious forms and teacher in "n". In contrast to yesteryears' simple classroom of a teacher teaching a student through guided instruction, now what one has is a connectome networking "n" teachers with "m" students. Effective information processing through this connectome then delivers effective learning. Mentors and industry experts are also pulled into this connectomnal network with each performing varied roles thus enriching the connectome further.

Changing Nature of Jobs – Higher Education's Perspective on Industry Expectations

The World Economic Forum's bi-annual Future of Jobs report 2023 (Di Battista, et al., 2023) widens its scope of tracking labour market impact the fourth industrial revolution to include not just technology but also interconnected factors such as climate change, geopolitical shifts, energy transitions, and macroeconomic movements. The net job-creation effect will be driven by green transition initiatives undertaken by businesses, broader application of Environmental, Social and Governance (ESG) standards within organisations and climate change adaptation initiatives. The fastest-growing roles too are driven by sustainability in addition to technology and digitalization. Vocational Education and University and Higher education are expected to grow. "Analytical thinking, creative thinking, resilience, flexibility and agility, motivation and self-awareness, curiosity and lifelong learning, dependability and attention to detail, empathy and active listening, leadership and social influence" are some of the skills the industry has stated it is looking for and planning to invest on training in addition to technical ability. Most of the fastest declining roles are clerical or secretarial ones.

The India Skills Report 2024 (Wheebox, 2024) on the basis of its Wheebox National Employability Test (WNET). The test was taken by 3.88 lakh people in the age group of 18-29 years drawn from across the country. The test covered English as a second language, numerical skills, critical thinking skills and computer skills. As per the findings of the report, the overall employability stood at 51.25%, employable meaning to be understood as achieving a score of 60% or above in the test. MBA graduates were found to be the most employable (71.16%) followed by Computer Science graduates (66%). Wheebox's Hiring Intent Survey saw 67% of organisations stating that professional networking or social media as the preferred channel of talent acquisition (Wheebox, 2024)

As can be seen, jobs involving repetitive tasks that are amenable to automation tend to disappear. The value of workplace learning is perceived as being important by both students and the industry. Higher Education now needs to go beyond teaching content and instead innovate newer ways of teaching-learning to enable students to acquire non-domain skills including social skills, environment sensitivity, empathy and lifelong learning as students would need to continuously learn-unlearn-relearn throughout their lives in diverse and changing world.

The view of the role of higher education institutions, in particular, universities is as a public good with teachers pursuing research to seek knowledge. Teachers are expected to promote independent and critical thinking in students. Both teachers and students have the right to question and freedom of expression with no fear or favour. These ideas are seen as being challenged by the 'corporatization' of higher education. Brownlee, J. (2014) states that "…governance models reflect business objectives and modes of operation; teaching is focused on vocational training and carried out by casualized labour; and research is conducted to serve corporate interests." Higher education institutions adopt corporate organization and practices and aim at maximizing profits and improving their 'brand' stature so as to attract students who are now viewed as customers or consumers. Zaidi, S. A. N., (2020) highlights the effect of partnering with corporations on the integrity of research using pharmaceutical and tobacco sector where research integrity is compromised under the guise of research funding which can be viewed as an example. Westheimer, J. (2015) takes a view from the angle of text books which can include other study materials including digital. The intrusion of large corporates, driven by profits, in dictating what study materials to use impinges on the teacher's independence to organize teaching-learning as well as the students' choices.

In the context of Digital Transformation, it is to be expected that this debate will be extended to adoption of technologies in all aspects of higher education institutions.

Movement from Industry Requirements to Society Requirements

While the first decade of the 21st century focused on Industry 4.0 leading to economic growth, there was the realization that focus on economic growth was necessary but not sufficient for overall growth of society. This led to the conceptualization of Industry 5.0/Society 5.0 to address the challenges of an increasingly complex and fragile world subjected to climate change, geopolitical tensions, energy crisis, and pandemics. There are also the implications of longevity that society will have to face soon. The industry with its focus on profits did not take into account the environment and societal costs leading to imbalance in development of society and deteriorating environment. The industry now has to expand its purpose to include overall wellbeing of the society and environment. Industry 5.0, put forth by the European Union, "recognises the power of industry to achieve societal goals beyond jobs and growth, to become a resilient provider of prosperity, by making production respect the boundaries of our planet and placing the wellbeing of the industry worker at the centre of the production process." It is expected to "complement the existing Industry 4.0 paradigm by having research and innovation drive the transition to a sustainable, human-centric and resilient European industry." Industry 5.0 is expected to keep the human at the centre of all of its activities, adopt circular economy practices for sustainability and develop robust business processes including supply chain for resilience. The technological framework rests on six categories: (i) Individualised Human-machine-interaction; (ii) Bio-inspired technologies and smart materials; (iii) Digital twins and simulation; (iv) Data transmission, storage, and analysis technologies; (v) Artificial Intelligence; (vi) Technologies for energy efficiency, renewables, storage and autonomy (Breque, M. et al., 2021).

Society 5.0, a strategy put forward by the government of Japan, envisages an innovation society that relies on using the innovations of the fourth industrial revolution (Industry 4.0) for the betterment of the society. It is defined as "A human -centred society that balances economic advancement with the resolution of social problems by a system that highly integrates cyberspace and physical space". It is put forth as a progression of the human society from Society 1.0 – hunter gatherer society to Society 2.0 – agricultural society to Society 3.0 – industrial society to Society 4.0 – information society to Society 5.0 - innovation society (Deguchi, A., et al., 2020; Keidanren, 2016). Mavrodieva, A. V. & Shaw, R. (2020) discuss disaster and climate change policies for sustainability in the context of Society 5.0.

Both Industry 5.0 and Society 5.0 frameworks rely on scientific and technological developments with the key difference being that whereas earlier the human was looked upon as a resource for achieving economic benefits, now the human becomes the centre of focus. Hence science and technology must now be made to adapt to human needs and not vice versa. This has far-reaching implications for higher education and also helps resolve the conflict between intrinsic and instrumental views.

The National Education Policy 2020 - NEP 2020 (Ministry of Education, n.d.; University Grants Commission, n.d.; Kumar, A., 2021; Behar, A., 2021a, 2021b;) from the Indian government attempts to go beyond the instrumental purpose of higher education which includes employment and economic growth; and tries to integrate the intrinsic with the instrumental purpose of education. According to NEP 2020, Higher education should "become the basis for new knowledge creation and innovation" leading to "vibrant, socially engaged, and cooperative communities" and a "prosperous" nation. To achieve this, it lists attributes of higher education emphasising new knowledge creation using real-world problem solving and multidisciplinary approach – this requiring a change in incumbent teaching-learning organisation. Some relevant deficiencies in the current higher education system as observed in the NEP 2020 are a rigid separation of disciplines, with early specialisation and streaming of students into narrow areas of study and limited teacher and institutional autonomy.

Gaps in Teaching-Learning Organisation and Efforts to Prepare Students for Digital Economy

Relevant concerns from student and teacher perspectives can be identified based on narrative in the previous sections. Changing nature of jobs, jobs disappearing, acquired knowledge and skills inadequate or irrelevant to jobs, dichotomy in internal and external goals and technology-induced distraction are some applicable student concerns. Addressing impacts of technology use in own domain of expertise, changing educational technology and pedagogy and corporatisation of higher education are some relevant teacher concerns.

Based on the requirements arising from industrial and societal progression, pertinent gaps that have arisen in Higher Education teaching-learning organisation can be stated as:

- Lack of individualization
- No content innovation – content pre-defined and static

- Innovation in pedagogy within the limitations of LTP structure
- Delivery innovation limited to online, blended learning
- Scalability of sameness in the place of scalability of variability (mass customization)
- Inadequate industry linkage
- No teacher transformation

Several research studies view higher education from the lens of preparing students for Industry 4.0. Al-Maskari, et al. (2022) identify Students' Characteristics, Students' Knowledge of 4IR (Fourth Industrial Revolution), and Organisational Dimension as three factors influencing students' preparedness for 4IR. Of these the Organisational Dimension which includes trainings and webinars, projects and assignments, and courses and internal talks on 4IR influences both Students' Characteristics and Students' Knowledge of 4IR. It also has the most impact on students' preparedness for 4IR compared to the other two. It suggests that events, conferences and competitions as a means to expose students to real-life implementations of 4IR technologies. It can be seen that pedagogic activities beyond lecture-tutorial means impact positively students' acquisition of any given domain's knowledge, skills and attitudes. Hart, J. (2019) examine interdisciplinary project-based learning as a mechanism to develop employability skills and concludes that collaboration with employer groups, embedding employability skills throughout the programme of study, supporting teachers to do the same, adding interdisciplinary component to projects are some factors that impact the acquisition of employability skills. Coşkun, S., et al. (2019) put forth three means of adapting engineering education for Industry 4.0 – curriculum changes/enhancements, new lab designs, and student clubs. The student club undertakes Industry 4.0-related projects as part of its activities.

Higher education institutions themselves are in the process of undergoing digital transformation as a response to Industrial Revolution 4.0. Benavides, L. M. C. et al. (2020), using a systematic literature review as a mechanism, examines digital transformation in higher educational institutions. It reports that 95% of the articles considered students and teachers as the actors in the DT process and 53% consider that industry should be linked with when the HEI begins DT. Surveyed article authors also suggest that while resources and tools based on digital technologies be used in the teaching-learning process as part of DT, they should be innovatively "enabling new roles for teachers and students", promote flexible, autonomous and collaborative learning. There was emphasis on a flexible curriculum that could respond to the evolving needs of the industry and also enable co-creation of value for all stakeholders. Based on the above, tussles between the incumbent way of teaching and new ways needed and incumbent teaching-learning organization and new organizations needed can be observed.

An Alternative View of Business Processes as basis for Teaching-Learning Organisation

The end of 20th and the beginning of the 21st century saw the emergence of Convergence Technology (CT) and Artificial Intelligence. CT is characterized by convergence of computing

(Internet and IoT included), communication (wireless, social media and open-source intelligence included), consumer electronics (visual electronics included) and content. Its direct T-L as well as Industry work implication is that learning and work have to be performed in a real-time information processing environment characterized by both exponentially growing information and high-speed information processing. What this requires is 'to use learned information' by engaging in productive economic activity delivery for customer satisfaction, unexpected customer included and thereby value-create for themselves and others. That is to say that the way one learns itself is changing in contrast with traditional instruction which relies on acquiring and retaining information. While the definition of work in the 20th century is force multiplied by distance, the paper proposes that work in the 21st century, characterized by complexity and uncertainty, can be said to be equal to information multiplied by information use. The view of a business changes from a product/service-centric view to information-centric view, from value-addition to value-creation, from operating in silos to operating as a networked organization using data and information processing for forecast and control. Digitilisation necessarily transforms from firm-centric to ecosystem-centric, from scalability of sameness to scalability of variability.

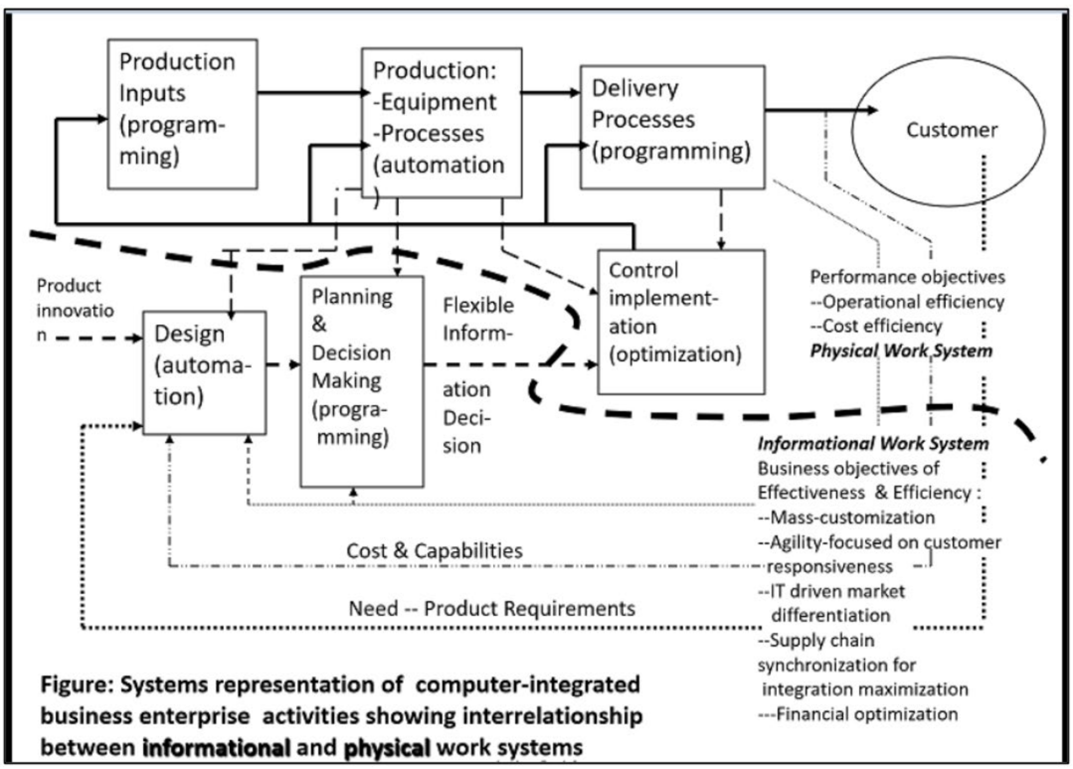

Figure: Systems representation of computer-integrated business enterprise activities showing interrelationship between informational and physical work systems

Figure 1: Systems representation of interrelationship between informational and physical work systems

In traditional businesses, the emphasis is on high-volume production of standardized goods and services and gaining competitive advantage by focusing on improving efficiency of operations and cost optimization. There is little need optimally processing information. In a networked organization there is shift from energy-based to data-based processing using technologies and uses information for real-time decision-making. This requires "maximization of 'informational work' for delivering flexible information decision for control implementation". The information work system changes continuously in response to customer needs and leverages newer technologies for better efficiency and effectiveness. The production system itself responds to changes in technology as depicted in Figure 1 (Mandke, V. V. and Nayar M. K., 2002), Industrial IoT and Digital Twin, being case in point (not shown in figure).

The traditional view of product/service development phases is given in Figure 2. It takes the view of expected customer, known result, known process and adequate resources to meet the goal indicative of the principles underlying Instrumental rationality. Its focus is to optimize materials.

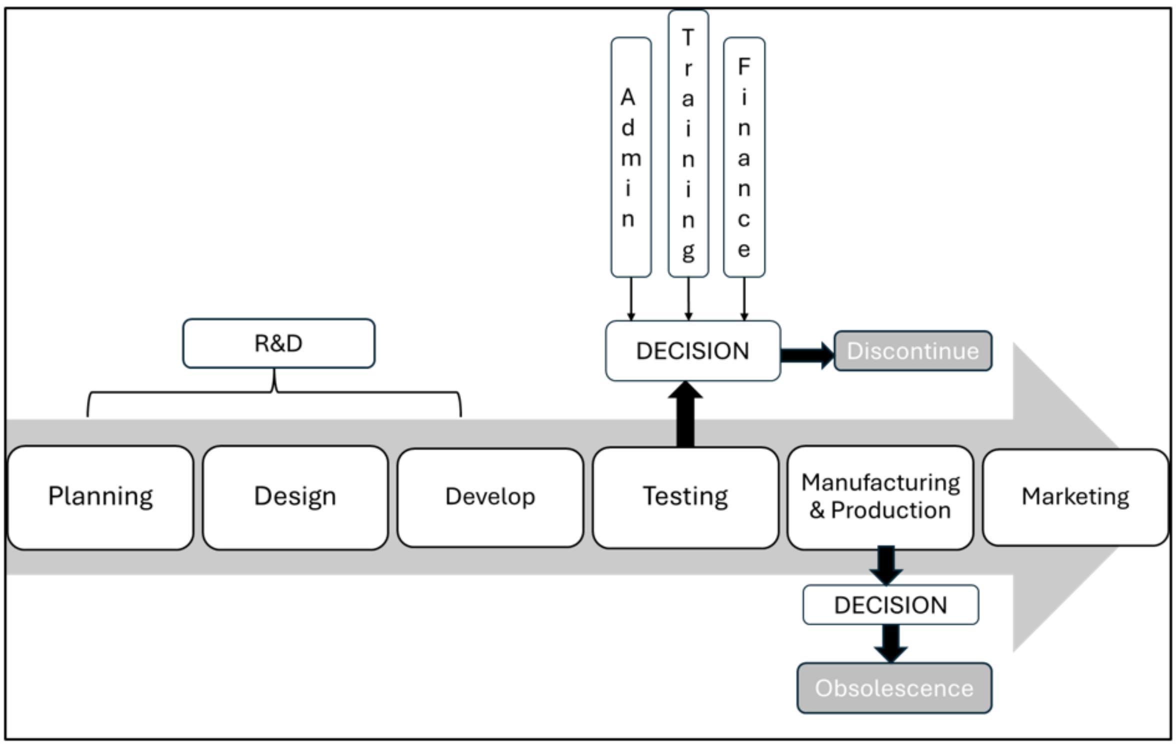

Figure 2: Traditional View of Product/Service Development Lifecycle

A new view of product/service development life cycle based on our observations of the digital economy and taking an information-centric view is given in Figure 3. In contrast to the traditional product/service development lifecycle, markets are discovered and tapped for output from each stage by leveraging technology so that the organisation benefits. It takes into consideration unexpected customer, unknown results, unknown process and inadequate resources in contrast to instrument rationality principles and hence we can say it rests on "Instrument Irrationality". The focus is on optimizing resources as opposed to optimizing materials. It makes demand on science and technology to adapt and evolve continuously. It expects the workforce to constantly 'learn' and 'unlearn'.

Thus, in the situation of rapid technological and economic change, an education system including the Higher Education system that can respond with agility and effectiveness to a workforce demand that constantly changes with time is needed. Such a system of education has to incorporate realistic and real-time education-work linkages and a adopt science & technology basis in its curricula design thus requiring a flexible operational approach.

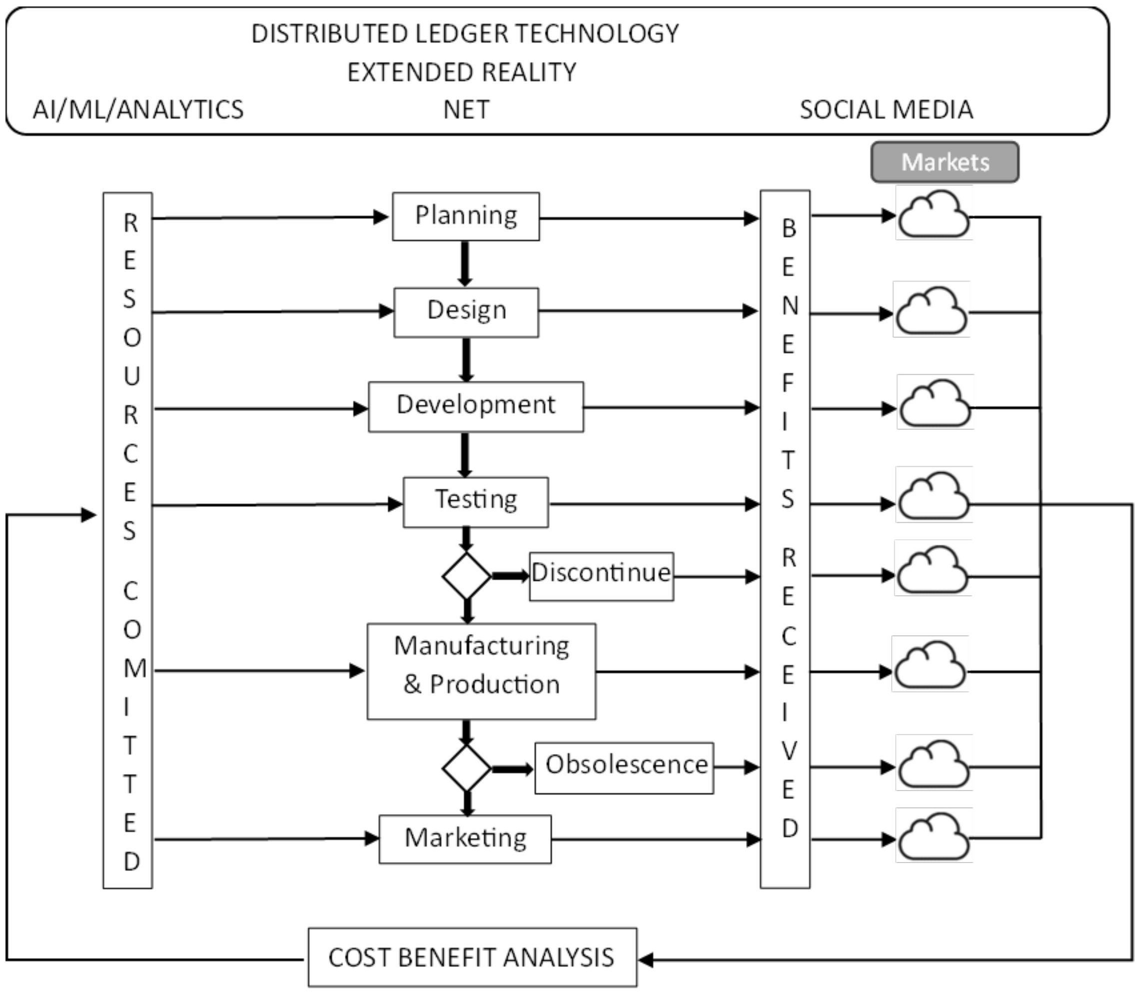

Figure 3: New Product/Service Development Life Cycle

To meet demand futures', industry requires a workforce consisting of self-directed, independent worker-learners who are adept in higher order cognitive skills of "learning to learn", "learning to collaborate", "learning to regulate" and display empathy. This is in addition to possessing the required incumbent technical skills and competencies required at the time of entry into the industry.

Higher Education teaching-learning processes and organization still assumes a product-centric view of the industry and views learning in terms of fixed content to be delivered and assessed using the L T P C (Lecture Tutorial Practical Credits) structure (Lewis, L. M. G., 1961). The instruction, delivery and assessment in a course is task-centric, normally of non-transferable and relatively static knowledge orthodoxies. They drive and are driven by pure cognitive variables of memory, critical thinking and problem solving and aim to achieve pre-determined learning target(s) normally exogenous to the learning circumstance. Thus, for education & training in skills futures', knowledge, skills, attitude included, it is required is to change from the traditional, incumbent non-transferable and relatively static curriculum, which can be seen to be a 'subtractive' curriculum.

A subtractive curriculum (Datta, M. S., & Mandke, V. V., 2021) can be viewed as:

> a process by which teachers teach and students learn by semester-to-semester cutting, i.e., delivering and completing; respectively, contents and learning outcomes from a well-defined course structure, and similarly structured course packages, under a pre-determined program structure. Traditionally, the subtractive curriculum content is delivered by lecture and practical method using chalk and blackboard and laboratory but is most typically done using e-Learning technologies. Given this subtractive curriculum specifies students by collective (and not unique) learning requirements. (p. 146)

When students perform in, say, gaussian statistics, there can be a bothering waste under the subtractive curriculum based T-L system. Further, in the absence of semester-wise/year-wise learning themes, with offering of courses and timetabling being done to fit the needs of the L T P C structure, students have difficulty in viewing the subjects being studied in a cohesive manner.

In contrast, the process-driven 'Additive Curriculum' model (Datta, M. S., & Mandke, V. V., 2021) defines a learning themes roadmap in the beginning itself. Learning is constructed by (i)recognizing and finding a bank of realistic business problems, (ii) identifying the customers and their needs including unexpected needs or needs that come with a delay, (iii) identifying the intermittent and final desired benefits to be delivered to the customer, (iv) articulating the value-creation artifacts that will be generated (v) the contextual knowledge progression stages, resting on learning themes, required of the students to do all of this, (vi) identifying courses within a semester or spanning across semesters and planning student engagements for enactive learning as well as assessment. The digitally driven engagements consist of instructional materials, resources and processes, and activities for assessment of "flexible learning objectives" such that the desired and end benefits are "demonstratively delivered" to the "participating and contributing" industry. The whole process is executed in entirety using Convergence Technologies.

The learning themes roadmap is constructed from Research and Discovery mode Decision-Making Competence stage (positioned in first year of undergraduate studies) to Supervisory Complex and Dynamic Decision-Making Competence stage (positioned in second year of undergraduate studies) to Professional Complex and Dynamic Decision-Making Competence stage (positioned in third and fourth year of undergraduate studies). Higher Education has to now prepare students not only for the world of work of today but also of the future by equipping students with learning skills needed handle requirements that come with a delay. The student will not just have to adjust as per changing environment but will also be part of/lead the change-making process.

Within the above framework, a systems view of a new teaching-learning pedagogic process that rests on integration of realistic business problem-solving processes with realistic learning problem-solving processes through value-creating experiential learning is depicted in Figure 4. It is based on Industry-Linked Feed-Backward Instruction Design framework in classroom teaching-learning that is both global, and context and individual situation specific at the same time Datta, M. S., & Mandke, V. V., 2021).

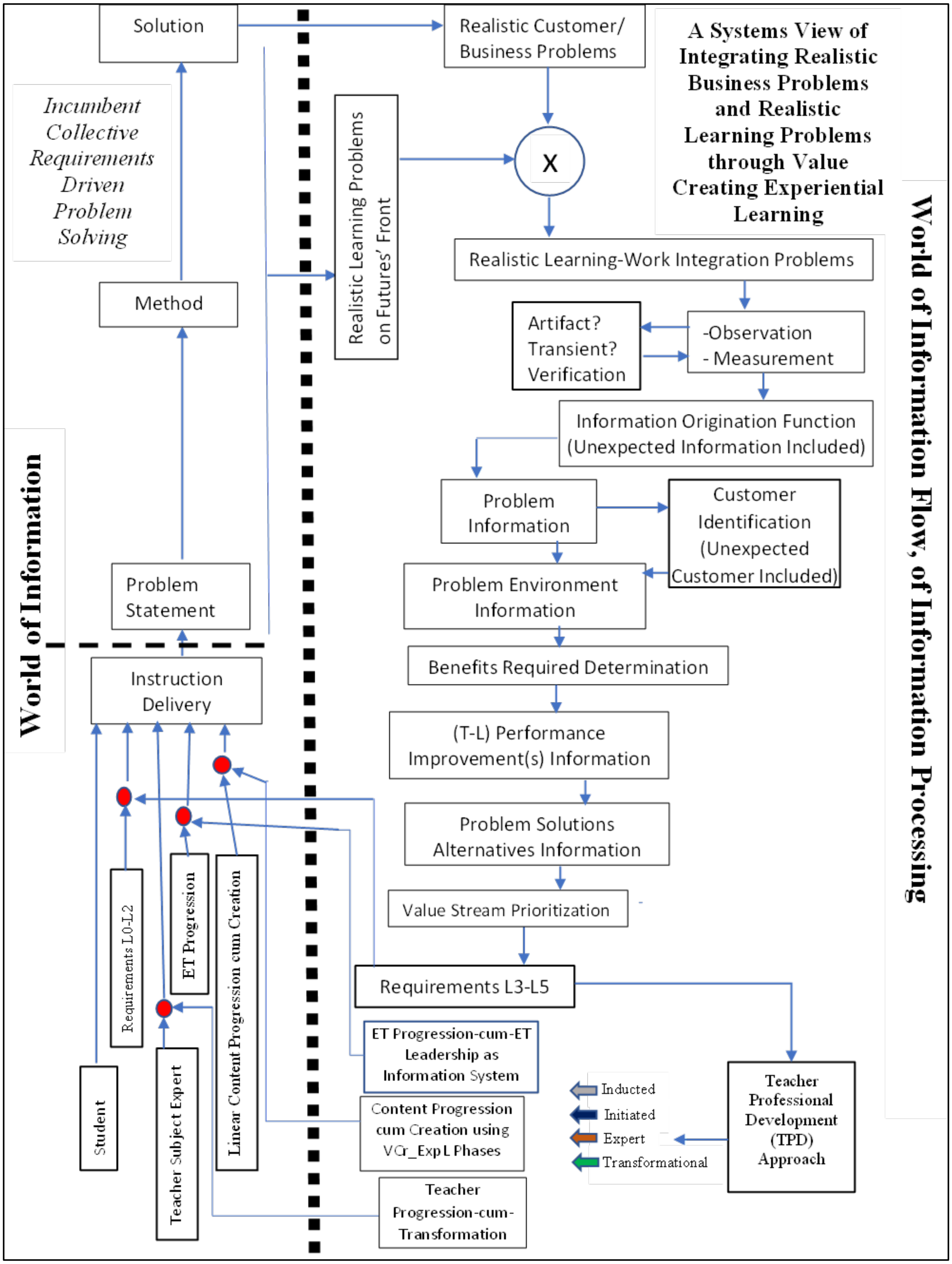

Figure 4: New Teaching-Learning Pedagogic Process – World of Information Flow

As depicted in the 'World of Information Flow, of Information Processing' sub-system of Figure 4, in undergoing real-time industry-linked value-creating experiential learning, students focus on concepts, topics, experiments, industry relevant product/system/process productions, realistic business problem solving for customer satisfaction (unexpected customer necessarily included) that students are concerned about. The project based learning taking place in the real world ensures that its learning and its outputs make sense, have meaning and relevance to each learner uniquely thus addressing individual motivation thus making it brain-aligned. It also takes place as part of courses studied by students thus enabling viewing the course content in the context of real-world problem solving leading to integrity learning (Mandke, V. V. and Nayar M. K., 2002). This new teaching-learning pedagogic process can be said to be Integrity Learning Brain Aligned Project Based Learning (IL BrainAL PBL).

Incumbent Credit System - Proposed Policy Change

Within the above Additive Curriculum framework, driving Business process-Learning Process Integration through Value creating Experiential Learning, with particular emphasis on Industry-connect and Authentic Problem Solving Assessment, it can be seen that it entails requirements of student engagements hours of a different nature than those considered under the L T P C structure.

The teaching-learning engagement hours required to be put in by students for instructional processes and activities are:

- Orienting teaching to learning strategies through continuous negotiation
- Teaching-Learning Functions:
  - Independent Work
  - Self-Directed Learning
  - Learning Strategically
  - Process-centric Learning Function
- Assessing Business process-Learning process Learning Functions that drive and are driven by value stream model of instruction through self-reflection

The teacher too goes beyond the incumbent L T P C descriptors, and very significantly integrates - with centrality - into student learning engagements at all levels the IL BrainAl PBL project seeking followed by planning, designing, developing, testing, deciding, implementation, maintaining, and closure processes as diagrammed in new product/service development life cycle (Figure 3) and right-hand side sub-section of Figure 4. In the process, students learn both effectively and efficiently, and not just efficiently as is the traditional instruction, while teachers, additionally, position themselves as learning consultants to industry work-desks to which, now, their students contribute by value-creating.

The above T-L processes and activities span the basic aspects of cognition, namely, concept, proposition, schemata, production and script making knowledge explicitly declarative, procedural and conditional (Bruning, R. H., et al., 1999). These T-L processes and activities are not provided for in calculating weekly academic learning hours under L T P C Taxonomy. In order to remove this pedagogic discrepancy and, thereby, bring benefit and improved experience to student and teacher, the paper proposes that another learning hours engagement denoted by Letter "E" (short for Experience driven/driving Learning) is incorporated in calculating Academic Learning Hours. The note arguing for the change from L T P C to L T P E C *[author(s)]* was placed before the Academic Council of the university the authors are currently affiliated with and has received approval after due examination by the Academic Council.

Conclusion

This paper traced how Higher Education continually modified its academic curriculum, processes and policies to satisfy the requirements of the society with its various stakeholders such as students, parents, industry and governments while at the same time adhering to its original, self-determined tenets of pursuit of knowledge and academic freedom. With the coming together of scientific discoveries and technology, the pace of technology development increased manifold changing the ways organisations and society as a whole function leading to the current Digital Economy and Digital Society. The paper presented an information-centric view of business in the place of the current product centric view and showed how it can better represent networked digital organisations. It also provided a new product development life cycle that is based on cost benefit analysis of resources committed and benefits received at each stage of the development life cycle instead of at the end of the cycle as is done traditionally.

Higher education's focus on content memorization and its application in simulated lab environments with mechanical industry connects that worked well earlier cannot cope with the requirements of networked businesses and society. With the rise of ICT usage, not only does information grow rapidly but is also processed equally rapidly using high-speed telecommunications. The Digital Economy is characterized by new knowledge creation and use with the result that content is changing constantly. From a Higher Education instruction perspective, the paper points out that process-oriented teaching-learning interplay based on connectomnal instruction organisation to enable a networked teaching-learning system is needed wherein, in interplaying, what the teacher and student can do with information, that is, information use, than the information itself that becomes important. The paper puts forth a new Teaching-Learning organization – the Additive Curriculum model – that operates in the world of information flow and of information processing and rests on a teaching-learning design and learning outcomes wherein the learning outcomes operate on learned information and learning processes in order to lead to knowledge progression through new knowledge creation. The teaching-learning design is based realistic education-work linkage through business process and teaching-learning process integration involving value-creating activities through real time project execution in collaborative groups using Educational Technology as a delivery mechanism leading to value creation for all stakeholders. The paper showed the inadequacies of the incumbent Lecture-Tutorial-Practical credit structure to support the requirements of the proposed and proposes adding a new component – "E". "E" stands for experiential learning engagements that arise out of integrating realistic business problems with realistic teaching-learning problems and necessarily customer-driven, the customer being not only the industry but also society with its problems. This has been approved by the university's Academic Council. In order to translate this into processes and practices, the paper opines that teacher transformation is needed as the teachers now has to extend themselves to participate in collaborative value-creating activities with teachers, students, industry and administrators forming a connectome.

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