Information and Communication Technologies in Architectural Documentation

*Armagan GULEC KORUMAZ, *O.Nuri DULGERLER, * Selcuk SAYIN, *Mustafa KORUMAZ,Turkey

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SUMMARY

Recent developments in the field of ICT (Information and Communication Technology) have an immense effect through life-cycle of buildings and built environment. It has an influence on future of urban planning, urban structure and on our cities. ICT provides a closer link between building participants and building information. Besides digital information technologies have produced a wide range of applications for collecting and processing historical data, documentation and visualization of historical buildings and environments, it creates an interactive link between professionals, students and public. With the rapid development of digital technologies applications in the field of historical research and heritage representation must be under taken with awareness of their uses and effects in this field. In order to achieve 3D model of architectural works, it is essential to take account of diverse information of the building and built environment.

This paper provides a vision on ICT developments in cultural heritage documentation and evaluates ICT influences in this field. The study also tries to draw a way to understand how ICT influence the complex mechanism of the documentation process. The aim of this paper is to contribute to a better understanding and overview of current ICT uses in the field of cultural heritage documentation.

1.INTRODUCTION

The development of a wide variety of networked digital field recording techniques and databases has added efficiency, cost-effectiveness, and power to the task of accurately documenting and analyzing monitoring the physical state of sites and standing historical monuments. New networking technologies and digital visualizations have now begun to rival linear narrative as a main method of historical documentation and interpretation for both scholarly and educational audiences(Niccolucci,2007).

ICT can play a decisive role in analyzing conservation problems, prioritizing their importance, and providing data that can assist in the formulation of overall policies in the CH sector. In addition to monitoring specific processes of decay and deterioration, interlinked ICT networks can offer detailed and updated "snapshots" and trend forecasts about the physical state(Niccolucci,2007).

2. ICT AND CULTURAL HERITAGE

ICT may contribute to ‘‘open" the doors of cultural patrimony to a wide number of people and that it allows communication and exchanges among people, thus sharing of knowledge, information and ideas. It is evident that the use of ICT may contribute to concretely drive people to recognize the importance of the past, by helping them value the background of today's Knowledge Society. In fact, it allows:
-An enriched and multi-perspective view of artifacts deriving
from the fact that they are available in a digital form.
-The adoption of innovative teaching and learning methods(Ott,2007).

If we take into account the full spectrum of CH data and circumstances (or 'business processes') the following areas could benefit from novel ICT applications:
- Data collection/recording
- Organization, structuring, analysis, and interrogation
- Cultural heritage research (e.g., humanities, local/regional/national/European history, etc.) where
ICTs offer potential intelligent tools;
- Interpretation and communication
- Preservation and archival of records and secondary data;
- CH site and resources management (e.g., monitoring and preservation);

- CH on-site and online visitors/users (e.g., requirements of researchers, professional, general public,etc.);
- CH exploitation/valorization and regional development agendas.

For most of these areas there are already ICT applications in use, which, however, are felt to have considerable limitations for exploiting the full benefits of ICT for key tasks and processes(Niccolucci,2007)

2.1.ICT in Cultural Heritage Documentation

Besides the more obvious applications in conservation and restoration of the buildings, the architectural documentation plays a vital role in preserving the memory of this heritage. This is a highly relevant aspect, given the impossibility of the physical preservation of all significant samples. All steps in this process involve the comprehensive and intensive use of digital technologies. Thus, the methodology proposed comprehends five main parts summarized here:

-The overall planning stage
-Data acquisition and field work
-Data processing and analysis, including handling or manipulation
-Management of data including indexing, storage, retrieval, data security, access, dissemination and publication of the data and information produced for concerned public,
-Control and documentation of the project, in which should be analyzed in the various aspects involved in the project's implementation.

This set of phases represents a scientific methodological approach for a documentation project in order to achieve best results and the best practices. So, in the development of these activities it is required a set of digital technologies in every related step(Amorim,2010).

The cultural heritage documentation specialist is now faced with an ever-growing array of tools made available by the information communications technologies (ICT) which are the hallmark of the information society. Some of these tools may be used in a stand-alone manner while others achieve their true potential when linked up to other ICT tools. The new digital tools include various forms of 2D imaging (photography, X-ray), 3D imaging (laser scanning, photogrammetry), relational databases, the Internet, web-based systems. The very nature of these tools helps define the objectives of *e-heritage* most specific to documentation(Cannataci,2003).

Fundamental work about the use of computerized systems for built heritage documentation was done in the early 1990s in the USA by the Society of American Archivists. Attempts leading to standardization and deployment of digital technologies in the built heritage documentation were undertaken also in Europe on both academic and governmental levels. The advent of the Internet created unprecedented conditions for access to, and exploitation of, public sector information including architectural heritage collections. This resulted in a real explosion of researches and implementations of computerized systems addressed not only to the specialists but to a wider audience with the new aims of increased awareness and education. Since the mid-1990s, a number of projects have been developed and implemented by universities, museums and heritage documentation institutions across Europe(Kepczynska-Walczak,2005).

Another technological possibility for use in documentation of sites is the GNSS - *Global Navigation Satellite System*, the best known and most popular segment is the GPS - *Global Positioning System*, maintained by the U.S. government. Although it may have an important application in particular cases, in most cases this technology comes with a secondary role, providing the georeference of sites and monuments.(Amorim,2010)

Another interesting affordance offered by technologies, such as GPS systems, consists in providing visitors of archaeological sites with mobiles, so that they can get information concerning points of interests while walking along, so as to enrich data coming from ‘‘direct observation” with further, ‘‘external” data(Ott,2007).

Geographical Information Systems have been developed to create relationships between data and to analyze spatial information recorded in databases. The principal applications of GIS are either heritage management (monitoring of known sites or identification of new ones) or explanatory framework (site catchments or analysis of the intervisibility of the sites)(Meyer,2007).

The advent of digital photogrammetry allowed a significant simplification of the procedures, When data acquisition is done by Photogrammetry, data processing consists in processing the photos and other data gathered in the field through the restitution models implemented in software algorithms, aiming to generate products of photogrammetric restitution, like orthophotos, rectified photos, mosaics, technical drawings, wireframe or surface geometric models(Amorim,2010).

The virtual reality(VR) technology offers not only an exploration of a single exhibit but of many virtual objects arranged into a *virtual scene*. The main difference from the previous

approach is that users virtually enter the virtual space - they get a feeling of being a part of the *virtual environment*. Being a part of a 3D space is naturally useful for presentation of interiors. It is even more convenient for visualization of exteriors where visitors meet historical buildings and generally any architectural objects placed in a space(Zara,2004).

In recent decades, *3D laser scanning* appears and is optimized with its great versatility for capturing any type of shape and amazing speed of data acquisition. This technology produces detailed geometric models in point clouds, realistic or false color. The great advantage of this technique is the speed of data capture in the field, and the possibility of working in the dark, if it is not necessary the capture of the surface texture of the object [4]. Besides the technologies previously mentioned employed in the capture of data to produce technical documentation to be used for purposes of conservation and restoration projects, or even for filing as safeguard, there are other digital technologies that have great potential to represent the building, its surroundings and the temporal context in flexible and versatile ways for other types of application, namely the photographic panoramas, videos and movies and audio testimonials(Amorim,2010).

With the advent of digital technologies, Cultural Heritage artifacts can be viewed both as a whole and in their minimal details; images are no longer strictly bi-dimensional, and detailed study and zoom possibilities of every kind/level are possible. What's more, the representation of artifacts becomes dynamic and interactive: it is the user herself who can directly choose the dimension, the level of detail and also the viewpoint to access each single artifact(Ott,2007).

In Cultural Heritage, ICT offers: it allows the user to shift from looking at each object as a single, isolated element, to viewing it as part of the wider context, where it lives or has been created/inserted. Contexts can be various and may differ in shape, nature and size; moreover, they can be real or reconstructed. Besides, ICT offers Cultural Heritage Education a new, interdisciplinary dimension, by providing the possibility of looking at each artifact within a broader network of historical, socio-cultural, economical and geographical links, which allow its better understanding and interpretation. Thanks to ICT, such a network becomes potentially unlimited and opens the way to genuinely interdisciplinary(13). The handling of documents thanks to an Information System sets the problem of the access to the information. It has to be fast, synthetic and multilingual, to be adapted to the today's practices and habits. Whatever the objectives of the data management may be, it implies synthetic representations of the information and possibilities to ‘‘navigate’’ through the documents. The principal interrogations are about indexation and structuring of the documents, and about presentation and representation for exploration purposes(Meyer,2007).

All these mentioned technologies have significant application in architectural documentation, although they might be more suitable and effective in specific situations. The studies and experiments done so far and the results indicate that a single technology is not sufficiently versatile and efficient to serve all ranges of existing applications. Thus, the technology to be used during both data acquisition and processing will depend on many factors such as characteristics of the application, implementation deadlines, technological, human and financial resources, besides the team experience(Amorim,2010).

2.2.Technologies Used in Cultural Heritage

Figure 3 demonstrates that the techniques used within cultural heritage projects presented at VAST 2003 can be summarized into recording, modeling, visualization and interpretation.

Recording could be viewed as 'data acquisition' technologies. Part of this process may involve converting one technology (such as slides) into another, so that it can be used in computer applications. For example producing a digital image of a slide(Owen,2004).

Modeling can be described as putting data into a specific order. Mesh adjustments encompassed positioning and aligning different meshes to increase the detail about an overall image. Orientation involves positioning fragments to estimate size and therefore determine the vessel's appearance. Image adjustments involve ordering images, for example stitching images into panoramas for output in a new application. Data management involves putting data into a structure(Owen,2004).

Visualization is where information is sorted into a format for the purpose of making it more accessible. Accessibility can be in two ways. Firstly a 3D model of a sculpture enables the visitor to view its image remotely, rather than being physically present at the exhibit. Accessibility can also be in terms of promoting understanding. For example presenting the subject in a visual way such as a walkthrough, or augmented reality helps to explain the subject. Databases visually depict the relationships between one subject and another. This can be seen when the user inputs their search criteria and the results are displayed. In the diagram databases are placed away from other visualization techniques. This is to reflect the fact that databases may be used to store other visualization technologies such as 3D models, augmented reality images etc. Placing databases to the right of other visualization Technologies emphasizes there may be another stage between visualization and interpretation(Owen,2004).

Virtual reconstruction is still a very frequent intent for the construction of 3D models in our time. More recently, surface models have also been applied in archaeology. In contrast to solid models these techniques incorporate no information regarding the solid geometry of a building and simply present it as a series of two-dimensional flat surfaces that can be rendered or viewed in a variety of ways(Meyer,2007).

Interpretation is divided into interpretation for: professionals and the general public. Sometimes technologies can be used for both categories. For example professionals and the general public can use web accessible databases for their own purposes. This is reflected on the diagram by showing the same text box in both categories. For brevity and to avoid confusion, the arrows from visualization Technologies are only linked to either professional or general public examples (not both). The horizontal arrows in between the boxes show that the visualization technologies apply to both categories. Figures 1 – 2 show that scanning and digital photography are the most frequently used forms of data acquisition technologies used in recording. Scientific process focused on image development and data management. Dissemination involved up to a three step process: enhancing information about a subject, perhaps storing on a database (or at least in computer files) and interpretation for professionals and / or the general public(Owen,2004)

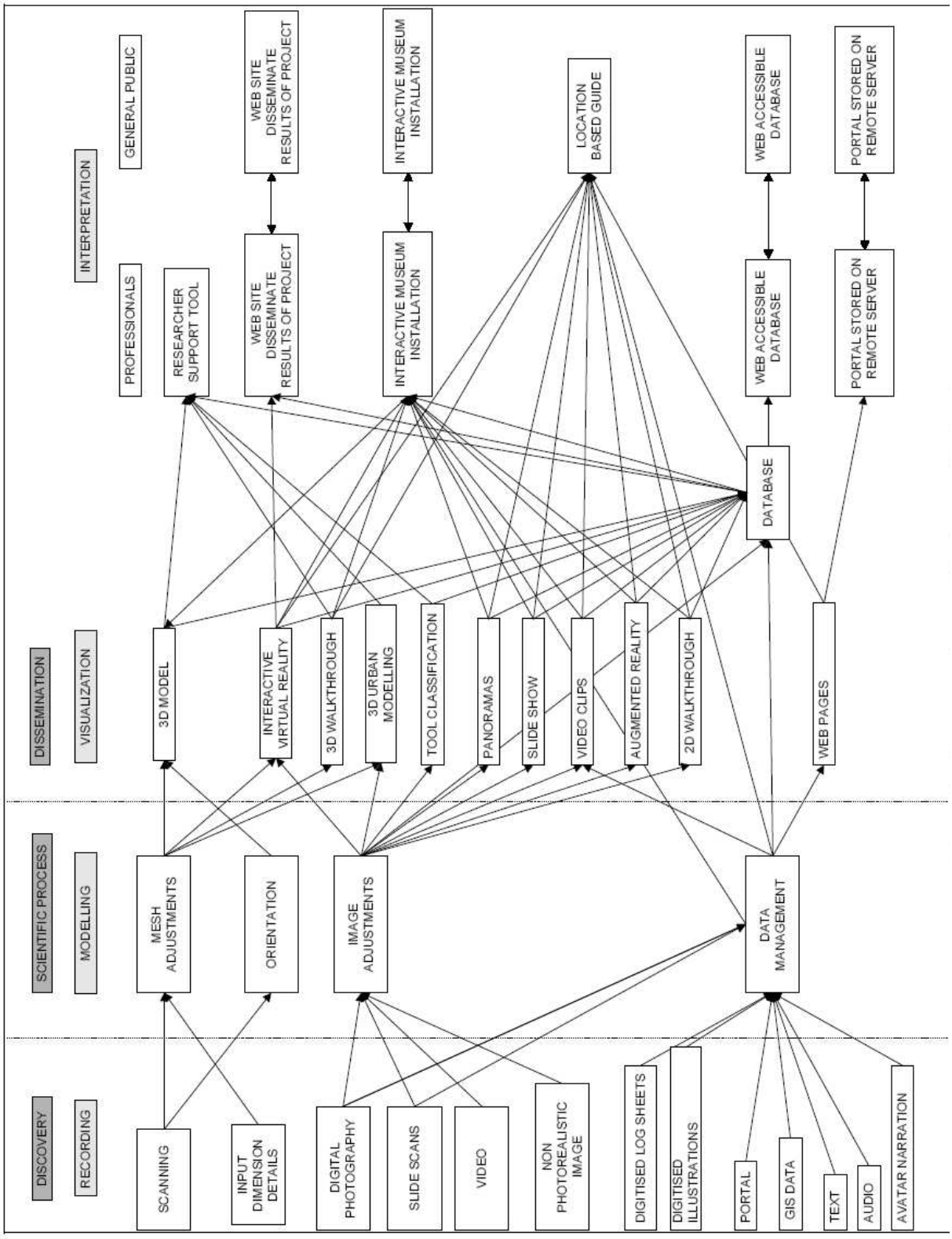

Figure 1.Techniques used within cultural heritage projects presented at VAST,2003(Owen,2004).

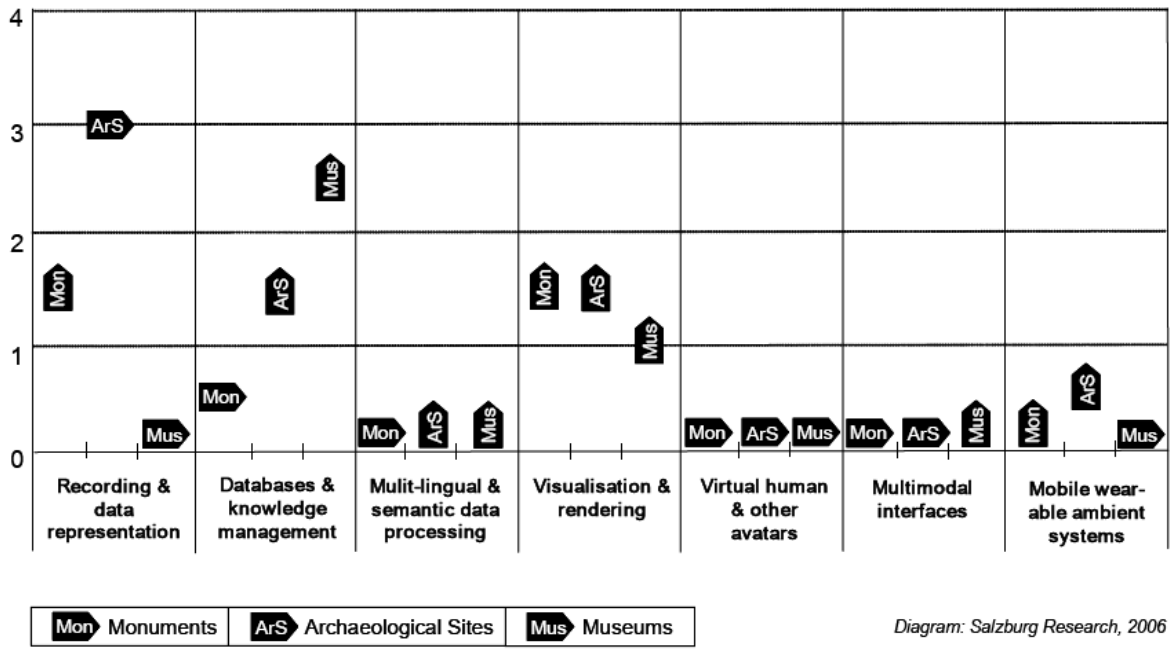

Figure 2. Hypothetical stakeholder interest in selected fields of ICT applications in different CH domains(Arnold,2008).

Of particular interest here are the technology areas for which an overall assessment would level out the considerable differences in interest. Most notable are the first two areas.
In the area of 'recording and data representation', besides the continuing high interest of the archaeology community in this area, we observe a considerable rise in interest of monument managers in digital monitoring technologies able to detect changes in physical conditions, e.g., humidity, corrosion, decay of material, etc. (cf. the results of the EPOCH expert workshop at ICCROM Headquarters in Rome, 6–7 March 2006 (Epoch, Chedi, 2006)

On the other hand, the interest of museums in recording and data representation technology is low because most museums do not record, process and represent datasets such as archaeological field recordings, but digitize objects (e.g., 3D scans of museum objects such as statues) more as a means of presentation than as documentation of the sources and, hence, are much more interested in the technology area of 'visualization and rendering'. The impetus given by initiatives such as the European Digital Library, which emphasized a broader vision of collection digitization, may impact on the museum sector's interest in this area.

Finally, in the area of ‘databases and knowledge management’ we would expect a rather low interest at monument sites, at least in comparison with archaeological excavation areas and museums. The latter deal with large numbers of different finds or objects as well as currently striving to provide integrated access to the knowledge of experts in different subjects and results of ongoing scholarly research. A case in point here may be the considerable rise in interest in knowledge organization systems such as thesauri and ontologies in these domains(Arnold,2008).

3.Conclusion

In the coming years, CH conservators (working on specific problems at specific sites) and planners (focusing on regional issues of urban and infrastructure threats to material heritage) will need to work ever more closely together within the information networks that can be provided by ICT. More than merely developing tools for specific conservation projects, ICT must help create a new information structure for new multidisciplinary teams of heritage ecologists, simultaneously addressing the challenges of conservation on local and regional scales. Here too, the contribution of ICT can be something more than bridging a static interface between technology and culture. The effort to establish interoperable digital tools for Data Collection, Structure, and Analysis can be the first step in creating innovative, new multidisciplinary forms of historiography. Widening access to new classes of networked data will encourage a deeper consideration of their commonalities and contrasts. Effective ICT research tools have the potential of not only producing meaningful bodies of interlinked data that has been collected within existing disciplinary frameworks, but can also help to reshape the wider intellectual strategies for the study CH information and production of knowledge in the years to come. The goal is certainly not to create a single, dominating heritage discourse that is simply the sum of all its presently fragmented parts. Through the serious collaboration of ICT and CH professionals it can be the first step in creating innovative, multidisciplinary forms of historiography(Niccolucci,2007)

As in the case of physical conservation, a long-term view needs to be taken and the role of ICT can be central. More than merely developing tools for specific presentation applications within marketed heritage attractions, ICT must help create new information structures for collecting, analyzing, and updating data about their performance for the effective shaping of future policies and development designs. Instead of taking the current economic trends for granted, ICT can take the lead in monitoring the long-term economic dimensions of the cultural heritage field. The integration of digital Technologies into CH offers a unique opportunity for increasing the flexibility of interpretation activities — in their capacity both to collect and to structure large quantities of divergent data for selective retrieval both within

and outside the formalized heritage institutions of museums and sites. They offer an independent channel — not only of one-way heritage communication — but also a forum for wide public discussion, reflection, and creativity. Within the CH sector, the communication of CH information is no longer seen solely as a process of distilling scientific results and presenting them to a largely passive public but encouraging their active participation in the documentation and discussion of the sites, objects, landscapes, and traditions in a variety of social contexts.(Niccolucci,2007)

ICT can
-Promote a higher level of use-inspired basic research in ICT that may pave the way to new or enhanced applications for purposes that are specific to cultural heritage
-Promote a higher degree of inter-disciplinary research and development
-Promote research that is needed for understanding CH operational and user situations
-Use effective approaches of disseminating and sharing results of the research work
-Leverage the offer of CH ICT programs and courses in tertiary education and training(Arnold,2008)

The ongoing developments in the field of ICT have an important impact on the spatial planning, architecture and building sector. The requirements and needs of the society are changing and this can be seen in our daily life such as living, recreating, transport etc. This in turn results in changes to spatial Planning. The influence of ICT can already be seen in architectural design. Designers can allow ideas and intuitions to take physical shape in ways that have not been possible before. Interpreting the capability of the digital technologies as a tool, medium, partner and an extension, in a creative way is the most fundamental issue. Since ICT has been a part of the architectural design and production processes, its tools, concepts, methods and forms experienced serious transformations(Sökmenoğlu,2006).

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CONTACTS

Res.Assist. Armagan Gulec Korumaz
Selcuk University Department of Architecture
42003 Kampus-Konya-TURKEY
Tel: +90 530 402 4141
Fax: +90 332 241 0635
Email: gulec.armagan@gmail.com
Website: http://mimarlik.mmf.selcuk.edu.tr/

Dr. Mustafa Korumaz
Selcuk University Department of Architecture
42003 Kampus-Konya-TURKEY
Tel: +90 532 440 1939
Fax: +90 332 241 0635
Email: mkroumaz@gmail.com
Website: http://mimarlik.mmf.selcuk.edu.tr/

Asist. Prof. O.Nuri Dulgerler
Selcuk University Department of Architecture
42003 Kampus-Konya-TURKEY
Tel: +90 533 520 8684
Fax: +90 332 241 0635
Email: ondulgerler@gmail.com
Website: http://mimarlik.mmf.selcuk.edu.tr/

Res.Assist. Selcuk Sayın
Selcuk University Department of Architecture
42003 Kampus-Konya-TURKEY
Tel: +90 532 361 5770
Fax: +90 332 241 0635
Email: selcuksayin42@hotmail.com
Website: http://mimarlik.mmf.selcuk.edu.tr/