

AN INTELLIGENT, INTERACTIVE AND INTEROPERABLE PLATFORM FOR THE 21ST CENTURY MUSEUMS

Francesco Longo^(a), Letizia Nicoletti^(b), Antonio Padovano^(c), Adriano Solis^(d), Arianna Monzon^(e)

^{(a),(c)} DIMEG, University of Calabria, Italy

^{(b),(e)} Cal-Tek Srl, Italy

^(d) School of Administrative Studies, York University, Canada

^(a) f.longo@unical.it, ^(b) l.nicoletti@cal-tek.eu, ^(c) antonio.padovano@unical.it, ^(d) sasdir@yorku.ca, ^(e) arianna.monzon@cal-tek.eu

ABSTRACT

This article presents a completely innovative comprehensive social platform that includes Intelligent, Interactive and Interoperable applications that will bring beyond the way cultural digital resources are created, disseminated, preserved and re-used based on new ICT solutions. The I3-CPM (Intelligent, Interactive and Interoperable Comprehensive social Platform for the 21st century Museums) is intended to demonstrate the museum's capability to foster an active participation of large number of stakeholders to create a European Cultural Digital Space where geographic distances and time are meaningless (any time and any place approach). To this end, the I3-CPM has been designed to be interoperable, modular, scalable and portable by interconnecting History, Archaeology, and Social Sciences with cutting-edge multi-disciplinary technologies, such as Virtual Environments, Augmented Reality, Holographic Displays, Intelligent Agents, Mobile technologies, Immersive Caves, and Gestures Sensors. Digital cultural contents and information are received by users according to a new transmedia, user-driven, adaptive, interactive, intelligent and meaningful experience where History becomes a guide for life.

Keywords: Digital Museums, Virtual Environment, Augmented Reality, Intelligent Cultural Heritage Fruition

1. INTRODUCTION

ICT changed the way cultural digital resources are created, disseminated, preserved and (re)used. Art galleries, archaeological sites and exhibitions all around the world have started investing efforts and money in extending their borders: consider for example the swift success of the museums' mobile applications available on the main app marketplaces. However, mobile applications as well as traditional "brochure" websites are only meant to help the user navigating the information, but do not deliver any educational content about the exhibit. Digital technologies have been introduced in the cultural heritage world by Malraux in 1947 with the concept of "Virtual Museum". Starting from then, a number of different types of "museums"

were identified (ICOM News, 3, 2004) in order to categorize different level of user's engagement. Several heterogeneous methodologies and technologies, based on virtual (VR) and augmented reality (AR), have been used in the latest years to make the user experience more engaging (see Hall et al., 2001), as showed by a sound state of the art proposed by Styliani et al. (2009). Unlike traditional websites or applications, VR and AR are able to convey information not in a mediated way (for example by using language) but intuitively and naturally by using sensorial feedback (images, sounds, etc.), thus conveying cultural content in an effective way. VR is capable to increase drastically the slope of the learning curve because cultural contents and information are absorbed spontaneously (Osberg, 1995) by the virtual visitors who are engaged in an "experience of learning" or "learning for fun" (Packer, 2006).

Significant immersive cultural experiences and projects have been proposed and developed in the field of advanced fruition of cultural heritage. Examples are the ReaCTor at the Foundation of Hellenic World (Gaitatzes et al., 2000), the ARCO framework (White et al., 2004), the PEACH project (Stock et al., 2007), the MINERVA project (Amigoni e Schiaffonati, 2009), the V-MUST (Virtual Museum Transnational Network, www.v-must.net) project, the 3D-COFORM project (Arnold, 2009), just to name a few. In order to enhance the cultural heritage experience, all these projects seek to take advantage of synergies among different technologies (multi-agent architecture, audio-visual technologies, 3D visualization, etc.). The most common solutions range from simple interactive screens to full-immersive systems that may include projection systems, 3D stereoscopic glasses or CAVE-like environments (Gaitatzes et al., 2001; Geller, 2006; Sooi et al., 2016). Although the preservation and fruition of cultural heritage through modelling techniques, graphics and virtual/augmented reality is widespread and has been widely documented (Addison, 2000), researchers and research communities are today concerned about how the content should be made more appealing. For example, as shown by Anderson et al. (2010), the use of SGs in the cultural heritage for teaching/learning

historical contents has been instead little considered. According to the taxonomy adopted by Mortara et al. (2014), SGs can have various purposes including cultural awareness, historical reconstruction, heritage awareness and can vary according to the learning objectives, genre (e.g. adventure, simulation) and application context.

Indeed, apart from the tools and systems that can be used thanks to the most recent technological advances, it is needed to design an innovative, intelligent and interactive cultural heritage experience based on the concept of experiential learning and “edutaining”.

To this end, the innovative aspect of this research work was the design and preliminary implementation of an Intelligent, Interactive and Interoperable Comprehensive social Platform for the 21st century Museums (I3-CPM) which leverages and benefits of cutting-edge multi-disciplinary technologies, such as Virtual Environments, Augmented Reality, Holographic Displays, Intelligent Agents, Mobile technologies, Immersive Caves, and Gestures Sensors with History, Archaeology, and Social Sciences. It is worth mentioning that some of these technologies have been already successfully integrated in other application areas (e.g. Industry and Defense) as shown by articles already published (Bruzzone et al., 2010; Bruzzone et al., 2013). The I3-CPM aims at creating a European Cultural Digital Space where geographic distances and time are meaningless (any time and any place approach).

Digital cultural contents and information are received by users according to a new transmedia, user-driven, adaptive, interactive, intelligent and meaningful experience – where History becomes a guide for life – supported by an advanced Personal Assistant and Cultural Navigator (called PHRONESIS) able to intelligently interact with the users by questions/answers mechanisms. This paper describes the main components of the I3-CPM architecture in the next section and the first results of the prototype developed (Section 3). The ultimate goal is to show how the project objectives have been addressed through:

- The creation of a Virtual Interoperable Environment (configured as a serious game) where multiple museums and multiple users may engage with multiple digital cultural resources at any time and in any place, being at home, in the museum site, off-line or connected on the web.
- The creation of an Augmented Interoperable Museums where multiple users can experience augmented reality contents and receive additional pieces of information by using their mobile technologies on the museums sites.
- The creation of an Immersive Interoperable Museum to bring beyond the immersive virtual reality experience and provide the users with the possibility to fully and intelligently interact with the virtual environments by means of helmets, immersive caves, gestures sensors and touch

technologies.

- The creation of the Holographic Interoperable Museums, to be deployed in museums sites that aims at creating an advanced kiosk solution.
- The creation of an “open” social platform that can be joined also by other projects in the field of cultural heritage, such as Big and Open Data initiatives. To guarantee the interoperability with other initiatives, a gateway called NON I3-CPM Applications Bridge will be designed, conceptualized and developed. The NON I3-CPM Applications Bridge will be a way to allow a gradual and continuous stakeholders involvement within the I3-CPM platform even after the completion of the project.

2. THE I3-CPM ARCHITECTURE: A MODULAR FRAMEWORK FOR MULTI-SIDED CULTURAL HERITAGE FRUITION

The I3-CPM (Intelligent, Interactive and Interoperable Comprehensive social Platform for the 21st century Museums) is an innovative and comprehensive platform that aims at bringing beyond the way cultural digital resources are created, disseminated, preserved, re-used and re-purposed. The main ideas, models and assumptions needed to create the I3-CPM platform are summarized in the architecture overview depicted in Figure 1, which illustrates the basic features of the I3-CPM platform and shows the most important segments underpinning the I3-CPM platform.

The I3-CPM Architecture (see figure 1) includes six main parts, a description of which is provided in the next sub-sections:

- The Virtual Interoperable Museums (VIM);
- The Augmented Interoperable Museums (AIM);
- The Immersive Interoperable Museums (IIM);
- The Holographic Interoperable Museums (HIM);
- The NON I3-CPM Applications Bridge (NAB);
- A Common Infrastructure (CI) underlying the whole system.

The *Virtual Interoperable Museums (VIM)* is one of the I3-CPM platform modules which is able to interoperate with the other parts through the I3-CPM Common Infrastructure as in Figure 1. Multiple Museums (*museum 1, museum 2..., museum n*) can create and share their cultural digital resources and knowledge contents as part of a common 3D Virtual Environment (3D VE) with the aim of recreating a European Cultural Space.

The *Augmented Interoperable Museums (AIM)* is an augmented reality based tool supported by the PHRONESIS system for storytelling. The AIM can be accessed by multiple users that, by using their own mobile technologies (or mobile technologies provided by museums), e.g. smartphone, tablet, glasses, etc., can receive augmented contents while interacting with the PHRONESIS Personal Assistant and Cultural Navigator.

What we said so far for the VIM module can be applied to the *Immersive Interoperable Museums (IIM)*. Indeed,

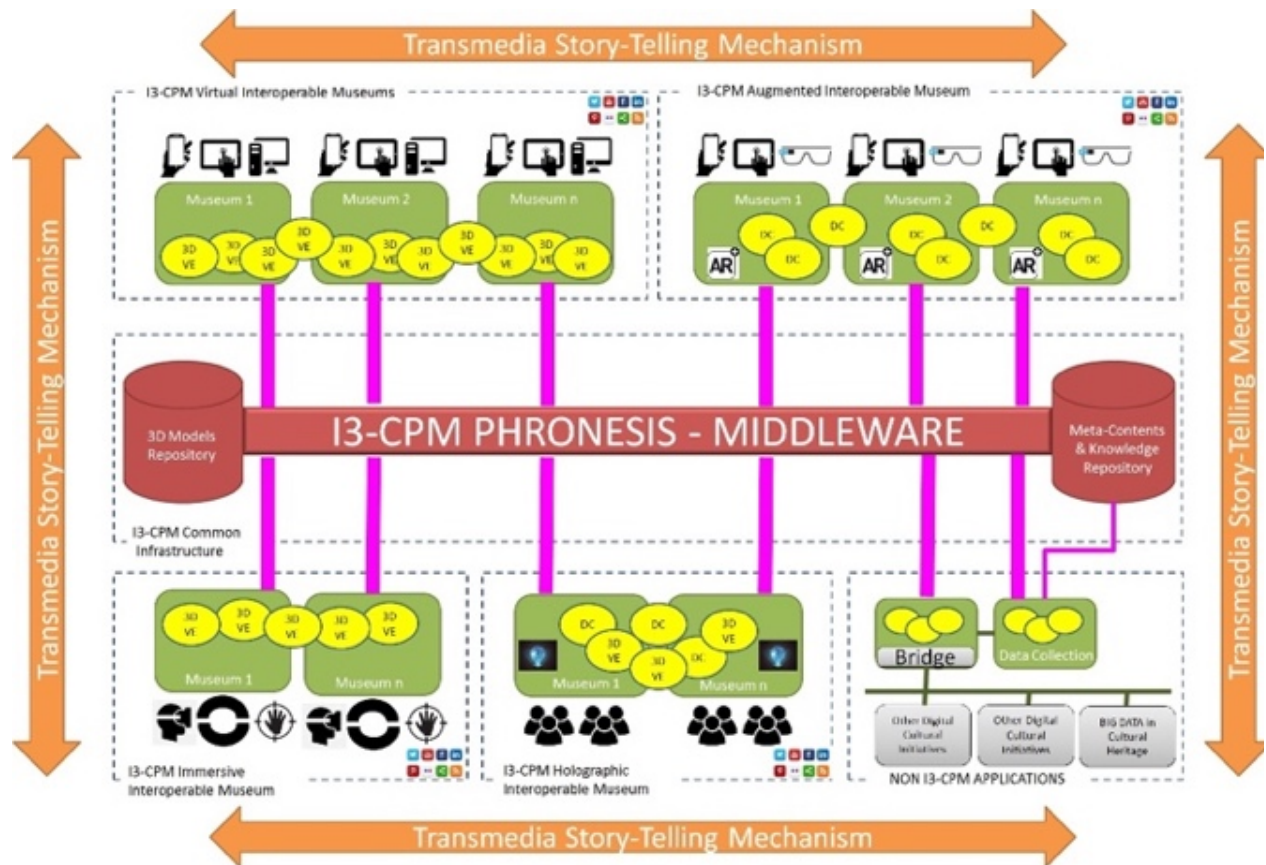


Figure 1 - I3-CPM Architecture Overview

VM are technologically demanding in terms of Virtual Reality and 3D experiences. While the VIM's 3D VE is experienced by using mobile technologies, within the IIM the experience becomes fully immersive thanks to virtual caves, helmets and gestures technologies.

The main idea of the *Holographic Interoperable Museums (HIM)* is to integrate a holographic display system able to recreate a human hologram (as well as other holographic images) with the PHRONESIS Personal Assistant and Knowledge Navigator. The result of this integration will be embedded in a kiosk solution to be deployed in the museums site to create a quasi-real museums assistant able to interact with the user, provide the user with suggestions according to his/her preferences, show multiple digital contents according to user requests.

The *NON I3-CPM Applications Bridge* allows the integration of I3-CPM applications with NON I3-CPM applications therefore extending the interoperability of the I3-CPM platform to other projects and initiatives in the field of cultural digital contents and virtual museums, such as Open Big Data Initiatives in the cultural heritage sector.

Finally, the *I3-CPM Common Infrastructure (CI)* is made up by the Middleware, the PHRONESIS system, the 3D Models Repository and the Meta-Content and Knowledge Repository.

3. I3-CPM EXPECTED IMPACTS

In terms of impact and benefits for the General Public, the I3-CPM will remove the barriers between the general public and digital cultural resources by implementing a Virtual Interoperable Environment that will allow the general public to access many digital cultural repositories as a semantically linked and interactively accessed continuum of data. To this end, I3-CPM will provide an effective content access and retrieval that will be intuitive and easily used by the general public, as well as personalized to individual users. Furthermore I3-CPM Virtual Interoperable Museums will allow both customizable single user and group experiences, online digital encounters, access from social media tools and will be portable and scalable according to the end-users needs. I3-CPM promotes familiarization of younger generations with cultural heritage through the use of media sharing and social networking technologies and a gamification context as well as it promotes the notion of shared cultural heritage thus creating a sense of community where people of various nationalities visit the same exhibition and/or share experiences. This approach also promotes the reduction of the level of social exclusion of the elderly, people with disabilities and those financially stressed by facilitating the access to content and places of cultural interest that would otherwise be

impossible to be accessed/visited by elders due to mobility or financial constraints.

In terms of benefits for educators, digital cultural resources allow educators to present material to their students in familiar formats that can be used to engage and involve the students, making culture come alive. Users are engaged in a specific self-reinforced context in which they are motivated to learn and educated through a serious game based mechanisms.

There are also benefits for researchers such as the creation of new personalizing algorithms and mechanisms for intelligent user-machine interaction such as the combination of Augmented Reality with PHRONESIS, available through mobile platforms, the development of new ways to use virtual helmets (or immersive caves), gestures sensors (e.g. MYO) and touch technologies and the creation of new solutions putting together hologram technologies with PHRONESIS.

Finally, there are also benefits for museums, institutions, curators and for the creative industry secured by dedicated and customized access to the digital content repositories, which will allow users access only to approved contents. The interactive and always available nature of mobile apps will foster deeper engagement of users with the available digital cultural material. To this end, I3-CPM provides a high potential for access, popularizing and advertising of cultural heritage through its applications using Augmented Reality, Serious Games and Holograms with PHRONESIS. The functionalities enabled by the I3-CPM will promote new interactions between the institutions and their target audiences. For example, cultural tourists or student groups might decide to visit a museum after discovering items of interest through interactions with the digital content.

4. I3-CPM PROTOTYPE AND PILOT

In order to provide evidence on the relevance of the I3-CPM and to show how all the objectives can be achieved, a fully functional prototype of the platform is going to be developed as continuation and extension of the SG-ICT research project, Serious Games at Increased Impact on Culture and Tourism (Longo et al., 2014; Longo et al., 2015). The prototype will be developed with and for users in a living lab approach fulfilling the open innovation paradigm, with the contribution of final users and all the stakeholders, centered in user needs and directly focused on market application.

A generic virtual museum has been implemented in order to shift later in time the choice of a specific real museum to use as partner in the pilot. The VE can be enjoyed through a very simple workstation (depicted in Figure 2) made up by three large screens, which give the user a very basic feeling of “immersion”, and a touchscreen to interact with the environment.



Figure 2 – Generic Virtual Museum for the I3-CPM

The deployment of one prototype for each museum requires the utilization of all the technologies and hardware needed to let users experience all the platform functionalities (VIM, AIM, IIM and HIM). Examples of already available and tested technologies are the Oculus Rift and the HTC Vive as VR Helmets (see Figure 3), the MYO Gesture Control Armband for hands/arms motion Tracking and the Virtuix Omni.



Figure 3 – Testing the VE with VR Helmets in the IIM

An initial set-up of an advanced visualization system made up of eight large touchscreens and a high-quality surround-sound system has been designed as in Figure 4 to be employed both in VIM and IIM applications and installed in museums.

As far as the AIM is concerned, some initial prototypes of a mobile application have been developed with the aim to enjoy cultural content about a specific artefact by simply pointing at a two-dimensional visual code (or tag) placed next to the real artefact as represented in Figure 5. This way augmented content, accurate 3D models of the artefact (see Figure 6), audio and video content can be enjoyed through an interactive experience which benefit also of the PHRONESIS system to ask for more detailed information.



Figure 4 – Set-up of an advanced visualization system for VIM or IIM applications



Figure 5 - Tag recognition for augmented cultural content on AIM

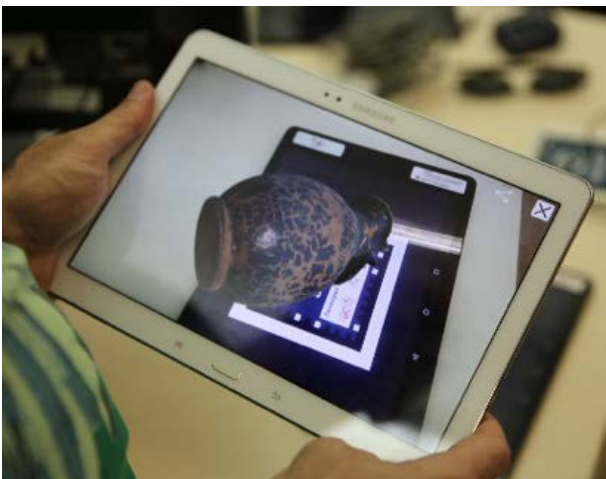


Figure 6 - Navigating a 3D model of an artefact on AIM

The prototype under development aims at providing a very intuitive and immediate environment for museums, institutions, galleries etc. that desire customizing the I3-CPM on their needs.

5. CONCLUSIONS

The ambition of this research work is to set the scene for a Cultural Digital Space that will allow the users to navigate a social platform where cultural digital contents and information are accessible to everyone any time and any place. This can be regarded as the 21st century museum concept that is expected to turn upside down the traditional museum visits. Promoting the cultural heritage through interactive and full-immersive experiences and setting new learning patterns by exploiting the informative and educational potentials of new methodologies and technologies (e.g. Serious Games) will bring beyond the way cultural digital resources are created, disseminated, preserved and re-used and will represent a “trait d’union” between past, present and future.

Since I3-CPM explores unconventional ways to deliver cultural knowledge contents (Virtual and Augmented Reality, Holography, Immersive technologies, Simulation, Serious Games, Knowledge based Systems, vocal interaction technologies, etc.), it is expected to provide users with new learning experience by:

- An interoperable and modular platform able to interconnect multiple technologies with the aim of creating Interoperable Museums where geographic and cultural distances are cut down and where physical and digital worlds are strictly linked each other.
- A scalable and portable platform that can be easily re-adapted to different types of collections (e.g. museums, archaeological sites, art galleries, etc.) and able to run using different types of technologies (Desktop Computers, Mobile devices, Caves, VR Helmets, Holograms).
- A platform able to encourage an active and gradual participation of large number of stakeholders also providing an easy way to connect with already existing and future platforms and Digital Heritage Initiatives.

Holographic visualization and the PHRONESIS system open new ways for the museums to think at the museums tour. The I3-CPM is indeed envisaged to be of benefit to General Public, Educators, Researchers, Memory Institutions, Curator Community, Creative Industry as summarized in Table 1.

ACKNOWLEDGMENTS

The research presented in this paper is part of an ongoing research project: “*SG-ICT: Serious Game at Increased Impact on culture and Tourism*” financed by the Italian Ministry of Education, University and Research under the Bando startup initiative. The main project partners include the University of Calabria and CAL-TEK SRL.

REFERENCES

- Addison A. (2000). Emerging trends in virtual heritage. IEEE Multimedia, Special Issue on Virtual Heritage, 7 (2): pp. 22–25.

- Amigoni, F., Schiaffonati, V. (2009). The Minerva System: A Step Toward Automatically Created Virtual Museums. *Applied Artificial Intelligence* 23(3): pp. 204-232.
- Anderson, E.F., McLoughlin, L., Liarokapis, F., Peters, C., Petridis, P., and de Freitas, S. (2010). Developing Serious Games for Cultural Heritage: A State-of-the-Art Review. *Virtual Reality* 14 (4): pp. 255-275.
- Arnold, D. (2009). 3D-COFORM: Tools and expertise for 3D collection formation. In *Proceedings of EVA*, pp. 94-99.
- Bruzzone A.G., Fancello, G., Fadda, P., Bocca E., D'Errico G., Massei M., (2010). Virtual world and biometrics as strongholds for the development of innovative port interoperable simulators for supporting both training and R&D. *International Journal of Simulation and Process Modelling*, Volume 6, Issue 1, Pages 89-102.
- Bruzzone, A.G. (2013). Intelligent agent-based simulation for supporting operational planning in country reconstruction . *International Journal of Simulation and Process Modelling*, 8 (2-3), pp. 145-159.
- Gaitatzes, A., Christopoulos, D., Roussou, M. (2001). Reviving the past: Cultural Heritage meets Virtual Reality. In: *Proceedings of Virtual Reality, Archeology, and Cultural Heritage (VAST)*: pp. 103-109.
- Geller, T. (2006). Interactive tabletop exhibits in museums and galleries. *IEEE Computer Graphics and Applications*. Volume 26, Issue 5, pp. 6-11.
- Hall T., Ciolfi L., Bannon L., Fraser M., Benford S., Bowers J., Greenhalgh C., Hellström S.-O., Izadi S., Schnädelbach H., Flintham M. (2001). The Visitor as Virtual Archaeologist: Using Mixed Reality Technology to Enhance Education and Social Interaction in the Museum. In: *Proceedings of VAST 2001: Virtual Reality, Archaeology and Cultural Heritage*, ACM SIGGRAPH, Glyfada, Greece, pp. 91-96.
- ICOM News, no. 3, 2004, available at: http://icom.museum/fileadmin/user_upload/pdf/ICOM_News/2004-3/ENG/p3_2004-3.pdf.
- Longo, F., Nicoletti, L., Vena, S., Padovano, A. (2014). Serious games at increased impact on culture and tourism *Proceedings of the 26th European Modeling and Simulation Symposium*, pp. 641-648.
- Longo, F., Nicoletti, L., Florio, G., (...), Bruno, L., Caputi, L. (2015). Inside virtual: A new app for interactive and intelligent cultural heritage fruition. *Proceedings of the 27th European Modeling and Simulation Symposium*, pp. 471-478.
- Malraux A., *La Musée imaginaire*, Gallimard, Paris, 1996 [orig. 1947].
- Mortara M., Catalano C.E., Bellotti F., Fiucci G., Houry-Panchetti M., Petridis P. (2014). Learning Cultural Heritage by Serious Games. *Journal of Cultural Heritage*.
- Osberg K.M. (1995). Virtual reality and education: where imagination and experience meet, *VR in the Schools* 1 (2), pp. 1-3.
- Packer J. (2006). Learning for fun: The unique contribution of educational leisure experiences, *Curator: The Museum Journal* 49 (3), pp. 329-344.
- Sooai, A.G., Sumpeno, S., Purnomo, M.H. (2016). User perception on 3D stereoscopic cultural heritage ancient collection. In *Proceedings of the 2nd International Human Computer Interaction and User Experience Conference*: pp. 112-119.
- Stock O., Zancanaro M., Busetta P., Callaway C., Krüger A., Kruppa M., Kuflik T., Not E., Rocchi C. (2007). Adaptive, intelligent presentation of information for the museum visitor in PEACH. *User Modeling and User-Adapted Interaction*. Volume 17, Issue 3, July 2007, Pages 257-304.
- Styliani, S., Fotis, L., Kostas, K., Petros, P. (2009). Virtual museums, a survey and some issues for consideration. *Journal of Cultural Heritage*. Volume 10, Issue 4, pp. 520-528.
- White M., Mourkoussis N., Darcy J., Petridis P., Liarokapis F., Lister P., Walczak K., Wojciechowski R., Cellary W., Chmielewski J., Stawniak M., Wiza W., Patel M., Stevenson J., Manley J., Giorgini F., Sayd P., Gaspard F. (2004). ARCO - An architecture for digitization, management and presentation of virtual exhibitions. *Proceedings of Computer Graphics International Conference, CGI*, pp. 622-625.

AUTHORS BIOGRAPHY

Francesco Longo is currently Assistant Professor at the Department of Mechanical, Energy and Management Engineering where he teaches "Industrial Plants and Facilities" and "Industrial Plant Management" for Master Degree Students in Mechanical and Management Engineering. His research interests include Modeling & Simulation for production systems design and supply chain management. He is Director of the Modeling & Simulation Center – Laboratory of Enterprise Solutions (MSC-LES), a research laboratory operating at the University of Calabria, which is member of the MS&Net (McLeod Modeling & Simulation Network). Starting from 2016, he is also serving as CEO of CAL-TEK Srl, a Spin-off company of University of Calabria. He has published more than 150 scientific papers on international conferences and journals participating as speaker and chairman to different international conferences. He actively cooperates with many research institutions all over the world (DIPTM, University of Genoa, Kennedy Space Center, NASA, Rutgers University among others). He is editor of several journals and journal's special issues and over the last years, he has strongly supported the organization of conferences in the area of simulation applied to Industry and supply chain as member of the

International Program Committees. Starting from 2003 he worked on private research projects involving manufacturing and logistics systems operating in Italy. He has acquired experiences in consulting for Business Process Re-engineering and Logistics in different areas.

Letizia Nicoletti was CEO of Cal-tek Srl from 2012 to 2014 where she is currently Senior Manager. She obtained her Master Degree in Management Engineering, Summa cum Laude as well as her PhD in Mechanical Engineering from University of Calabria, Italy. She has followed as Scientific Responsible many research projects in different areas including logistics and distribution, Defense and Cultural Heritage. She was also the main Responsible for all the services provided by CAL-TEK to NATO STO CMRE.

She carried out several work experiences travelling in Europe and United States working as CEO of Cal-tek Srl and attending Conferences and Workshops in the M&S area.

Since 2009 she has acquired a strong experiences in software development and Modeling & Simulation (M&S) including High Level Architecture (HLA) and Distributed Real Time Simulation. Her skills include requirements definition and development, conceptual modelling, model simplification, data collection and analysis, representing unpredictable variability and selecting statistical distributions, models and software coding, experimentation, verification and validation, serious games development, visualization, simulation software in different areas, to name a few, defense, healthcare, complex systems and tourism.

She is author of more than 50 scientific papers and technical reports. In 2011, she successfully completed the NATO CAX Operator Certification Course.

Antonio Padovano is PhD student at the University of Calabria where he received his degree in Management Engineering summa cum laude.

His work focuses on the development of interoperable discrete event and agent-based simulations for decision support in complex systems in the area of Industry, Logistics and Defense with a particular attention to Human Modeling & Simulation to reproduce the main functions of human behavior in order to assess the impact of human choices, decisions and actions. He participated to different research projects both in cooperation with MSC-LES and CAL-TEK Srl (e.g. T-ESEDRAS, SMARTDISTR, SG-ICT).

He participated to different international conferences (EMSS, MAS, HMS, China-Italy Science, Technology and Innovation Week, etc) and he also served as Advisor for University of Calabria students at ICAMES 2016 (Istanbul, Turkey).

He was visiting student at the Business School at Rutgers University (The State University of New Jersey, USA) between June and September 2015 working in the field of simulation modeling and development aimed at analyzing and improving the performance of supply chains and industrial systems, in

particular, container terminals as well as implementing a software tool whose main objective is to support decision making processes within complex industrial and logistic systems in order to evaluate green management practices in terms of both environmental impact.

He teaches as tutor for undergraduate and graduate students enrolled in the Degree in Mechanical Engineering at the University of Calabria in the classes “Industrial Systems” and “Industrial and mechanical systems”.

Adriano Solis teaches and conducts research in the areas of operations/logistics/supply chain management and management science. More recently he also started to extend his research areas to other topics including the application of simulation based solutions to different domains (including cultural heritage). He served for different years as General and Program Chair of the International Conference on Applied Modeling & Simulation therefore providing a strong contribution to the organization of the I3M multiconference. He is currently Director of the School of Administrative Studies at York University, Canada

Arianna Monzon is currently doing researches in the area of virtual environments for mobile applications with particular attention to Cultural Heritage area. She worked as programmer in CAL-TEK srl where she firstly acquired experience in the development of serious games by using graphic and physics engines and where she was also involved in the SG-ICT project.