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A NEW LOOK AT VIRTUAL ENGINEERING

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Abstract: *This paper introduces a new interpretation of the approaches of virtual engineering. The proposed reasoning model offers three levels, which take into consideration the gradually broadening scope of product-oriented engineering activities and/or system functionalities. The first level is interpreted as comprehensive modelling and simulation of products and characteristics through the development and investigation of virtual prototypes. The second level involves a knowledge-intensive integral support of the phases of the lifecycle of products, including all stakeholders and activities in dislocated virtual environments. The third level extends virtualization to the whole of enterprise operation and leads to a radical re-engineering of the paradigm of industrial product realization.*

Keywords: *product development, virtual engineering, virtual prototyping, virtual enterprise.*

1. INTRODUCTION

The digital future of design and engineering is here with us [1]. From the very beginning of the 'digital revolution', the advancements in information and communication technologies have had a strong influence on the development of product design and engineering [2]. In the early 1950's, digital information processing powered by mainframe computers lent itself to the emergence of numerical computation algorithms and graphical information processing. In the following years, the paradigm of standalone workstation-based computing emerged, which enabled the development of interactive design and engineering support systems. In the beginning of the 1970's, quite a large number of computer aided drafting, design, engineering, and manufacturing systems came out of research laboratories, and have been tailored to the needs of industrial users by commercial developers [3].

The beginning of the 1980s was dominated by workplace-oriented integrated CAD/CAM software packages, which were based on validated scientific and engineering knowledge, and sophisticated modelling and computing techniques. From the mid-1980s, network technologies created opportunities not only for interconnection of various workstations, desktop and portable personal computers, but also for web-based engineering computation services and information repositories. As an outcome, web-hosted collaborative work environments have emerged and substituted the conventional autonomous workstations [4]. In addition, product data and knowledge management systems appeared on the market, which have extended the functionality of web-based design/engineering support systems to cover the whole life cycle of products, and have given floor to a wide-ranging digitalization of steady and volatile organizations [5]. Fuelled by the research in virtual reality (VR), new immersive visualization technologies/environments appeared in research labs at the end of the 1980s, together with sophisticated interaction and sensation techniques [6]. These achievements gave an impulse to the development of (VR extended) advanced design and engineering systems. From the mid-1990s, the emerging and rapidly proliferating mobile and ubiquitous computing technologies, such as ad-hoc connectivity and context processing, are creating new opportunities for further advancement.

These important milestones in the development of design/engineering support systems show that the progress in terms of the visualization, communication, and computational capabilities of digital computers has vitally contributed to the emergence of virtualization. Virtualization has become a global trend, and the strategy of having more than that exists and can exist in the real world. In other words, the strive after exploiting ICT for the industrial practice have created a third, virtual world for conducting design, engineering and business operations [7]. This computationally created virtual world however is not a substitute of the human mental (abstract) world, or the physical (material) world (Figure 1). This world: (i) relies on the technologies (resources) offered by the physical world, as well as on the assets of the mental world, (ii) creates a synergetic (two-way) transition loop between the abstract world and the physical world, (iii) offers an (alternative) genuine way of creating optimized manifestations of human concepts, and (iv) allows modelling and investigation of artefacts (imaginary physical systems) within the limits of knowledge and techniques incorporated. It can provide support for each of the four main activity elements of creative work: inspiration, conceptualization, implementation and experiencing.

2. VIRTUAL ENGINEERING: A PARADIGM FOR THE 21ST CENTURY

Virtual engineering (VE) is a term widely used to express the operationalization of virtualization in the field of engineering processes. The emergence of VE cannot be associated with a given point in time. It is an on-going process, which began at the end of 1990-ies with collaborating across organizational boundaries and is still rapidly progressing and proliferating in the current days. Roughly speaking, VE means a focused combination of engineering activities and a rather broad range of digital (on-line) data processing activities [8]. As for now, there is no one universal definition of virtual engineering – instead a large number of specific and ambiguous designations exist. The origin of the word ‘virtual’ can be traced back to the Latin word ‘virtualis’, which means something has the potential to exist

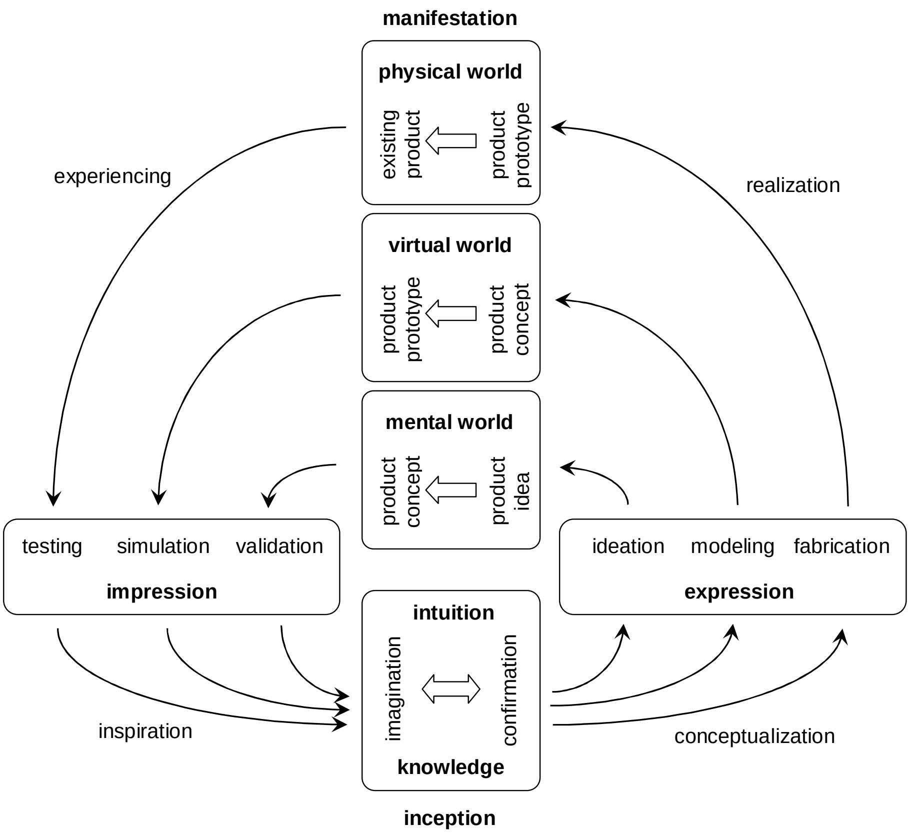

Fig. 1. Placing virtual world in the cognitive model of creative work

as possible, although not real or actual. This is important to note since the adjective ‘virtual’ is also frequently used in the literature as a synonym of ‘visual’ or ‘imaginary’. VE manifests as a trans-disciplinary approach that employs the same principles in several various engineering disciplines in order to save costs and investments, increase efficiency and cooperation, improve quality, and provide enhanced user experiences [9]. On the other hand, VE operates with very different technologies, methods and tools in the various fields of engineering.

There are three main players in a product development process: (i) the developed artefact, (ii) the development process, and (iii) humans concerned by the artefacts or processes, or both [10]. Extending the generally accepted view, we can differentiate three categories of computer support resources: (i) procedural support resources (addressing the information included in representations of artefacts, such as geometric modelling, and virtual and rapid prototyping), (ii) strategic support resources (dealing with the execution of design processes, such as document management and workflow integration), and (iii) societal support resources (encompassing human and social aspects, such as customer research, user experiences, and human assets). The goal of this paper is to deliver a structured survey of the various approaches of virtual engineering and to point at the role of these resources in the approaches. Toward this end, first a categorization of the approaches is proposed based on the focus and scope of the activities. Then, the technologies and methodologies currently used in virtual engineering are reviewed. Finally, some of the (foreseeable) emerging/future resources are considered, and the most probable trajectories of evolution are sketched up and discussed.

3. PROPOSAL FOR A REASONING MODEL

VE is multi-faceted, that is, it has technological, business/economic and organizational dimensions, in addition to the human dimension, to operate in. Based on studying the current literature and the industrial practice, our impression has been that, as a whole, VE is typically treated somewhat ambiguously. In order to demarcate and explicitly identify the various approaches (i.e. categories or manifestations) of VE, we propose a reasoning model, which considers and correlates both the orientation and the scope of engineering activities. This reasoning model is depicted graphically in Figure 2. In the order of mention below, they represent growing complexities and integration, which have been referred to as ‘levels’. Figure 2 also shows the inclusion relationships among the three approaches.

According to our interpretation, Level-One Virtual Engineering works in the artefactual and technological dimensions, and involves a comprehensive modelling and simulation of products and characteristics through the development and investigation of virtual prototypes. It investigates product and service combinations as multi-disciplinary artefactual systems, with the consideration of product intelligence, human factors, and sustainability aspects [11]. Level-Two Virtual Engineering works in the product realization and economic dimensions, and comprises a knowledge-intensive integral support of the phases of the lifecycle of products, including all stakeholders and activities in dislocated virtual environments. It starts out of multipurpose virtual prototypes of humans, products and environments, integrates them into a workflow oriented system, and simulates the interaction with and behaviour of products throughout the entire lifecycle [12]. Finally, Level-Three Virtual Engineering works in the organizational and business dimensions, extends virtualization to the whole of enterprise operation, and leads to a radical re-engineering of the paradigm of industrial product realization [13]. The supporting systems allow modelling the organization structure, representing material-energy-information flows, and investigating the operation of virtual enterprises.

The proposed reasoning model may be helpful in multiple ways. In industrial application\, the particular levels may give the objectives, as well as the scenario of the

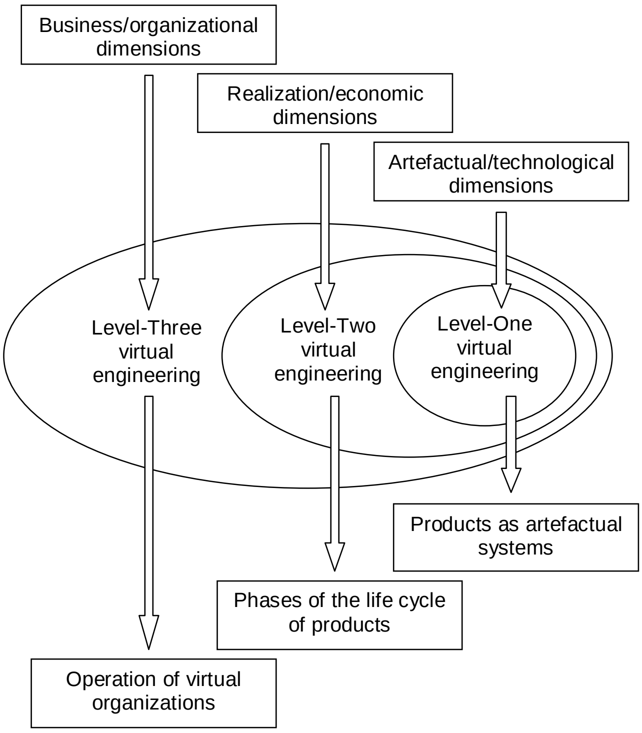

Fig. 2. Demarcating the approaches of virtual engineering

development of virtual engineering. In the first phase, a company may focus on a comprehensive implementation of virtual prototyping of its products; in the second phase, on computer support of the products' lifecycle and virtual team operation; and in the third phase, on re-engineering of the mainstream and auxiliary product design, manufacturing, assembly, acquisition, delivery, marketing, etc. processes towards a fully fledged virtual enterprise operation. In design and engineering education, it may support structuring of knowledge and sorting it into course materials in a systematic manner. In the field of research and development of supporting tools, systems and methodologies, detailed versions of this reasoning model may be considered as the basis of multi-level information, knowledge and workflow models, may provide the framework of single-level and trans-level integration, and making plans for future research.

4. LEVEL-ONE VIRTUAL ENGINEERING

As mentioned above, Level-One VE is based on information that is needed for and embedded in artefacts, and concentrates on the effectiveness of digital creation and investigation of virtual artefact models. Traditionally, making physical prototypes played an important role in industrial product design and development. In general, physical prototypes: (i) are made from the same or similar materials as the final product, (ii) include the same or a reduced set of functional components, and (iii) provide the same or some specific functionality. They are used both in presentation of product concepts and in various tests and measurements to validate concept feasibility. In order to represent the target product with the highest fidelity, physical prototypes are usually built at the end of product conceptualization, or before launching mass production. However, this is not what is desired.

Sophisticated geometric and assembly modelling technologies made it possible to change this situation and to build product prototypes virtually, while keeping the fidelity and richness of information at a high level. Virtual prototypes can be forerunning replicas of complete products or parts thereof. In the latter case, they are usually called digital mock ups [14]. In most of the cases, virtual prototypes can be made cheaper (by eliminating the use of physical materials), faster (by reducing the need for lengthy manufacturing processes), and easier (by using networked collaborative systems for development, presentation and communication) [15]. However, virtual prototypes cannot capture and make tangible all physical properties of the physical products, though many characteristics can be computed or simulated digitally. For this reason, virtual prototyping is often combined with the use of physical parts, or extended with sophisticated physical sensation enabling technologies. The first case has been called augmented prototyping (AP), and the second case virtual reality (VR) [16]. These augmentations imply that virtual prototypes are not only testing means that are used at the end of the creative processes, but can be employed as evolving and reflexive means during early product conceptualization and development [17].

Creating, presenting and using virtual prototypes for engineering modelling, analysis, simulation, and optimization are the major tasks addressed by level-one virtual engineering. The goal is to provide a user-centred, first-person perspective, to enable the engineers to interact with the designed product in a natural way, and to provide the engineers with a wide range of accessible tools [18]. In this narrowest scope, VE typically involves linear and non-linear structural deformation and stress analysis, kinematic and kinetic analysis, contact and fracture analysis, and vibration and response analysis, laminar and turbulent fluid (liquid and gas) analysis, and physical effects (thermal, acoustic, optical, magnetic, etc). Virtual prototyping also facilitates the investigation of dynamic (time- or spectrum-dependent) changes in artefacts and processes. Artefact oriented simulations are such as kinematical simulations (e.g. motion analysis), thermal behaviour simulation (e.g. heat propagation), and fluid flow simulation (e.g. virtual wind tunnel). Process oriented simulations are such as process logic simulation (e.g. Petri-net) and time-dependent process simulation (e.g. operation of a hydraulic system). Related to virtual prototyping-based analyses and simulations the most important issues are fidelity of modelling and computation time. Current trend is integration of the analyses of various specific physical effects into multi-physics effect analyses. It has to be noted that advances in modelling and simulation are intimately linked to progress in experimental methods and techniques, and vice versa. Sometimes regarded as antithetic, a direct correlation and strong mutual dependencies exist between the two fields, both in the model development and in the validation phases.

One aspect of processing geometric, connectivity and positional information is high-end visualization of the evolving artefacts, which is supported by projective, immersive and aerial visualization technologies. Virtual reality technologies have first been introduced as advanced visualization solutions [19]. Advocates of using immersive (wall-projection, CAVE-based or head mounted display (HMD) generated) visualization often define virtual engineering as the integration of virtual product models and related engineering visualization tools to facilitate multidisciplinary and collaborative product realization among distributed engineers. VR is capable of constructing a user-centred, three-dimensional environment in which abstract and complex information can be visualized in an intuitive and realistic manner. Nevertheless, even the most sophisticated and expensive VR environments suffer from the limitations of the supporting modelling technologies, the closed world syndrome, and the general industrial availability and interoperability of similar facilities. This triggers research to go beyond using VR only as a visualization tool for showing geometries of products and engineering analysis results, and to define next-generation VR as an efficacious tool-box for product realization [20]

5. LEVEL-TWO VIRTUAL ENGINEERING

Level-two virtual engineering concentrates on the whole lifecycle of products and extends the functional coverage of digital support systems to the lifecycle activities and relationships of products. It processes information that describes the product in the various phases of its lifecycle, or the processes, resources and decisions related to the various phases of the lifecycle in a coherent and integral manner. The underpinning assumption is that digital information processing can cover modelling, analysis, simulation and optimization not only with respect to artefacts and physical phenomena, but also to courses of actions and processes of transforming systems. Level-two VE aims at a holistic digital representation. There are two important issues to take into consideration. First, representation and handling of the whole lifecycle of multiple products incur structural, informational, and procedural complexities.

Due to these complexities, more sophisticated work environments than those represented by traditional three-dimensional computer aided design and engineering systems (CAD/E) are needed. Second, in the subsequent phases of the lifecycle of products, multiple disciplinary teams may be involved in creative, development, and management activities in various distributed digital environments. Therefore, level-two VE should facilitate the collaboration of dislocated professionals and virtual teams.

As a basis of enhanced virtual work environments, web-hosted collaborative systems have been developed, involving knowledge portals, collaboration support systems, shared work environments, distributed VR environments, and virtual product realization environments [21]. In the industrial practice, distributed immersive VR systems and desktop VR systems have received unbalanced attention. The reason is that immersive VR systems lend themselves to a sophisticated environment for presentation and processing virtual prototypes and sophisticated human models, but imply large investments. Desktop VR systems are somewhat modest in terms of high end functions, but are more affordable. Research is engaged with understanding of user modelling from perceptive, cognitive and interaction points of view, and with capturing the context of operation and investigation of use scenarios in realistic working environments. Working in these distributed, three-dimensional, immersive, interactive, multisensory, viewer-centred, computer generated environments, designers and engineers will be able to conduct all product life cycle related engineering activities in collaboration.

Virtual collaboration of members of dislocated design and engineer teams is a central issue when solving the tasks at hand needs to create working relationships between teams of experts, who are active in different phases of the product lifecycle [22]. Virtual teams (VT) are temporary arrangement of individuals belonging to different organizations and cultures, possessing different functional backgrounds, and working across different time zones on a common task. The work of VTs can be supported by using various telecommunication and information technologies, as well as by virtual presence, shared understanding, team inspiration, version management, negotiation management, and stakeholder involvement methodologies and techniques. An obvious advantage of forming VT is the opportunity to draw from a large pool of qualified participants while minimizing cliques and politics. Among the typical pitfalls, the loss of social contact, feelings of isolation, and lack of trust (especially with new members) are mentioned. Hence, trust building and accountability are important issues in virtual teams that involve geographically and organizationally dispersed co-workers with complementary skills, different background knowledge and commitment. Trust building should cover calculus-based, knowledge-based and identification-based trust.

In fact, complexity management and distributed virtual operation are interconnected in level-two VE. Addressing complex problems requires system oriented thinking, sophisticated problem/requirement engineering, effective outsourcing/brokerage mechanisms, intensive supply chain management, network hosted applications, and ensuring the best possible user experience. These are interwoven with the success factors of virtual team operation, such as effective use of technologies, multi-disciplinary cooperation, high level trust amongst the cooperating partners, compliance with the objectives and agreed upon workflows, and achieving security within increasingly open environments. There are many standard technologies and standard specification to support digital collaborative work, such as extensible mark-up language (XML), Java, and simple object access protocol (SOAP). In addition, dedicated virtual team and collaboration support technologies have been developed, such as tools for increasing virtual presence and shared awareness, telepresence techniques to provide remote control with sensory data and to give the illusion of being at a remote location, avatars to replicate designers, engineers, users, and other stakeholders' graphical persona inside a virtual world. Some web services protocols and standards, such as the lightweight directory access protocol (LDAP), the service provisioning mark-up language (SPML), and the security assertion mark-up language (SAML) are also available for administering user access rights and for exchanging resources information across heterogeneous environments.

6. LEVEL-THREE VIRTUAL ENGINEERING

The third level of virtual engineering oversteps the boundaries of the technological and production realms of product realization and moves towards the organizational and business dimensions. In the business dimension, virtualization concerns the way of existence and operation of companies and communities, which contrasts the physical existence and operation. An accompanying objective of the establishment of level-three VE is to transform real entities to virtual entities, in the form of digitally supported virtual enterprises [23]. In fact, the term 'virtual' has three connotations in the context of a virtual enterprise. Firstly, it means that physical enterprises with different processes, systems and cultures are aggregated and dissolved in non-physical organizations/formations which have common objectives, share responsibilities, allocate resources, and harmonize working practices. Secondly, it means that the constituent enterprises are geographically not in the same place; therefore, they should rely on the use of virtual team technologies and techniques to complete their daily tasks. Thirdly, it also means virtual assets, such as volatile labour capacities, virtual enterprise knowledge and memory, and virtual enterprise networks, which allow the enterprise to incorporate external skills and resources in order to make new innovations and to exploit new market opportunities.

Virtualization of enterprises can be considered from three perspectives, namely, as virtualization of: (i) organization and infrastructure, (ii), resources and capacities, and (iii) knowledge assets and decision-making [24]. Virtual enterprises are typically thought of as extension of real enterprises, though virtual enterprises without any physical basis are expected to become even more widespread in the near future. The goal of the first enterprise virtualization strategy is to create an organizational platform for virtual operation. Creation virtual infrastructure is the goal of the second strategy, which is about the availability of resources. Virtualization allows organizations to hire and retain the best people regardless of location. The third strategy aims at supporting collaborative decision making in a virtual environment, which is required at two levels: among the entities included in virtual enterprises, and among collaborating decision makers inside each enterprise.

A virtual enterprise is based on the ability of creating temporary co-operations and realizing the value of a short term business opportunity (technological and economic objectives) that the partners cannot (or can, but only to lesser extent) capture on their own [25]. In the virtual enterprise, value is created, not added. The involved virtual team can employ teleworkers, who are working from home or from anywhere. Virtual enterprises are organized according to frameworks and workflows that allow much larger flexibility and adaptability than those typical for real physical enterprises, and facilitate permanent restructuring. Restructuring is seen from three aspects, namely from the aspects of values it creates, the virtual operation that it supports, and the resources (network of resources) enabling restructuring. Globalization, increasing competition, inter-organizational alliances naturally call for virtualization that in turn gives birth to virtual teams and virtual enterprises.

In the context of virtual enterprise, virtual engineering means dynamic organization and maintenance of all productive and business processes related to product and/or service development over geographic and organizational boundaries. The virtual enterprise enables multiple business entities to join together to offer consumers anywhere and anytime access to a variety of related services, for instance, through one convenient portal. One of the key issues is addressing the technology challenges associated with creating the open yet secure environment to support virtual enterprises [26]. Another is the set of assets, overheads and cost to create, maintain and control virtual operation. A surprisingly successful way of existing of virtual enterprises is the one without any physical resources, except the networked digital infrastructure. The best example is in the entertainment industry where virtual worlds, such as Second Life, Cyworld and Entropia Universe are established. They allow creating avatars of individuals, which can interact with other computer generated individuals and artefacts, or which can even virtually run global businesses in real-time with virtual currencies. But virtual worlds lead us back to the technological dimension, where intensive research is going on to clarify the information science and behavioural science principles of defining and getting involved in complex virtual worlds in various forms. Conventional VR environments create an artificial world in which the user has the impression of being immersed, and can experience virtual and telepresence.

In virtual worlds, presence happens not only in the perceptive world of humans, but also in their cognitive world. It has already been investigated and found that various virtual user embodiments (avatars) and replicated environments provide possibilities: (i) to manage users' appearances and identities realistically, (ii) to enable the users to control and manipulate their environment, and (iii) to interact and communicate with the other individuals in a natural way. An important research question is how virtual engineering can be conducted in a completely virtual world, using entities that cannot be experienced and tested in the physical world. We are just in the first phase of development of truly virtual environments and studying the opportunities of tangible virtuality, which attempt embedding physically behaving synthetic objects in the real environment, rather than embedding human beings in an immersive virtual environment. These kinds of new enabling virtual technologies are awaited for in the medical industry, telecommunication industry, education, space research, underground and –water operations, not to mention the defence industry, the entertainment industry and the digital game industry.

7. UBIQUITOUS COMPUTING TECHNOLOGIES FOR NEXT GENERATION VE

What we can expect for the next decades is an incremental development of the concepts, methods, tools and practices, most probably without any dramatic change in the conceptual fundamentals of the paradigm of VE. On the one hand, as far as it can be seen today, VE will be supposed to address more complex innovation challenges, which originate in the need of ecological and social sustainability of products and services, the shortage of fossils-based energy resources, the limitation and scarcity of certain industrial materials, and the ever-growing need for socially contextualized innovation. It is also expected that the boundaries of VE will dissolve in the future and a more robust integration of the policies, infrastructure and approaches will take place. The conceived fusion will extend to hardware, software and firmware platforms and systems. On the other hand, it can also be assumed that some currently emerging technologies will find their ways to VE and will become both technological and methodological enablers of VE processes. Ubiquitous computing technologies are definitely the leading-edge technologies with high potentials and potential impacts on all areas of future virtual engineering [27].

Ubiquitous computing technologies are capable to operate in the domain of: (i) digital information exploration and extraction, (ii) collaborative detection and elicitation of physical signals, (iii) transmission of digital information from short to long range, (iv) wired and wireless networking in a predefined and/or ad-hoc manner, and (v) conversion of remote physical information to human sensations at a distance [28]. Facilitated by various application enablers, ubiquitous computing technologies can be applied and exploited in the realms of organs, artefacts, and environments. Figure 3 presents a comprehensive reasoning model that shows a more detailed classification of the technologies and a taxonomical decomposition of the most important application domains, respectively.

The ubiquitous computing technologies form a holistic pool of resources and facilitate a component-based innovation of new product and service combinations. As indicated by

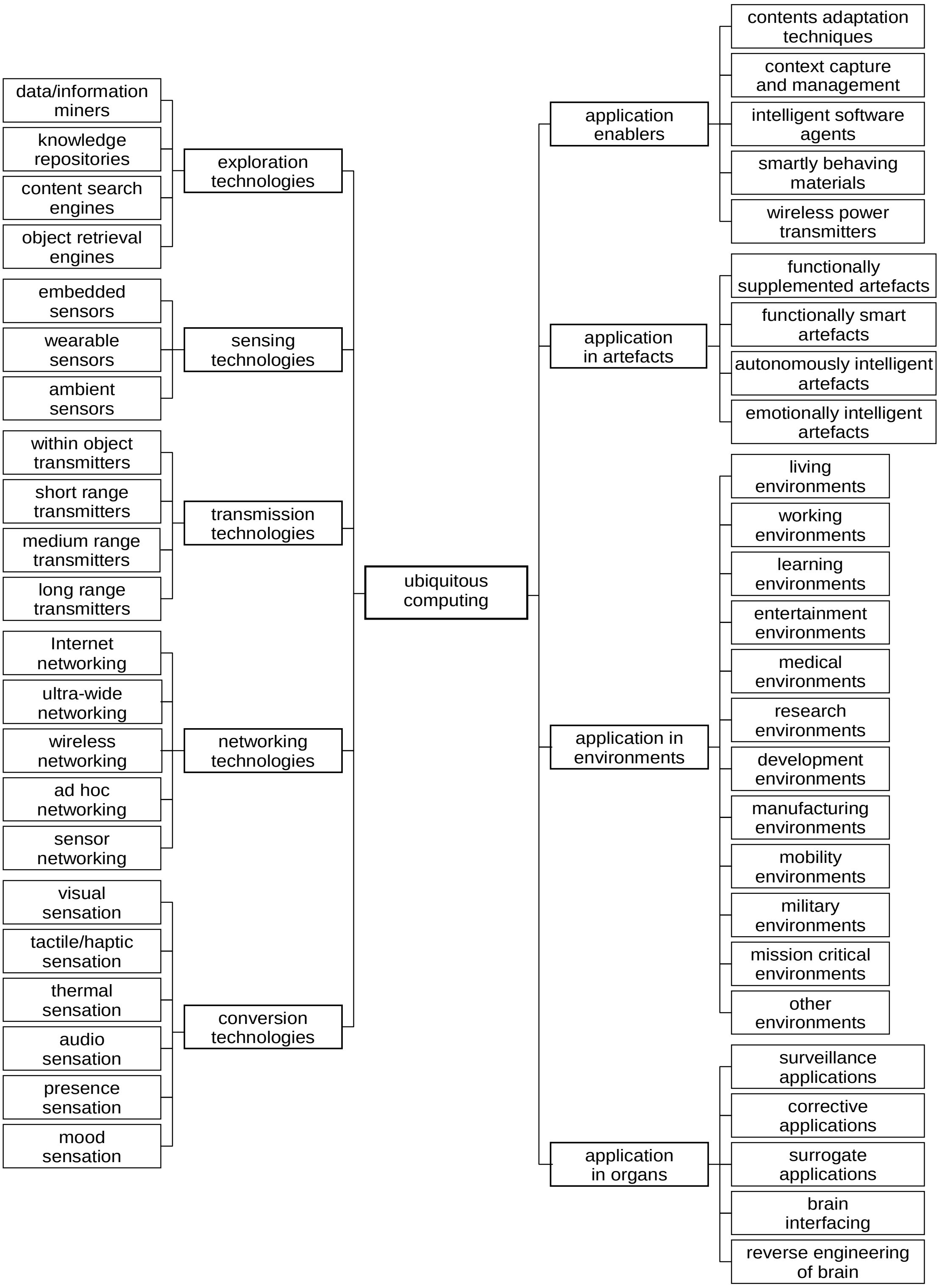

Fig. 3 Enabling technologies and potential applications of ubiquitous technologies

Figure 3, ubiquitous computing technologies consist of a very wide spectrum of portable, mobile, wireless, wearable and embedded sensors, transmitters and actuators, as well as of controlling, networking and computing (reasoning) appliances. Their application in products and environments will increase smartness.

Due to their specific characteristics, ubiquitous computing technologies lend themselves not only to sustainable products, but also to genuine socio-technical solutions. The six most important characteristics are: (i) small physical sizes, (ii) low energy consumption, (iii) decreasing production and use costs, (iv) reduced ecological and cognitive impacts, (v) high level connectivity and flexibility, (vi) opportunity of a unique identification at a distance, and (vii) proactive and adaptive (smart) behaviour in applications. These characteristics make it possible: (i) to use these technologies in large numbers (clusters) in various applications, (ii) to embed them in artefacts, environments and even in organs, (iii) to realize a highly collaborative operation without user control, and (iv) to network without predefined servers and protocols. Products involving current ubiquitous technologies are effective on a short distance: (i) inside or on an artefact, or the human body, (ii) between carried and/or worn personal devices, and (iii) amongst persons and personal devices and environment. As for today, being a many-to-many communication medium, the Internet is becoming the ultimate repository of human knowledge in a form which is publicly accessible. In the future we can foresee a network of artefacts, communicating with human beings, other artefacts, and ambient environments – and eventually establishing the Internet of Things.

Current research already addresses the issue of establishing communication channels between the human brain and ubiquitous (embedded, wearable, implanted) computing appliances by directly recording and transforming thought-modulated electroencephalogram (EEG) recordings into a control signals. Current brain-computer interfaces are based on the detection and classification of motor-imagery-related EEG patterns, and on the analysis of the dynamics of sensor-motor rhythms. A virtual world contact interface (VWCI) would give information to the muscles and nerves, which would deliver it to the brain, in order to convert it into contact (tactile and haptic) sensation.

These radical innovations are forcing us to reconsider the ways of obtaining, processing and communicating digital information for product design, engineering and innovation. The main target field of applying smart technologies is providing support for inspiration, conceptualization, realization and experiencing, which are the four main activity elements of creative work [29]. They facilitate of context awareness, content sensitiveness, knowledge intensiveness, and human centeredness. Omnipresent computing technologies will be supportive to socially-based virtual innovation processes. These inclusive product innovation processes should feature a rapid transfer and synthesis of scientific and social knowledge, extensive information collection, widely-based ideation and concept development, and concept testing and validation, which all can be facilitated by dedicated computational resources.

8. CONCLUSION

This paper introduced a new reasoning model on the various manifestations of virtual engineering, relying on the concepts of procedural, strategic and societal support resources. It identified: (i) virtual prototype development, (ii) virtual lifecycle management, and (iii) virtual enterprise operation as three subsequent levels of manifestation. The paper argued about the relevance of this reasoning model by referring to retrospective, contemporary, and prospective trends and facts. It is difficult to summarize all historical achievements that paved the way to modern virtual engineering environments. As an outcome of the aggregation of scientific findings and practical experiences, current commercial systems provide the designers not only with tools and methods for the development and investigation of virtual prototypes, but also with a wide range of frameworks and assets that can support many stages of product lifecycle and many aspects of virtual enterprise operation. From a methodological point of view, future VE is contemplated to show some characters of meta-engineering. From an infrastructure point of view, VE platforms will become more and more ubiquitous, smart and proactive.

In fact, the advent of VE has lead to a kind of re-inventing of engineering. It intends to provide pervasive support for engineering practice, combining global engineering collaboration with contextualized decision support. VE has changed the manner of designing engineering organizations, and put engineers in the position of agents of change. Management of complexities of human-artefactual systems, rapid technology transformation, and socially contextualized innovation seem to be the main challenges for near future VE. We are heading towards what can be termed a “ubiquitous network society”, in which networked VE environments are omnipresent. Smart technologies offer many new affordances and opportunities for the implementation of the necessary infrastructure.

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Take a quick look at some of our undergraduate labs and facilities in the Department of Electronic & Electrical Engineering. Chemical engineering undergraduate lab tour. Take a tour of our chemical engineering undergraduate laboratories, including an introduction to the techniques and equipment you could use during your degree. See more of campus. Hear about our placements scheme. Getting practical experience during your degree is a great way to get ahead in the graduate job market. Our dedicated Faculty Placements Team can offer help and guidance to find a role. Improve your employability wit Analysing processes with â€˜virtual engineersâ€™. One way of looking at this is engineers programming an AI solution to create its own â€˜virtual engineersâ€™. As with virtual colleagues in back-office functions or call centres, designed to take on repetitive tasks from human workers, â€˜virtual engineersâ€™ represent the next evolution in automation. Some companies are already doing this with IPsoftâ€™s fully automated platform, 1Desk, composed of virtual engineers and a virtual colleague named Amelia.Â Responsibly-created AI, or what some are referring to as ethical AI, is human-controlled: meaning when it learns a new task, it will always ask a human whether or not it can apply this to future processes. Essentially, automations can only create automations if they have been approved to do so. Take a look at the virtual reality training programmes that will soon be used to train nuclear engineers. Researchers at the University of Exeter have teamed up with VR programmers Cineon Training to produce training for high-risk jobs. Funded by the Nuclear Decommissioning Authority, the immersive technology means engineers can be trained before the facilities have even been built. They are also developing counter-terrorism exercises for the Metropolitan Police. Video Journalist: Chris Quevatre. We look back at the year that has passed and are pleased to note that Virtual Engineering continues to develop as a premium PLM consultancy service company. We continue to increase our footprint on the Swedish market, we have established the foundation for growth in Europe, we are increasing our business in the area of Software PLM and we have established a remote IT development service ca...pacity. Weâ€™re looking forward to continuing to develop Virtual Engineering in 2020 together with our customers and partners.Â Virtual Engineering is growing through a new partnership with KARON Beratungsgesellschaft mbH. Germany is one of the leading industry countries in the