State Government Victoria
Department of Education & Training

FUTURE TECHNOLOGIES
for Construction Industry

An International Specialised Skills Institute Fellowship.

DR ADIL M. ABBAS

Sponsored by the Higher Education and Skills Group, Department of Education and Training (Victorian Government)

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i. Executive Summary

This report presents the activities performed by the ISS Fellow during the fellowship tenure. During this tenure the ISS Fellow had the opportunity to study the current status of the construction technology in Australia. In addition, the Fellow investigated some of the worldwide efforts and trends to develop and innovate the construction technology to increase productivity, reduce waste, and improve safety.

The construction sector in Australia is the third largest employer. The sector contains over 338 thousand businesses and employs about 10 percent of the work force. The sector contributes about 8 to 10 percent of the Australian Gross Domestic Product with annual expenditure in the range of A$200 – A$210 billion. On the other hand, the construction industry contributes about 31 percent of the waste generated within Australia. In addition, the industry ranked fifth industry in incidence rate of serious claims and third in work-related fatalities. The major challenge to the industry is coming from its current reliance on processes that require intensive manual labour. With aging population and tightness of immigration policies the Australian construction industry is facing uncertain prospects. Globalisation is another challenge that faces the construction industry in two aspects; by draining the skilled labour to work overseas and opening the local market to more skilled, competitive and technically advanced international construction companies which may ultimately wipes out the weak domestic industry.

At the international level the construction industry has realised the challenges ahead and acknowledged the need to innovate and develop the industry to be on line with other industries. Throughout the Fellowship the Fellow has identified a number of initiatives and technological advances that would have a remarkable impact on construction industry. The use of digital technologies in construction industries would open the door to many advancements and innovations. Building Information Modelling would improve the way that construction projects would be documented and communicated throughout the different phases of construction from conceptualisation to de-commissioning.

3-D printing is another form of digital technologies that will change the way certain construction processes or products would be conducted or produced. 3-D printers can print, with great precision and detail, building components at a fraction of the cost. Similar printers can print small well detailed 3-D models of buildings or construction projects in hours - not in days or weeks, at relatively low cost. Contour crafting, which is a technology analogous to 3-D printing technology, can be used to digitally print or construct real houses or buildings in less than 24 hours for an average house.

Another innovative technology that has been recently introduced to construction industry is the use of robots to perform some construction processes. For example, SAM 100 is a robotic brick layer that is capable of laying bricks or blocks for buildings. Self-controlled and operating machines can be used to lay and finish concrete and asphalt surfaces for road construction.

Virtual and augmented reality is another technology that is introduced to the construction industry. These technologies can be used for project visualisation and realisation at the early stages of design to define the details and develop the construction procedures and methodologies.

Drones equipped with video or optical cameras, radar technologies and or infra-red sensors are used throughout the construction stages for various tasks. During the early stages of construction drones can be used to collect data about the topography of the site or setting out of the project. During construction drones with high visibility cameras may be used to control and document the site operations as well as in the inspection of the quality of work. At any stage of construction drones can be used to detect defective works especially in inaccessible areas.

These emerging technologies will change the nature of construction industry workforce. The future workforce will be more digitally literate with new sets of skills. In addition, some new jobs may be created such as Robot Administrator or Programmer and some traditional trades may disappear or become redundant. Accordingly, the Construction Industry Reference Committees, the Skills Service Organisations and other stakeholders should start planning for this change in the nature of the industry by identifying the new skills required and setting the parameters for the training required for upskilling of the current workforce and training of future workforce.

1. About the Fellow

Name: Adil M. Abbas

Employment:

» Currently Head of Department, Applied Building Technology, Bachelor of Engineering Technology (Civil), Holmsglen Institute, Victoria Australia.

Qualifications:

» Ph.D., (Civil Engineering)l University of Strathclyde, Glasgow, UK

» MSc. (Civil Engineering), University of Khartoum, Khartoum, Sudan.

» Graduate Diploma of Education, University of Victoria, Australia

» BSc. University of Khartoum, Khartoum, Sudan.

Experience:

During his past career in construction and education the Fellow held the following positions in various institutions:

» Head of Department, Applied Building Technology, Holmesglen Institute of TAFE.

» Head of Program, Bachelor of Civil Engineering Technology, Melbourne Polytechnic, Victoria, Australia

» An Australian Fellow, Institute of Professional Studies, UNSW, Australia.

» Project Manager, Yamamah Consulting Engineers, Saudi Arabia

» Civil Engineering Specialist, Ministry of Communications, Saudi Arabia

» Assistant Professor, Building and Road Research Institute, University of Khartoum Sudan.

Memberships:

» Institute of Engineers Australia

» Australasian Association for Engineering Education

» Concrete Institute of Australia

» Australian Steel Institute

2. Aims of the Fellowship Program

The aim of this Fellowship was to establish a better understanding of the status and application of automated systems and robotics in construction.

This would be achieved by:

- Recording and investigating the automated techniques and systems that have been already developed for construction industry worldwide especially in Japan, South Korea and USA.
- Visiting the research institutions and industry centers in USA where most of these technologies have been developed and applied to exchange knowledge and advice with the leading developers and experts in automated construction.
- Identifying the techniques and systems and assess their relevance to Australian construction industry applications.
- Investigating and analysing the impact of introducing these systems on the current practices in the Australian construction industry to achieve the most appropriate outcome.
- Investigating the hard technology used in these systems for possible technology transfer to Australia.
- Identifying the skills required to develop and implement the emerging technologies in construction.
- Learning a new emerging technology that will soon prevail in the international construction market in the foreseen future and therefore improving the competitiveness of the Australian construction industry in the global market.
- Generating and stimulating the industry to realize the need for a unique center to transfer the emerging technologies and automation in the Australian construction industry.
- Disseminating the knowledge gained and presenting the recommendations to:
  - Concrete Institute Australia
  - Engineers Australia
  - Master Builders and Building Designers Association
  - Association of Consulting Engineers Australia
  - Housing Industry Association (HIA)
  - Civil Contractors Federation
  - Australian Institute of Building
  - Australian Institute of Architects
  - Department of Industry, Innovation and Science, Australian Government.
  - Department of Education and Training, Government of Victoria
  - The Department of Economic Development, Jobs, Transport and Resources (DEDJTR), Victoria
  - Construction and Property Services Industry Skills Council.
  - Students studying building construction and civil engineering.
  - Melbourne Polytechnic colleagues
  - Victorian Building Authority and other equivalent authorities in other states and territory.

3. The Australian Context

The construction industry sector in Australia comprises residential building (i.e. housing, units and apartments), non-residential building (i.e. office buildings, retails shops, warehouses, education facilities, entertainment facilities, health and age care facilities) and civil construction (i.e. infrastructure construction such as roads, railways, bridges, harbours, sewerage systems, airports, pipelines, electricity generating plants and transmission lines and mining). The sector in terms of employment is the third largest industry in Australia. It employs directly between 1 – 1.1 million people, which is about 10 percent of the overall work force in Australia (Vandenbroek, 2016). About 12 percent of construction workers are members of unions (Quezada G, 2016). The industry comprises over 338,000 businesses (AiGroup, 2015) and contributes about 8 to 10 percent of the Australian Gross Domestic Product (Trading Economics, 2016). The annual expenditure on construction industry is forecasted for the next decade to be about A$200 to A$210 billion (ACIF, 2016).

However, this important input of the construction industry in the Australian economy comes at a cost. The industry has the greatest impact on the environment. In 2009 the construction industry generated about 31 percent of the total waste generated in Australia and about 23 percent of the national total greenhouse emissions (Quezada G, 2016).

In the State of Victoria, construction industry is state's fifth largest industry, is valued at $21.6 billion and employs about 240,000 people in 89,000 businesses (Victoria State Government, 2016). The sector employs about 9.0 per cent of the Victorian workforce. Over 84 per cent of workers were employed on a full-time basis (Building and Construction Industry in Victoria, Australia, 2016). As the construction industry is vital for economic development and growth in Victoria, the state government listed the construction industry in the strategic future industry and sector priority list that is required support to drive Victoria's economic and employment growth. As outlined by the Victorian Government, the strategies for the sector involves (Business Victoria, 2016):

- Build strategic leadership and a well-connected sector.
- Support innovation and growth.
- Advance the use of Building Information Modelling.
- Capitalise on digital technologies.
- Strengthen market competitiveness in off-site construction.
- Streamline compliance pathways for new construction materials and products.

The construction industry is changing due to several external and internal drivers including (Business Victoria, 2016):

- Demands for better environmental performance, including for existing building stock.
- Expectations of higher safety levels.
- Rapid advances in information technology applications.
- Changing demographics bringing new consumer preferences.
- The ongoing search for new ways to contain costs and minimise construction times.

The Productivity Commission identifies the most significant future challenges to the industry as (Richardson, 2014):

» project definition and procurement approaches

» firm level project management

» prefabrication.

» design.

» labour utilisation and workplace relations

» incentives for innovation

» regulation and competition.

Quality control during construction and on-site safety are the other issues that add to the problems facing the construction industry (Research Australia, 2015). The construction industry is ranked fifth among industries in incidence rate of serious claims. In 2011 – 2012 the incidence rate for construction industry is 18.7 serious claims per 1000 employees which is remarkably higher compared with the average of 12.2 serious claims per 1000 employees (Work Health & Safety Perceptions - Construction Industry, 2017). Based on the number of work-related fatalities the construction industry is ranked nationally in Australia as number three (Fatality Statistics, 2017).

However, as the industry depends largely on human intensive processes the greatest challenge to the industry is the aging population and the consequential expected shortage in the workforce that are vital to the development of the sector. By 2034/35, almost 20 percent of Australians (6.2 million) are projected to be aged 65 or over (Quezada, 2016). This skilled labour shortage has the potential to cripple the industry (Cott, 2016). The shortage will consequently lead to other potential problems such as lower quality, increased cost, site safety issues and the potential for work-place disputes to rise.

Unfortunately, the issue of skilled labour shortage remained the most critical issue for the construction industry due to its domino effect. Trying to solve it by simply opening the borders for skilled construction workers to migrate from other countries may not be the simple solution for a wicked problem as the skilled labour shortage looms to be an issue facing the construction industry in other industrialised countries as well (Leeds, 2016).

To maintain the prosperity and competitiveness of the industry it is therefore very important to change the construction process to be less human intensive. This would be possible only by introducing digital technologies and robots to be part of the construction process. The end results for using these innovative technologies would be better quality, more sustainable practices, improved site safety, reduced cost, better workplace relations and consequently better productivity with increased output to the GDP.

In China, USA and Netherlands, building innovators used the 3D building technology to build full-sized houses comprising up to 250 square meter using concrete, specialised plastics and metals (Guertzgen, 2016).

In USA, Japan and locally in Australia the use of Robots in building construction has emerged as a possible solution to some construction problems especially when seeking higher efficiency and less hazardous working conditions (Domanska, 2016). In Australia First Bricks Robotics is about to revolutionize the industry through developing Hadrian X which is an innovative robotic system that can print the walls of any building using bricks or blocks (Leading an Industry Revolution, 2017).

Image 1: A Model for Hadrian X (fastbrick Robotics, 2017)

There is no doubt these innovative solutions to some of the construction industry problems would lead to the following improvements (Robotics Business Review, 2014):

» reduced construction costs

» increased construction speed

» reduced construction waste and greenhouse emission

» safer work environment

» improved sustainability.

4. The Required Skills Enhancement Areas

As discussed in the previous section the construction industry is facing several challenges and needs to change. One of the proposed changes is to move from a labour-intensive industry to less reliance on manual labour via use of automation and digital technologies in the construction processes. Accordingly, the workforce of the industry needs to be trained to meet the emerging skills required for automation and digital technologies. A profile for new skills and jobs that may be needed for the construction industry by 2036 may include (Guertzgen, 2016):

» Building Assembly Technician to oversee robotic systems and check the data flow through the construction process.

» Virtual/ Augmented Reality Trainers to train apprentices in low-cost and safe immersive virtual environments and construction sites.

» Building drone operators to control and program the drones to carry out complex site tasks such as inspection and maintenance.

» Robot Resource Manger to take care of commissioning, software programming, maintenance and re-purposing or recycling of robotics parts.

Within this context the skills enhancement for this Fellowship were:

Skill Enhancement 1: The Fellow conducted the following visits to research institution and industry centres to have a better understanding of application of digital technologies and automation in construction industry.

» University of South California to meet Dr. Khoshnevis who developed the technique of contour crafting which simulates 3-D printing.

» The Robotics and Intelligent Construction Automation Lab at Georgia Institute of Technology.

» Construction Robotics Inc. where a robot is used for constructing brick work.

Skill Enhancement 2: The Fellow identified the techniques and systems and assessed their relevance to Australian construction industry applications.

Skill Enhancement 3: The Fellow analysed the impact of introducing digital technologies and automated systems to the construction industry in Australia.

Skill Enhancement 4: The Fellow investigated and gained an understanding of the hard technology involved in these innovative techniques.

Skill Enhancement 5: The Fellow intended to understand and identify the skills required for the development and implementation of these emerging technologies in construction.

5. The International Experience

During the Fellowship the Fellow had the opportunity to attend the 'Inside 3D Printing Conference' between 13 – 14 December 2016 which was held in conjunction with RoboUniverse and Virtual Reality Summit at San Diego, California USA. The conference and the accompanying expo featured the latest developments in 3D printing, robotics, remote sensing and controls using drones and Virtual Reality.

The Fellow had the opportunity to explore the impact of those technologies in the Future of Construction processes and training.

5.1 3-D Printing

3-D Printing and the associated digital technologies has a significant impact in the building and construction industry throughout all construction projects' life cycle. During the first stage of construction design 3-D models are digitally printed and produced from digital files to communicate and visualize the features of the buildings. These models are composed from layers of different materials.

The 3-D printing technology can be further used to print components of the buildings such as specially designed hardware that can be digitally printed in a relatively lower cost and less time as compared to other methods of production such as fabrication, moulding and machining. In rehabilitating and maintain heritage buildings, the 3-D printing technology can be used in replicating the artefacts and specially made components.

The 3-D digital technology has evolved to contour crafting which is used to digitally print real houses and buildings using real construction materials such as concrete. According to Khoshnevis (Khoshnevis, 2016), who is the first inventor of the contour crafting technology, contour crafting significantly reduces the cost of construction, remarkably reduces the construction time and reduces the waste of construction materials. For example, the current construction time for an average house is about 6 to 9 months. When using contour crafting for the same house the construction time is less than 24 hours with a subsequent reduction in financial cost. This technology will change the nature of the construction industry from manual unskilled labour intensive that requires physical power to more technical and digitally skilled labour. This would consequently lead to less site injuries and more gender balance in construction industry.

According to Khoshnevis (2016) the contour crafting technology will be available for commercial use in 2017-2018. The contour crating machine is relatively light in weight. It is about 800 lb. (approx. 400 KG). This light weight provides the machine with ease in transportation and installation on construction site. Accordingly, the technology would be very suitable for low cost housing and emergency housing and shelters needed for relief operations after major natural and human made disasters.

The Chinese company WinSun expressed an interest in the concept of contour crafting. The company has surprised the world by constructing the first buildings using the contour crafting technology in early 2014 (Sevenson, 2015). The company used a technology that is a hybrid of 3-D Printing and off-site prefabrication. The materials used for the construction consists of concrete, fiberglass, sand and a hardening agent to speed up the setting of the cementitious materials. According to Khoshnevis (2016) WinSun uses 3-D printing technology to print small sections of walls and then stitches them together on-site, similar to pre-cast technology, which eliminates the versatility offered by using contour crafting to print the entire building on-site.

Armatron systems (Brian C. Giles, 2016) anticipates that the 3-D printing technology would evolve in the next 5 years to be used in the construction of complicated buildings and high-end homes similar to Taj Mahal and Arabian Nights style buildings. The company expects such buildings would be built during 2017 – 2018 using their own developed technology which they believe it is more superior to contour crafting developed by Khoshnevis and other 3-D technologies developed by Chinese WinSun and the Russian Apis Corp.

5.2 Robotics

Though the 3-D printing or contour craft uses a robotic arm that is digitally controlled by a computer to print the building, it may be more logically to distinguish the 3-D technology from the other robotics technologies. Most of 3-D printing technologies rely on the use of cementitious materials for construction while other robotics systems can us a variety of construction materials.

SAM100 may be the most advanced robotic brick laying system. According to Peters (Peters, 2016) Sam100 is a semi-automated system that requires one operator or a trained Mason. The training requires a few months before the mason becomes very competent in operating SAM100. A fully trained operator when using the system is capable of laying up to 350 – 400 bricks per hour in a single or double skin wall construction. The system can lay any brick size and has already been used in the construction of different types of buildings with different heights. Clearly the most significant benefits which derive from using SAM100 is the increased productivity with lower cost and better occupational health and safety impact in the workplace. It is claimed (Peters, 2016) SAM100 increases the productivity of a mason by around 3 – 4 times while the installation cost is reduced by about 50 percent. One of the greatest impacts that SAM100 may have is providing improved ergonomics for masons as it reduces the heavy lifting by about 80 percent which may reduce or eliminate the risk of body injuries that are quite common for brick layers or masons.

Image 2: The Fellow with Prof. Khoshnevis, the inventor of Contour Crafting

Image 3: A demonstration model for Contour Crafting ((Contour Crafting, 2017)

Image 4: The Fellow with Armatron Team

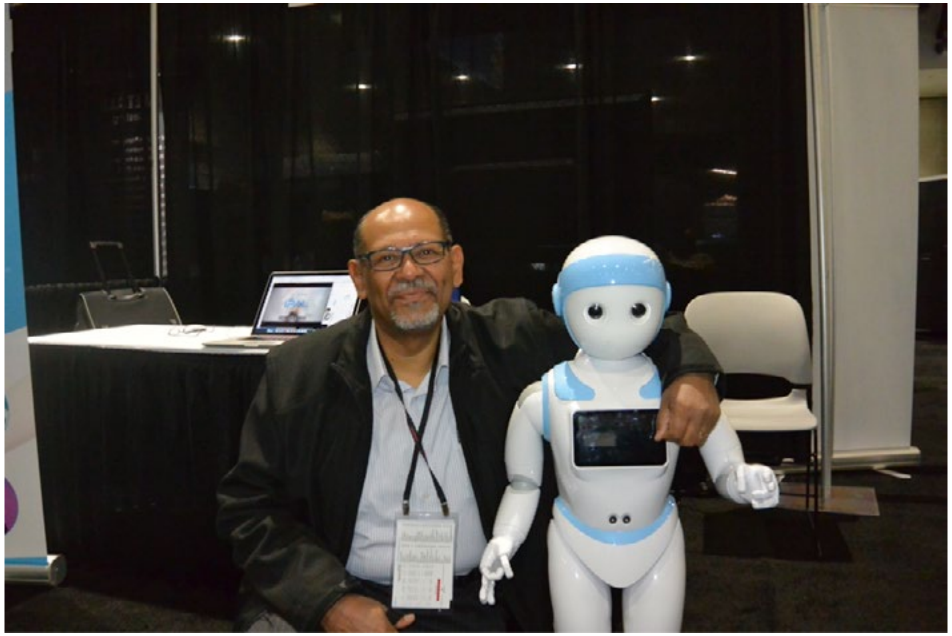

Image 5: The Fellow with AvatarMind, the Tutor of the Future

5.3 Virtual and Augmented Reality

Virtual reality is another digital technology that will have an impact on the construction and building industry. During the design stage this technology can be used to offer clients and potential users of the building an opportunity to walk through and interact with the virtual building. This early interaction and immersive experience can feedback into the design process to improve the building functionality or aesthetic to meet the expectations of the potential users. The virtual reality may also be used by the project team to plan for the construction process, selection of suitable materials and appropriate construction methods as well as the site planning. Building surveyors may use the virtual reality rather than just relying on the drawings to inspect and assess the buildings' compliance with the codes and regulations before issuing the permit for the building. Other project professionals such as engineers and quantity surveyors may also need to utilize the opportunities provided by virtual reality to produce better design that is based on simulation rather than just relying only on 2-D drawings or 3-D models.

Virtual construction sites can be developed and used to educate, and train future building workforce in many practical skills such as OH&S, site management, construction technologies.

Another area that would have a great impact in the construction industry is augmented reality (AR), which integrates the digital information with the user's existing environment. This technology has the potential to be used in construction in several aspects. For example, AR can be used to provide the information required for workers on-site to complete their tasks in more efficient and safe ways, and with less waste. For example, a plumber installing a water system can retrieve all updated installation information presented in 3-D format from the manufacturer website in real time. Another example, a site inspector can access the latest information regarding the updated design drawings, standards, specification and regulations in real time and in 3-D format to avoid any misinterpretation of the 2-D drawings or lengthy texts. A building owner can apply and visualize the designed or proposed finishing and fittings in real time and therefore alleviate any risk of rejection and consequently disputes.

The Emerging Analytics Centre at the University of Arkansas at Little Rock presented the Topography Collaboration TopoCollo at the exhibition, which was held in conjunction with Inside 3D Printing Conference. TopoCollo is an application that allows the users to interact with virtual reality installations built using SD data and Hi-Res Photography.

Virtual reality as well as augmented reality would have a greater impact in educating and training future construction workers. AR has the potential to give learners real time access to location specific information and data in 3-D digital format to facilitate learning and understanding (Yuen, Yaoyuneyong, & & Johnson, 2011). For example, an apprentice can have real time access to 3-D presentation or animations to assist him/her when completing a certain task either on site or at the workshop.

AR and VR can be used in conjunction with Building Information Modelling that simulates the field operations and processes as a pedagogy to enhance the learning experiences of students studying architecture, engineering or construction (ARANDA-MENA, 2017).

5.4 Drones and its applications

Drones are another technology that is gradually being introduced to the construction industry. Drones can be used as a quick, timely and relatively less costly method to perform site surveying and collect relevant data, especially rough terrain, during any stage of construction (Drone Solutions for Construction, 2017). The data collected can be used in various ways to better design, construct or manage site operations.

Furthermore, drones are used for inspection and maintenance of buildings and structures. For example, drones equipped with advanced sensors such as infra-red or radar sensory devices are used to perform external and internal inspections to identify defects with buildings (Smarter Construction, 2017). Some other applications include using high digital cameras attached to drones to perform construction monitoring and tracking as well as visual inspection (Anderson, 2017).

5.5 Robot Avatars

At the exhibition that was organised in conjunction with the conference AvataraMind presented iPal Robot. iPal can talk, dance and socially interact with children through a complex system of sensors and video cameras. The robot can be used to mentor children as well as to educate and tutor children at home. iPal can be used also as a companion and carer for elder people to remind them of their daily activities such as taking medications (AvatarMind, 2017). Robots can be used to enrich the interaction between the student and the teacher in a personalised and self-learning mode (Causo A., 2016). Furthermore, a humanoid avatar can potentially be used to mentor multiple classes at different places, therefore creating an online virtual learning environment (Abdullah, 2016). Apparently, the involvement of robots in creating a much engaging learning environment is emerging as a new educational technology. It is worth noting, the Queensland Government is planning to introduce robots to achieve much better engagement and interaction in the learning environment (Advancing Education: An action plan for education, 2016)

6. Conclusions and Recommendations

6.1 Conclusions

The construction industry worldwide is undergoing a massive transformation. The transformation covers all stages of construction from conception and design through to construction. The transformation is driven by the need to improve productivity within the industry, reducing waste in materials and time, improving quality and sustainability as well as reducing the cost of construction and improving safety during the construction operations.

This transformation is characterised by the application of digital technologies, robotics and automation to various stages of construction. As a consequence, the industry will move gradually from being dependent on intensive manual labour to digitally skilled workers, in other words physical body power to mental and mind power. Accordingly, traditional construction jobs will gradually disappear and some new highly technical jobs will be created. This change in the nature of construction jobs and skill and knowledge sets required may lead to increased female participation in the industry.

As yet in Australia the transformation is anticipated, however, except for just a few scattered efforts, there is no strategy or vision either from the industry, educational and training institutions, research centres, government or other stakeholders to take part in the innovation process or to deal with the challenges associated with the expected changes in the profile of the industry. This lack of vision may have very serious consequence on the future competitiveness of the Australian construction industry locally and globally.

6.2 Recommendations

1. As the change in construction industry will require a change in skills sets of the future workers, steps need to be taken immediately to start re-designing the training packages and curriculum. This is vital in order to provide the industry with the required knowledge and skills at the right time so as to avoid any potential skills shortage in the local market. This should be undertaken in association with strategic plans for upskilling and training the existing and future workforce for the construction Industry.

2. The training and educational institutions should consider seriously their training and teaching pedagogies in order to meet the needs associated with the expected transformation in the construction industry and to better equip students with the skills needed for the future. Accordingly, an investment and upgrade in ICT infrastructure is urgently required to accommodate the future needs of virtual and augmented reality as well as other digital technologies. In addition, application of robot avatars may create more opportunities for training and educating the future workforce.

3. As yet the Fellow has not found any application of robot avatars in educating and training construction workers and practitioners. As the construction industry is moving towards using automation and application of robotics it would make more sense to apply similar technologies in education and training.

4. The current training model for the construction industry, which relies on apprenticeships, may not be the ideal one for the future skill building needed for the industry due to the current high specialisation and fragmentation of the construction industry as well as fragmentation of training and educational

providers. This could be resolved by establishing Centres of Excellences with appropriate models of funding from industry as well as the government.

5. As noted above the current innovation and development participation of the Australian construction industry is comparatively weak when compared to the rest of the developed world. This may be due to the large fragmentation of the industry. However, this should not relieve the industry from the need to invest appropriately in research and development to remain competitive in the future. The proposed model for funding should be based on establishing Centres of Excellence for innovations and technology transfer to link industry, research and training providers in one network.

7. Acknowledgements

The Fellow thanks the following individuals and organisations who have immeasurably offered their time, experience, support and advice to guide and lead him thorough the journey of the Fellowship program.

International Specialised Skills Institute (ISS Institute)

The ISS Institute exists to foster an aspirational, skilled and smart Australia by cultivating the mastery and knowledge of talented Australians through international research Fellowships.

The International Specialised Skills Institute (ISS Institute) is proud of its heritage. The organisation was founded over 25 years ago by Sir James Gobbo AC CVO QC, former Governor of Victoria, to encourage investment in the development of Australia's specialised skills. Its international Fellowship program supports a large number of Australians and international leaders across a broad cross-section of industries to undertake applied research that will benefit economic development through vocational training, industry innovation and advancement. To date, over 350 Australian and international Fellows have undertaken Fellowships facilitated through ISS Institute. The program encourages mutual and shared learning, leadership and communities of practice.

At the heart of the ISS Institute are our individual Fellows. Under the International Applied Research Fellowship Program the Fellows travel overseas and upon their return, they are required to pass on what they have learnt by:

- Preparing a detailed report for distribution to government departments, industry and educational institutions
- Recommending improvements to accredited educational courses
- Delivering training activities including workshops, conferences and forums.

The organisation plays a pivotal role in creating value and opportunity, encouraging new thinking and early adoption of ideas and practice. By working with others, ISS Institute invests in individuals who wish to create an aspirational, skilled and smart Australia through innovation, mastery and knowledge cultivation.

For further information on ISS Institute Fellows, refer to www.issinstitute.org.au

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» Mary Faraone, CEO, Holmesglen Institute of TAFE

Organisations Impacted by the Fellowship

Government:

» Federal, State and Territory Governments.

» Building and Pluming Authorities (in different states and territory)

» Department of Industry, Innovation and Science.

» Department of Education and Training, Government of Victoria

» Victorian Skills Commissioner

» Office Innovation and Science Australia

- The Department of Economic Development, Jobs, Transport and Resources (DEDJTR), Victoria

Industry:

- Construction and Property Services Industry Skills Council (Skills Oz)
- Victorian Building Authority and other states building authorities
- Australian Construction Industry Forum

Professional Associations:

- Engineers Australia
- Concrete Institute of Australia
- Australian Association for Engineering Education
- Master Builders Association.
- Housing Industry Association (HIA)
- Civil Contractors Federation
- Australian Institute of Building
- Australian Institute of Architects

Education and Training:

- Skills Service Organizations
- Vocational Education and Training (VET) Providers
- Higher Education Institutions.

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