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EDITORIAL - NEXT GENERATION CONSTRUCTION IT: TECHNOLOGY FORESIGHT, FUTURE STUDIES, ROADMAPPING, AND SCENARIO PLANNING

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1. INTRODUCTION

The construction sector is characterised by delivery of one-of-a-kind product and service delivery through competence sharing between different organisations, many of whom are SMEs of which some may have never worked together. ICT (information and communications technologies) usage in the sector is however still limited and lags far behind other manufacturing sectors (e-Business W@tch (2005). At the same time however, there is growing evidence (as reported in the papers featured in this special issue) that there is now a growing paradigm shift in thinking by the construction industry as it embraces itself to take-up and implement next generation construction IT that has been researched and reported in pioneering journals on the subject like ITcon (www.itcon.org), and proposed through numerous strategic national and international roadmapping initiatives such as those by Department of Trade and Industry (DTI, 2001), ROADCON (Hannus et al, 2003), FIATECH (2004), CRC for Construction Innovation (Hampson and Brandon, 2004), UK National Platform for the Built Environment (2006), Strat-CON (Kazi et al, 2007), European Construction Technology Platform (ECTP, 2008), etc. Some questions that emerge include, "what now?", "what next?", and "what in the future?". The portfolio of the 23 refereed papers in this special issue of ITcon address these questions and provide answers that are expected to serve as value propositions to the industry for technology take-up; provide guidelines to ICT providers on what needs to be further developed; and equip researchers and academia with new research topics and ideas on relevant emerging ICTs for the construction sector.

2. NEXT GENERATION CONSTRUCTION IT – REVIEW

In response to a call for papers for a special issue of ITcon on "Next Generation Construction IT: Technology Foresight, Future Studies, Roadmapping, and Scenario Planning", 43 contributions were solicited. Of these, 23 were finally accepted for publication after several iterations of peer reviews and revisions to the submitted manuscripts. A summary of the published papers follows.

1. Application of D^4AR – A 4-Dimensional augmented reality model for automating construction progress monitoring data collection, processing and communication: In this paper, Golparvar-Fard, Peña-Mora, and Savares (2009) address mechanisms for early detection of actual or potential schedule delays or cost overruns as an opportunity to understand and initiate remedial actions thereby increase the likelihood of controlling such delays and overruns or minimizing their impacts. They propose using 4-dimensional augmented reality models that consist of a new image-based modelling technique for visualising progress monitoring wherein progress discrepancies between as-planned and as-built construction performances are visualised through superimposition of 4D as-planned models over site photographs using different visualization techniques.

2. Towards minimizing space-time conflicts between site activities using simple generic algorithm – the best execution strategy: In this paper, Mallasi (2009) presents a 4D (3D + time) visualization system which uses a simple Genetic Algorithm to search for the best execution strategy to optimize workspace conflicts between different site activities. It is argued that through better understanding of the semantics of a site activity's execution pattern, it is possible to efficiently visualise and rehearse different 'what if' scenarios for coordinating site activities and to allow planners to better communicate project schedules.

3. A framework for using interactive workspaces for effective collaboration: In this paper Leicht, Messner, and Anumba (2009) discuss ongoing research on interactive workspaces as a subset of virtual environments where physical spaces facilitate ubiquitous and intuitive interactions with virtual content. They present a framework for comprehensively planning the traits of an interactive workspace within the context of facility design and construction tasks. It demonstrates the value in planning the modal interactions with shared information during collaborative tasks, and the impact it has on team communication.

4. Collaborative multi-agent systems for construction equipment based on real-time field data capturing: In this paper, Zhang, Hammad, and Bahnassi (2009) discuss a multi-agent system framework to support construction equipment operators by using agents, wireless communication, and field data capturing technologies. Relying on data collected from sensors and an up-to-date 3D model of the site, it is possible to detect potential collisions or other conflicts related to equipment operation in real time. This in turn allows for more awareness of construction site conditions, a safer and more efficient work site, and better decision support.

5. Control enhancements of a biomimetic structure: In this paper, Smith (2009) presents ongoing research on active control of biomimetic structures demonstrate increased functionality through mimicking qualities that are normally present only in biological organisms. This could allow for example for self-repair and adaptation mechanisms that improve with time. The paper proposes integration of intelligent control methodologies such as self diagnosis, multi-objective shape control, self repair and reinforcement learning to an active tensegrity structure creates an example of an adaptive civil structure that can be applied to a range of other practical situations in the future.

6. Lifecycle management of facilities components using radio frequency identification and building information model: In this paper, Motamedi and Hammad (2009) propose permanently attaching RFID tags to facility components where the memory of the tags is populated with accumulated lifecycle information of the components taken from a standard BIM database in addition to other BIM information that may not necessarily be related to components. They demonstrate through case studies that by having BIM data chunks stored on tags provides a distributed database of BIM and allows data access for different players who do not have real-time access to a central (BIM) database.

7. Prototype development of an ICT system to support construction management based on virtual models and RFID: In this paper, Sørensen, Christiansson, and Svidt (2009) address the need to develop new ICT systems with better support of the contractor's working practice in order to gain more advantages from the virtual models created during the design of buildings. Their research indicates that future ICT systems must be more user-friendly, enable object-oriented quality assurance procedures, capture data to be used in process optimisation, support a wide range of user environments for presentation and editing data shared in virtual model resources, enable real-time tracking and location of machines and materials, and integrate traditional document/drawing based working practice with the use of virtual models.

8. Intelligent wireless web services: context-aware computing in construction-logistics supply chain: In this paper, Omar, and Ballal (2009) report on ongoing research on context-aware services delivery in construction project supply chain logistics. They advocate integration of context-aware services with Intelligent Wireless Web technologies in an intelligent system that would improve just in time operations, reduce waste and enhance cross-functional activities.

9. An architecture for decision support in ad hoc sensor networks: In this paper, O'Brien, et al (2009) present a three-tiered (a layer for expressive yet approachable decision support application development, a layer for expressive data processing, and a layer for efficient sensor communication) architecture for decision support applications in mobile ad hoc sensor networks. Through two construction jobsite case studies addressing hazardous gas detection and crane safety, they demonstrate potential realisation of construction specific visions for ubiquitous computing by enabling flexible and robust discovery and use of data in an ad hoc manner on intelligent jobsites.

10. Communication in design, results of a field research: In this paper, Esposito, and Macchi (2009) present research on methods and tools (focusing on data integration for product development) for the effective planning and management of communications in design and development projects in situations of temporary and multidisciplinary collaboration among different participants having different cultural backgrounds, focusing on data integration for product development. Relying on the information requirements of individual participants (user profiles), it proposes a toolkit to rapidly build an efficient and customized model of team communication, calibrated according to the specific design (project requirements, project phases, ways of organizing and contract, professionals and skills involved, etc.).

11. A process view on end-user resistance during construction IT implementations: In this paper, Hartmann and Fischer (2009) identify that the value of process conceptualization of user resistance is more valuable to understand change processes during the implementation of Construction IT than the conceptualisation of resistance as individual user characteristic. Based on a process perspective analysis of two construction projects they report that user-resistance is not always a negative barrier, but oftentimes a necessary and important part of a Construction IT implementation. The paper suggests that Construction IT change agents start involving resistant Construction IT recipients within an ongoing discussion that focuses on the immediate benefits the technologies offer to improve the day to day work processes of AEC professionals.

12. Contractual standards for enhanced geometry control in model-based collaboration: In this paper, Ku and Pollalis (2009) explore the current state of model-based practice, the geometry control it facilitates, and the legal and contractual considerations that make model-based collaboration possible. Through several case studies, they illustrate the impact of design changes that may compromise design integrity, and to discuss the larger implications of other professions threatening the architect's design responsibility of geometry control. The paper advocates efforts to create standard contract language for BIM, to standardize efforts towards interoperability, and to collaborate broadly between owner and professional organizations to integrate BIM and collaborative project delivery processes.

13. RATAS, a longitudinal case study of an early construction IT roadmap project: In this paper, Björk (2009) revisits the RATAS project that was a catalyst for significant research and implementation of building product modelling within Finland and beyond. It reports on how within a small country like Finland where all relevant construction IT stakeholders know each other, significant research and industrial impact can be achieved through persistence over time. It advises that while some detailed recommendations from roadmapping projects tend to become obsolete over time, the central issue that transforms the industry is the need to reach a common understanding of main priorities for R&D and standardization among the central stakeholders in the industry.

14. Strategic roadmaps for construction innovation: assessing the state of research: In this paper, Froese and Rankin (2009) report on a strategic planning initiative that was undertaken to advance innovation in the Canadian construction based on an inventory of the current state of research relating to the construction process that was conducted within Canadian Universities. Based on an analysis of over 100 research projects, a framework was developed covering application, technology, innovation, scale, drivers, and time. This framework serves as a mental checklist of what needs to be considered and the ability to identify gaps in the innovation process from multiple perspectives.

15. Construction informatics in Turkey: strategic role of ICT and future research directions: In this paper, Isikdag et al (2009) investigate the strategic role of ICT implementations from an industrial perspective, and explore if organisations within the Turkish AEC industry view ICT as a strategic resource for their business practices. They also investigate the 'perspective of academia' in terms of future research directions of

Construction Informatics. The main findings of the paper indicate that while ICT is seen as a value-adding resource, a shift towards recognising the role of ICT in winning work and achieving strategic competitive advantage is required. From an academic perspective, ICT training is found to be of highest priority.

16. ICT development strategies for industrialisation of the building sector: In this paper, Ekholm and Molnár (2009) present their findings from Swedish study concerning the benefits of modern object based information and communication technology, ICT, for industrialisation of the building industry. They report that the current business model for house-building has neither drivers nor instruments to create a coordinated information process despite the fact that with modern ICT, there are incentives to integrate information even in traditional project based building processes. The paper advocates the need for education to raise the building sector's overall competence to work with processes and products in a structured way and call for a joint, sector level action to create a framework for integrated information management in the traditional building process.

17. Future integrated design environments: In this paper, Christiansson, Svidt, and Sørensen (2009) present a roadmap with a time frame of 3-10 years for development of future Integrated Building Design Systems (IBDS) with end-user participation. The paper provides grounds to higher success rate in capture of explicit and implicit end user needs and requirements on functional performance in use and re-use of buildings, taking into account effective tools for creative and innovative design. It furthermore emphasises a great need for increased efforts within building informatics education to secure needed competences for leading and carrying through the future research, development and innovation activities.

18. A roadmap to personalized context-aware services delivery in construction: In this paper, Aziz, Anumba, and Peña-Mora (2009) present a roadmap on personalised context-aware information delivery, with a focus on creating a pervasive user-centred intelligent work environment capable of serving relevant information needs of busy construction professionals by intelligent interpretation of their context. It is argued that context-relevant and personalised information delivery will allow for time saving and has the potential to improve efficiency and productivity by making construction ICT applications and worker's immediate work environment more responsive to work demands, thereby allowing better management of construction projects.

19. Engineering collaboration 2.0: requirements and expectations: In this paper, Klinc, Dolenc, and Turk (2009) investigate the concepts, trends and technologies which can affect the way how construction industry currently works and the key reasons why the AEC community should seriously consider the shift towards the next generation of the web to support engineering collaboration. Slow adoption of next generation technologies is attributed to cultural barriers, technological and security barriers, lack of awareness and generational barriers, and the fact that there is no one-size-fits-all model. The paper stresses that it is important for the industry to become highly collaborative, much more open, decentralized, on demand, ad hoc, capable of quick adoption, lightweight and customer-oriented while staying cost effective and competitive.

20. VR-roadmap: a vision for 2030 in the built environment: In this paper, Dawood (2009) presents a roadmap on future developments of virtual reality (VR) technology for construction. It is reported that the future thrust for R&D will be to make VR technology simple to use and accessible/integrated to key new generation tools to aid collaborative design, concurrent engineering and provide digital architecture in the form of a single internet based interface that retrieves related and shared data in the form of images and drawings etc., and visualises the whole-life cycle of projects. It is argued that the key challenge in VR development is to retain individuality and artistic design/creativity and have capability and flexibility to capture and model user/client requirements.

21. Semantic product modelling and configuration: challenges and opportunities: In this paper, Böhms et al (2009) discuss the potential and role of semantic web-based technologies to define, design, and configure products through a product modelling ontology (PMO) that contains all necessary and sufficient modelling constructs to define any end-user product ontology, taking into account all relevant end-user's product classes, properties and relationships (in particular the predefined 'specialization' and 'decomposition' relationships) together with cardinalities, data types, units and default values. A roadmap is provided to move from the current state to a widely-spread demand-based product configuration and optimisation that provides maximal value to customer (including time, cost, performance, etc.), by relying on appropriate standard methodologies, models and ICT tools.

22. Futuristic construction communication infrastructures: secure and safe with no wires: In this paper, Strachan and Stephenson (2009) provide an in-depth analysis and investigation of current and future wireless and security technologies and explore their impact on the construction industry through a series of scenarios with practicing professionals. The paper identified authentication issues and interference as some of the barriers for take-up of wireless solutions on construction sites. It advocated that as wireless technologies converge and security

solutions develop, the construction industry should see a wireless solution that meets all their differing needs, providing communication facilities quickly, easily, securely and with no interference.

23. Construction IT in 2030: a scenario planning approach: In this paper, Erdogan et al (2009) present findings from a scenario planning effort carried out in order to identify the possible futures that construction industry and construction IT might face. Eight main themes that would drive change in the future were identified to include: global environmental change, financial frameworks, seismic power shifts (west to east), demographic changes, knowledge generation, technological progress, and political stability. The paper proposed an ICT vision for 2030 covering people (people are the centre of focus; more creative, and less drudge; better work-home balance), process (best practice of integrated business processes which are consistent and compatible), places (less geographically dependent; more flexible home working, remote working, and mobile working), and technology (tools and technologies compatible with and supporting each other; open standard based software).

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