CAD, BIM, GIS and other tricks of the computer science in the education of the Building Engineer

IMProVe 2011

International Conference
on Innovative Methods
in Product Design

Proceedings

June 15th – 17th, 2011
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Proceedings of IMProVe 2011

International Conference on
Innovative Methods in Product Design

San Servolo, Venice (Italy), June 15th – 17th, 2011

Scientific Associations:

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Conference Organization:

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Facoltà di Ingegneria – Univ. Padova
Dipartimento di Architettura, Urbanistica e Rilevamento (DAUR) – Univ. Padova

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IMProVe 2011 International Conference originates as the 5th Joint Conference of *ADM* (the Italian Associazione Nazionale Disegno di Macchine) and *INGEGRAF* (Asociación Española de Ingeniería Gráfica) and has been organized by the Design Tools and Methods in Industrial Engineering Lab. and the Drafting and Representation Lab., both belonging to the DAUR Dept. of University of Padova. From this edition, the Conference is also supported by *A.I.P. PRIMECA* (Ateliers Inter-établissements de Productique - Pôles de Ressources Informatiques pour la MECAnique) and *IJIDeM* (International Journal on Interactive Design and Manufacturing). This event has been proposed as a significant opportunity for discussing on product innovation issues from interdisciplinary point of views, to promote new workgroups and international networks in both engineering and architecture areas.

As can be recognized by these proceedings, *IMProVe 2011* has proven to be a forum of experts in engineering and architecture design from academia and industry, committed to share the different experiences, skills and ideas and to, jointly, identify new working hypothesis for the design of innovative products.

The quality of the contributions was assured by a double blind review under the supervision of the Scientific Committee, as explained hereafter. I want to personally thank every member of the Scientific Committee and of the Reviewer Committee for the strong commitment and expertise demonstrated in this sensitive and very important task.

Finally, I hope that this event could be one step towards a stronger and fruitful cooperation among ADM, INGEGRAF and AIP-PRIMECA associations, and also open new links with the innovative experiences in the fields of industrial design and architecture.

Gianmaria Concheri

IMProVe 2011 Chair

IMProVe 2011 Scientific Committee note

The IMProVE 2011 Conference has reached a quite large audience of researchers interested to its topics, and 223 submission have been gathered by the OpenConf CMS, mainly from Europe.
The review process has been possible with the work of the Scientific Committee, to which other 43 colleagues, mainly Italian and Spanish, have given their cooperation to guarantee at least two assessments per paper. Each reviewer has assessed 5 papers (average value) with a variance of ±3 papers. The double blind review process has selected 156 papers (70%), that have been subdivided between 98 for oral presentation (63%) and 58 for the poster session (37%).
Accepted for oral presentation were the papers that reached a score greater than 4/6 (being 6 the greatest value used by the CSM). The paper assessed by a score lower than 4/6 was selected for poster session, even if in some (few) cases the improvement received by the paper, on the basis of reviewer comments, brought it up to oral presentation. Fortunately in few cases (lower than 10) was necessary to assign the assessment to a third reviewer, and this allowed the Scientific Committee to solve the conflict emerged. The papers with scores lower than 2/6 were rejected by S.C. or withdrawn by the authors.
Submitted abstracts: 223
Accepted papers: 156
Papers rejected or withdrawn after the revision process: 67
Accepted papers origin:
- Argentina 1
- China 1
- Colombia 1
- France 13
- Hong Kong 2
- India 1
- USA 1
- Italy 82
- Poland 1
- Spain 61
- Tunisia 2

(The above list cites only the corresponding Authors. The Author nationalities include more countries e.g. UK, NZ, etc.).
Number of reviewers: 82:
- Italy 50
- Spain 18
- France 12
- UK 1
- USA 1

On behalf of the Scientific Committee, I would like to thank all people who spent part of their time to give a real improvement to the papers that will be presented at the Conference.
A further step will remain to do. During oral sessions the quality and the interest of the presentations will be also assessed. On the basis of this latter and the previous scores, a very reduced number of papers will be selected by Scientific Committee for publication on the Int. J. on Interactive Design and Manufacturing.
Good luck and thanks again

Sergio Rizzuti

Scientific Committee Coordinator

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Title: *Innovative Methods in Industrial Engineering and Architectural Design*

TEACHING PRODUCT DESIGN AND DRAWING HISTORY

CAD, BIM, GIS and other tricks of the computer science in the education of the Building Engineer

G. N. Massai (a), M. M. Bocconcino (a)
(a) Politecnico di Torino – I Facoltà di Ingegneria

Abstract:
Purpose:
The paper aims to develop some thoughts on the upgrade implemented in the disciplines of drawing from the latest forms of digital representation, commenting on the experiences under way in some university courses included in the learning curriculum provided to engineering students with regard to the course of study in Ingegneria Edile (Building Engineering, also known as Architectural or Construction Engineering) at the Politecnico di Torino. It's a matter of reasoning on what and how to suggest knowledge and practises in the experience of teaching that result as an improvement of skills and abilities appropriate for future commitments required by the job world.
Method:
Methodological reasons, subject contents and experiences positively carried out during the activities of the course of Representation Techniques and Data Management (in the post graduate "Laurea Magistrale") are treated, focusing on all the resources needed to conduct profitable operations training and first clarifying the specific skills and experience required for the teaching staff, essential qualities to ensure good results: all the activities organized to achieve the training objectives are based on the belief that early training is needed to trigger virtuous review processes for engineering practice and that opportunities to practice through simulations in the academic curriculum for future engineers can produce effects of greater permanence and enable an enhancement of learning outcomes.
Result:
The analysis, which is addressed primarily to illustrate the result of some of the outcomes of exercise activities leaded by students, brings attention to a solicitation that seems to be constraining and that concerns the system of relations required between operators of the design and construction process, which are requested to enter into shared aims while operating in the specificity of the various technical fields; in this sense, the tricks of the CAD, which is at the service of a geometric knowledge, measured and fulfilled by its attributes, the attention demanded by BIM, which builds a widespread and open network of relationship, the cunnings of the GIS, which has to gather dynamic information and alternative choices, appear to address areas of operational testing following a single purpose directed towards a better characterization of the process of conceptual development and a more advantageous control of the working method.
Discussion & Conclusion:
So, with the design and over the usual representations, we speak of computer tricks to say that to be understood as the necessary infrastructure to solicit and investigate the reasons of doing and how to solve the complexity of operating on the field, upon which students must impractical themselves to identify qualities and limits, whether they are exploring

the reasons of the survey or the reasons bound with the design; certainly a renewal for the most usual ways of designing useful to produce different levels of knowledge and a new shared place for the exchange and discussion of the hypotheses, with what results?

Keywords: Teaching experience, Representation techniques, Data management, Building engineering

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Teaching Methods for Concept Design and Prototyping

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Abstract:
In a product development process, the definition of an adequate design methodology allows to reduce the Time to Market (TTM) and to create new products meeting user's requirements. The design of industrial products starts from the Mission Statement, which gives a brief description of the product and its goals, underling target market and stakeholders, assumptions and constrains that guide product development. Hence, in the early steps of the development process, alternative concepts of new products are generated, evaluated and then selected for further development and testing. In this phase, the first activities consist in identifying customer needs and establishing target specifications. Following actions regard concepts generation and selection. In this context, new technologies, such as knowledge based engineering and rapid prototyping have a significant impact on the reduction of the time and costs needed to verify the technical and functional aspects of the project. This paper reports the teaching experience carried out in the course of "Project Methodologies for Industrial Engineering" of the MSc in Mechanical Engineering at the Second Faculty of Engineering at the University of Bologna. The aim of this course is to supply students with design methodologies and all the related activities that are at the basis of concept development and prototyping. Therefore, students are directly involved, through a design experience, in the creation of a new product from some defined topics and issues. In addition to the conceptual design methods and the Computer Aided Industrial Design tools, students experience the Rapid Prototyping of the designed shape by means of a FDM (Fused Deposition Modelling) technique. In 2008, students, working in groups up to 4 persons, were requested to design a helmet, with an advanced level of customization. Following the phases of the design process, their ideas evolved into new products, which addressed latent needs defined in

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Abstract

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The analysis, which is addressed primarily to illustrate the result of some of the outcomes of exercise activities leaded by students, brings attention to a solicitation that seems to be constraining and that concerns the system of relations required between operators of the design and construction process, which are requested to enter into shared aims while operating in the specificity of the various technical fields; in this sense, the tricks of the CAD, which is at the service of a geometric knowledge, measured and fulfilled by its attributes, the attention demanded by BIM, which builds a widespread and open network of relationship, the cunnings of the GIS, which has to gather dynamic information and alternative choices, appear to address areas of operational testing following a single purpose directed towards a better characterization of the process of conceptual development and a more advantageous control of the working method.

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1 Introduction (gnm)

The education of higher technicians, hence also engineers, has always been a difficult area of exploration, because of the importance of the implications associated with the composite technical culture and forms of development.
"The difficulty we face every day is growing and it is a consequence of increasingly complex dynamics that govern all forms of intellectual activity and that is manifested through a succession of increasingly frequent branches. Finding the connection lines of this species of tree, whose branches grow, divide, and are intertwined in a seemingly inextricable way, is a task that involves all of us." The quotation is from the fascinating lecture that Professor Edoardo Vesentini, professor and former president of Accademia Nazionale dei Lincei, held for the inauguration of the academic year 1997-1998 at the Politecnico di Torino. That lecture, titled "On this side and beyond the technology", effectively condenses the invitation to awareness for those who work in higher education, especially in the university, suggesting the maintenance of an intellectual tension capable of overcoming the diaspora framework and that, without prejudice to the need for specialized in-depth, it sticks to the purpose of continuing to consider the various technical and scientific terms ideally reassembled as part of the unity and universality of culture.
Enthusiastically we joined this spirit of speculation by

presenting an experience designed in a purely educational framework that seems to make more explicit our interpretation. We will do this by presenting cultural motivations, methodological devices and operational initiatives that inspired the design and represent the core of the teaching of Techniques of Representation and Data Management (hereafter TDR&GD, set as an optional module in the second year, second semester of the Laurea Magistrale in Building Engineering at our university [1]). The ambition is to expose the intentions and the things done, some critical considerations and some evaluations of the experience to enable a constructive dialogue with those who, in our scientific community, strive to improve the quality of the educational process and its outcomes.
This paper is divided into two parts. The next section is devoted to the presentation of some issues of more general nature that bind the Building Engineer qualification using the methods that different courses, through their specific educational filter, can be taken to achieve better results. The second section, paragraph 3, covers the organization of educational initiatives in relation to the training objectives of the teaching of TDR&GD, highlighting methological aspects and the outcomess obtained by the students.

2 The Building engineering: a disciplinary contribution to improve education (gnm)

As mentioned above, compared with the era of the classical Engineering, today it is almost impossible to express considerations that are universally valid because of the substantial fragmentation that characterizes the system of ‘contemporary engineering’, as it should be named the coordination of the various sectors that compose the current frame. In fact this situation, the result of a process of gradual, continuous upgrading, appears to be a substantial change with respect to previous periods in the history of engineering [2]. For example, we can read through the unifying representation made by Bernard Forest de Belidor in the first half of the eighteenth century, a vision set out in "La science des ingénieurs dans la conduite des travaux d'architecture et de fortification civil" [3], a demanding task and an important contribution for understanding the technical culture of those times, which is the result of the assumption that the engineering was just one and undifferentiated. To describe the knowledge and the art of the engineers, Belidor sets up a general overview of all disciplines serving engineering, aiming at systematically encompass, in a single framework, theoretical principles, empirical criteria and applications. The method used to communicate this concept relies on an ante litteram hypertext that associated a set of comments, notes, references, illustrations and tables of images according to the criterion of cross-references to the sequential exposure of the text. This is a revealing approach, emphasizing the anxiety to unify the composition, as already mentioned, and implicitly admitting an almost utopian exaltation of technical knowledge [4] [5].
The appeal of such a vision, certainly congenial to the culture of that time, ideally remains alive and unchanged today. However, it is the case to focus on current situation, considering the theme of the education of contemporary building engineers, trying to understand if there are margins that allow to improve the teaching process in order to build a more qualified professional, satisfying the demands posed by this conference, which stimulates us to upgrade to improve. In Italy, in recent years, an intensive review has been undertaken, that has affected many university courses, operation promoted by the need to comply with some regulatory changes that, even in schools of engineering, has resulted in a redefinition and redesign of 'educational offer. The process was long but it has proved necessary and useful to clarify the contents, methods and delivery modes of teaching in relation to some purposes of qualification which have become increasingly pressing.
Citing the presentation on the internet, on the portal of the Polytechnic of Turin, describing the educational objectives of Laurea Magistrale in Building Engineering, it is stated: "[...] this figure works in construction plans and directs their implementation, even coordinating other specialists, working in architecture, engineering, urbanism. The building engineer develops the project at different levels of analysis, preliminary, final, executive; he directs the execution of works in traditional and industrialized construction, both for new and rehabilitation of existing constructions; he is active in the management and organization of real estate transaction, in the management and organization of the building process, with respect to materials, products and components and in the survey and assessment of the housing stock. The building engineer is aware of the complexity of the building, both in connection with its subsystems and in relation to the environment, and the competence for its operation in full and independent responsibility. "[6].
In the section that defines the employment and career opportunities, we mention the elements that define the management role assigned to the building engineer and his responsibilities that are very challenging in any working contexts: "These professional figures are primarily employed in construction and architectural design activities, as well as in managerial, organizational and construction activities, at public technical offices and private construction firms and engineering companies.. "
Even from the information set out in the section on “expected learning outcomes”, it is obvious a need for strong coordination between the educational actions, to be continuously evaluated, to ensure appropriate qualifications to the demands of the workplace[1].
The relevance of these principles and the need to ensure their practical implementation has been expressed through a redefinition of the programs of all courses, designed to form an active educational system that was capable of promoting the educational process as a whole and, at the same time, be flexible enough to ensure rapid development and not hindering future update operations. The contribution offered by the TR & DM is in line with these aims. This course is offered at the second year of Laurea Magistrale, hence in the final phase of post graduate education, allowing for a close link of a large part of the subject content to a foundation of knowledge and skills, deeply rooted. The course was designed taking into account the complex set of skills required for the profile of the building engineer outlined above, as a class

[1] *Based on the Dublin Descriptors (the General Descriptors of education for each teaching degree, 2004, defined by an informal group of specialists from different countries, a reference framework adopted in the European Area for Higher Education) some of the objectives pursued by higher education have been strengthened. Each course defined them according to its own disciplinary characterization: knowledge and understanding, ability to apply knowledge and understanding, making judgements, communication skills, learning skills.*

that elaborates on previous teaching experiences, with the following main objectives:

- presenting, as complementary and integrated, the various forms of technical representation,
- highlighting that the codes of these representations, derived from the different areas of Building, civil and environmental engineering, can be put together in a coordinated and integrated system
- contextualizing the critical survey of representation forms and uses, posing it into a historical and methodological framework.

Basic element in the design of some teaching actions was to promote the use of information methods and technologies for advanced management of technical documentation, activity to be considered as an opportunity to analyze the role of currently used processing media, and to evaluate some innovations compatible with the standards of practice and its trends. In parallel, the presentation of some historical forms of representation is proposed as an opportunity to understand the reasons of those traditional practices that have outlived their function, confirming the purpose of providing evaluation tools to select the most suitable processing techniques for the management of the designing and surveying process.

The presentation of the activities in the program of the course, that Maurizio Bocconcino exhibits in the next section, may further clarify the role assigned to digital elaboration, used for the construction of that managerial sensitivity required to the building engineer. I would like to express some views on this, in order to better illustrate the reasons for some choices made in setting uo the course. I would like to start by making more explicit the use of the sentence “tricks of the computer science”, that appears in the title of this paper and is used to indicate the degree of pervasiveness of digital processing in many design processes.

When adopted, the methodologies promoted by ICT can become a filter that affects or, on the contrary, an element of strong support for computing tasks (for example, the active aid offered to compose the design alternatives in comparable series, which allows to target decision-making by comparative operations). In this way, during the education process now based on a short and focused teaching, it is possible to encourage less rigid speculative behavior, getting used the young engineer in training to assess different solutions, having the possibility to review their validity, without making too heavy the overall process. Also, if we pose the right attention on the complex reporting system that links those involved in design and manufacturing, who are asked to adhere to common goals while operating within the specifities of the various technical areas, we understand that the creation of a communication infrastructure recognized by all becomes very profitable. I believe that the use of computer science mediation in the management of complex design processes, is an exercise that stimulates the conceptual thinking necessary to plan and design the management of the various stages and operations, and therefore it also requires appropriate and specific technical – cultural tools. The digital processing of information can help and become a ‘healthy habit’, that can be transformed from a mere support, designed for the exchange of data, into a framework where structural elements form a functional system for specific and customised purposes, allowing for enhanced construction actions.

For our course, it is worth repeating, the fact of having students who already have design skills, at different levels and degrees of complexity, has facilitated the formulation of a learning path that can take over certain elements from previous courses, trying to re-elaborate on them, putting them together in a more integrated system, supported by increased awareness, often through a revisitation of some experiences centered on the representation.

Thus, through various teaching methods, students are proposed to (see figures 1, 2 and 3):

- reconsider the reasons of CAD (Computer Aided Design) computing environments, with insights that will examine the properties and potential to overcome some habits of use and practices to make it smarter;
- explore how management and organizational attentions offered by solutions for BIM (Building Information Modeling) realize a widespread network of relationships and open to the multiplicity of actions and actors in any process of building production;
- understand the values offered in the field of analytical decision by the GIS (Geographical Information System), data processing to collect dynamic information and requiring a strong organization for the management of resources invested in the process to reflect and conceptualize on the operative testing.

The combination of these fields of application is a functional planning exercise for achieving the educational objectives, is based on the belief that early training is needed to trigger virtuous review processes for engineering practice and the opportunity to practice through simulations during the academic curriculum for future engineers; it can produce effects of greater permanence and enable a strengthening of the same learning outcomes with interesting reflections in the following areas of work.

Indeed, to achieve these desired outcomes, is essential to take great caution regarding both the quality of resources and the necessary investments that make possible the effectiveness and efficiency of the educational process; it’s the matter of fact, of course, to prepare a set of equipment and logistics, but it is above the system of skills and sensitivity of the didactic team that we can produce the strongest effects. Our recent experience confirms these assessments and reaffirm the needing to lead different activities with figures of highly qualified trainers and managers. Our recent experience confirm that, besides the usual representations and technologies, we need help to produce them, we need people able to speak to the students of the needing to investigate the reasons of doing and how to solve the complexity of the engineering field, evaluating opportunities and limitations of different procedures, certainly a renewal for the more usual forms of processing, a new place of speculative and experimental methodology.

3 Methodological issues, practical problems (mmb)

The engineer or the architect who decides to pursue the career of studies addressing the Laurea Magistrale in Building Engineering, has a stock of theories and concepts learned in a relatively short time and in any case closely linked to the executive aspects of the profession, not yet fully aware of the possibilities given from speculative and methodological approach to the questions that should be taken into account if the construction project is required to develop and express itselves in terms of particular complexity of the legal and financial

framework, involving a very articulate variety of institutional and private actors and stakeholders.
If the design is the primary tool to uncover plots and contents for the project [7], computer technologies that support the creation and analysis of information systems allow you to structure the items within a graphic database which can be strictly extracted from the different categories of representations.
Referring to the elements of the system based on their content rather than their location in relation to a reference system - through space and time analysis - there are many cognitive paths that allow you to define and understand the relationships that exist between elements to study and to govern.
In this sense, we must think that the use of automatic processing to make representations on the plan of the paper, it is not only an easier and faster way to produce designs for analysis and design. The efficiency in the production of technical drawings is only a marginal success. The shift that is happening today is what leads from a static representation of the process of knowledge - based on the position and meaning of information, fixed format, that can not be automatically analyzed, although under the guidance of the human intellect – to a dynamic representation, polymorphic information content-based, variable in size and precision in relation to the support and the scale of representation, and analyzed as "fast."
The idea of working with the components of the data project (alpha-numeric, geometric, topological, descriptive) in an unique integrated environment, in addition to not being entirely new to human thinking - that naturally and spontaneously aggregate and analyze heterogeneous data to generate information - is the foundation for good governance of complex processes of knowledge: managing large amounts of data to provide frameworks related to information and knowledge, that's mandatory requirement of the current working teams for the construction project.
If we think to the classical approach oriented to the computer aided design, the ability to organize data can no longer be limited to the old metaphor of "transparent sheets". A more flexible strategy is to enable the association to every elementary geometric entities (point, line, plane) of its non-geometric attributes. Some of these will contain the values needed to access other information and to control the display of graphical entities. Others may be set to associate with each entity more descriptive elements. Entities can be selected, rearranged and displayed based on any combination of these attributes.
Nowadays, the design is then thought as a graphic database, containing semantically described objects, which can be extracted from different categories of listings and offer a significant advantage because you can refer to the structural elements of the system in response to "what they are" and as a function of "where they are located" or "with which elements and how they are related."
The consideration that links the theoretical elements of the Course of TDR&GD with moments of practical activities can be summarized as follows: for the preparation and implementation of the construction engineering project, the design teams are becoming more articulated and composite, the processing time must respond to increasingly insistent demands by increasingly aware users, design needs to collect and process data of various types and formats, and then later to have information that can guide decisions; then there is the need to provide processing tools that consistently meet deadlines for this need of knowledge (efficiency) through a solid organizational scheme of skills and resources involved in the process (efficiency).
The practical activities of the Course of TDR&GD are intended to highlight the exchange of data that can arise between different computer applications while maintaining and, indeed, enhancing and enriching their quality of information and their techniques of representation; these exercises are divided into two complementary phases[2]:

- a first time dedicated to a personal elaboration of the student, through the preparation of his curriculum vitae and the analysis of a website of an excellent professional engineer or architect; in terms of education contents, these two exercises introduce an important aspect of self-awareness compared to the world of work: to present their experiences and their attitudes requires critical thinking, reading the skills to be known by the professionals is also a critical tool to recognize the distinguishing features of an established curriculum;
- a second time dedicated to a group activity based on a theme assigned by the teaching team (thereafter called project); the development of the theme of the project is very complex and involves, for the first time in their academic career, a significant number of people. Probably, until they choose this Course, the working groups to address issues of representation, of urban and environmental survey, of integrated design, were not composed by more than three/four units. The group formed for the Course must rely on the contribution of about ten to fifteen individuality, each one with its own baggage of prior knowledge and enthusiasm with regard to the topics that the teaching aims to develop and that some students meet for the first time. Compared to this organization, it requires the identification of a person for the active coordination of resources, usually represented by a member of the teaching team, which identifies a person responsible for each thematic area of development of the theme of the project: collecting and data analysis, drafting of the "Documento preliminare alla progettazione", the document that describes all the characteristic and needing of the group activities in terms of methods, tools, resources and timetable, organization of the relational database, of the territorial and urban information system, of

[2] *Looking at the tools at his disposal and, for simplicity, to make a list of them, the student engineer that is going to attend the Course:*

- *has already used programs for word processing, but not always used them properly structuring the content of the text or identified with a semantic parts to extract automatically indexes, tables of contents, lists, or hyperlinks to portions of the same document or external to it;*
- *has already used the programs for computing, but without linking it to other information processing programs;*
- *has already used programs for the presentation of multimedia content, but without letting them emerge from documents ordered;*
- *made extensive use of software for computer aided design, but rarely has managed the building elements as a model meta-documented;*
- *has only rarely used relational databases management systems, including geometric components, applied to urban, environmental and architectonic survey;*
- *has adopted graphical languages for the schematic of the building and its features, sometimes called the conceptual model, without knowing deeply their potential of integration with the design of the operative steps of the building process and with the timetable and the financial activities.*

information system building aimed to study geometric modelling or simulation of reality.

To introduce students to some reflections of content through the learning of key concepts for the survey, design and data processing for their representation [8], the first task we assign them, as mentioned, regards the preparation of its curriculum vitae, organized by the interaction of a word processor with a spreadsheet[3]. The "simple" written text has a hierarchy of syntactic units such that the higher-level elements are constructed using disaggregated level units linked together (characters, words, sentences, pargraphs, chapters). In addition to the syntactic level, there are hierarchies and levels within the text related to the meaning of each part (titles, subtitles, captions, notes, lists, etc..) and their relative "indexing". It is not enough: beyond the structure and content of the text, there is a representation code of hierarchies and levels, the style, whereby it is possible to recognize and customize the different parts of the text, the different levels of structure and meaning.

Content, *structure* and *style* are the foundations for the organization, processing and presentation of data, that the Course assume as a constant repeated leitmotif, and we highlight this structuring of information in a simple program for word processing, tool to build, manipulate, extract and analyze the structures, indeed, anything but simple.

The analysis of the website of a designer of international relevance, ask the student to highlight the aspects mentioned above (content, structure and style elements of the site), with the map of the links to the various sections of the site, and method of consultation, along with digital formats available for thematic deepening on the works and projects carried out by the professional.

In this occasion, the main techniques of managing data in a hypertext and the digital formats used for diffusion are introduced and it is highlighted as often a hypertext project has to be derived from the design data by imposing a filter on content that can be made accessible and giving them a graphical representation of communication impact; a set of graphical tools for representing processes and systems such as mind maps and map solution (proposed by Tony Buzan), conceptual maps (theorized by Joseph Novak) and, derived from the last, dynamic and structured maps, entity relationship diagrams, flowcharts and timelines are formally introduced, also through computer applications that graphically support them, generally free and offered by academic institutions and research centers.

Since the articulation made by prescription on the levels of planning for public works - whose contents, in terms of technical drawings, are addressed methodologically in the theoretical part of the Course - the drafting of a well-structured preliminary document for design, which welcomes information from a central database and from which to extract the keywords for the drawing of a concept map, list of planned activities, their estimated time of realization and tha allocated resources and from which to create a presentation from the title contained in this document and a hypertext available on the Internet. And yet, organize a set of tables to be connected to geometric entities that represent the geo-referenced points of photographic survey, or analysis of the urban destinations of use or traffic flow on the arteries or the distribution of public transport in relation to the frequency of passage and to the bus stop nodes, or quantification of the parking areas and private vehicles with respect to the foreseen interventions rather than the functional areas of the project, or the technical specifications, or receive from the system used to design the quantity relevant to the costs estimation or to evaluate the progress and timing of implementation. The conceptual metric model described in the building components that became the virtual simulation to put the project in the urban context. Finally, to coordinate the materials produced in a hypertext reference, also using audio and video. These are, read as listing, the activities that the working group have to organically develop.

The topics of the Course, from academic year 2004/2005, focused on groups of buildings and areas of the City of Turin and were, in order: Murazzi along the river Po, the Palazzo di Torino Esposizioni, the olympic work Palaghiaccio Tazzoli, the Parco del Valentino, the Palazzo del Lavoro, the area of enlargement of the Politecnico di Torino (see figures 1, 2 and 3).

Compared to programs for writing, calculating and summary presentation, re-read in the light of experiences of the first exercises, the management systems databases are introduced in the Course to move a bit beyond the horizon for the processing of data as a representation of facts and phenomena which, although belonging to a particular class (class given by human thought), can relate themselves, and so increase their significance, to other data in the same or in other collections.

Historically, the management systems of databases have made possible to organize the data as sequences, hierarchies and networks of stored numbers and letters: data structures encountered in many contexts. The term database is used with the meaning of permanent and centralized data collection, managed by a computer. Students are asked to represent the schema of the database taking into account: the metadata, a collection of definitions that describe the data structure, restrictions on allowable values of the data (integrity constraints), the relationships between sets and the possible operations, responsability and accuracy of the values, the reference system used, the reference time period, etc.; data, or representations of certain phenomena and facts organized into homogeneous groups with appropriate mechanisms of abstraction (model data), high abundance, permanent, accessible through specific operations, protected from unauthorized access or from problems due to malfunctioning hardware or software, that can be used simultaneously by different users.

From the perspective of the student, this structure is represented by a set of tables where each row represents the elements contained in the homogeneous class or group (elements or instances of that class or group) and the columns represents the attributes that describe the items. The indexing of the elements (usually defined primary key) is the unique identification of each element through an identification code by which you can relate this to other elements of the same class or different classes, according to a relation that can be, from time to time, one to one or one to many and vice versa.

It is therefore necessary that the students build the first general map of the system, from an abstract model (the entities and relationships between entities), to reach, after

[3] *The spreadsheet, list of the experiences of the student curriculum, used within the text document as a source of constantly updated information; the dynamic link between the document's presentation of the curriculum and a set of data outside the text, is used to understand how the presentation of information today is based on the centrality of a dataset continuously updated, retrieved, within structured contents, with their style that reflects their hierarchy through the graphical representation.*

the subdivision of the individual components, their verification and the determination of specifications.
According to the traditional approach, the design usually makes use of models such as entity-relationship for the static component (data), while the functional component uses the data flow diagrams. These tools facilitate the conceptual-graph description from general to specific contexts, respecting the natural capacity of the human intellect, and therefore facilitates the comparison of the elements common to several points of view.
The component-oriented approach to urban and building components has the advantage of following a procedure similar to human reasoning (abstraction, generalization and specialization) at any stage of development. It usually goes along the following steps:

- abstraction of the digital environment: all sources of information shall be released from the context hardware / software that will manage them;
- abstraction of the architectural context: entities (objects) identified in the first step areas cleaned of all the design features related to a particular computer technology;
- identification of the distances between the abstractions:
- all points of view, freed from all kinds of design choices and implementations, are compared to identify differences and commonalities of vision.

The methodology adopted by the working group has therefore an initial conceptualization phase, during which it is studied the problem domain in order to clearly determine the boundaries and highlight the reality of interest. In this phase we have the elaboration, in natural language, of the specific of the domain (the preliminary design document) and is therefore first formalized the conceptual model. The first model is the initial description of the objects of the domain and provides the structure necessary for the definition of the model relations for the project.
In principle, a relational database can directly support a graphics system or a system for geometric modeling. The high-level graphics systems are based on data structures, however, often highly specialized and organized, and therefore not transparent to the user, in order to maximize performance in the most common management and displaying operations. Relational databases, whose main goals are the conceptual simplicity, general applicability and the simplification of update operations and management, resulting in this way too slow, even if the evolution of computing is reducing these effects. However, it is possible to use a relational database and a graphical high-level system combining the data describing the geometric entities. In this way, graphical operations such as insertion and removal of geometric elements can be reported instantly into the database and, in parallel, the processing alphanumeric data can be translated in terms of graphics.
Defined this as the primary purpose of the system, the project requires a structured and sequential series of activities:

- analysis of the main models and information technology for the survey, representation and organization of data processing;
- analysis of the information environment and of applications and distributed information on the internet, needs and requirements;
- analysis of information flows;
- evaluation of implementation time and cost and feasibility study;
- model and conceptual schema of the data;
- technological design of the organization;
- logical data model and schema;
- physical data model and schema of the application.

Actually, the individual steps are not always fully implemented, but there is definitely a trend to which the students seem to begin participating. Professional experience has the task of consolidating a number of methodological aspects that in this time of training can not be completely understood by the students.
As mentioned in the previous paragraph, to establish cross-references between the geometric data and non-geometric information described above, there are two main technologies used in the high level of professional practice and therefore proposed within the course: those for building information systems (Building Information Modeling, BIM), which are primarily to generate, manage and present data of the manufactured housing and its context in relation to its life cycle (from design, implementation, maintenance and eventual disposal) and those of geographic information systems (Geographic Information System, GIS), applied extensively to studies of regional scale, urban environment, with some application of spatial analysis and numerical modeling also at the scale of representation of the building.
The description of the project contained in these information systems of alphanumeric graphic data maintain aggregated elements necessary to disciplines and software that it mixes, relating itself with a solid model in a multiple dimensions space, semantically described and complete with tables of the characteristics of objects used in the composition. This forms the basis for the production of the design details, sectional views, axonometric, perspective, structural analysis, thermal, lighting, financial, and green building.
As for "simple" organization of the text, important consequences can be determined by having a clear idea of the separation between the definition of geometric information and their representation in the drawing. Using more sophisticated techniques of database management, it can be specified the type of entity to be displayed at a certain level of representation. The selective display is not only convenient, but it can be an important tool.
Within the BIM, the students represents the artifact as a set of architectural elements (precompiled library, but customizable, of objects: walls, ceilings, roofs, columns, pillars, doors, windows and so on) associated with elements (rows and colums) of a relational database that stores all non-geometric attributes (precompiled library, but customizable, of attributes: physical and chemical characteristics, materials, functions, suppliers, product codes, unit costs, position within the composition and so on). Rather than simply display layers or views of the model building, the system can then calculate and display technical reports based on attributes and quantities. You can then ask the system to display a map of all divisions of a given settlement plan, an isometric view showing only the structural elements of the building, a list of frames ordered alphabetically or numerically by provider or by financial cost, the calculation of internal surfaces to be decorated, with a diagram that shows all unities intended for a particular purpose and with areal extent exceeding a threshold value, color-coded to highlight the dimensions.
Reports can also be generated to use it as input for other computer applications as database, structural calculation, rendering, animation, spreadsheet, ecc.
The concept of "levels of information" is thus amplified and made it very flexible. Such systems are able to

ensure effective mainstreaming of design processes on a database, allowing a description of centralized and non-redundant information. Every decision and change for the workflow is recorded and becomes an up-to-date and definitive source about the current state of design.
In the light of special needs, you can automatically generate (in the form of technical reports extracted from the database) graphic displays, technical representation for printing on paper or virtual, textual records and other documents as an input for other processing phases. In this way, several members of the group can access portions of data and information appropriate to their duties and to their needs.
The computer applications for cartographic analysis – we propose tools freely licensed and comply with standards - allow the combination of the values belonging to different grids issues (eg permitted use of building elements in urban areas, population density, distribution registry, etc..) to combine them and get answers to specific questions of the project. The same set of values can then be analyzed statistically, and produce graphs and histograms summary of the topic studied. When you have raster representations of the same area collected at different points in time and in series such representations may be made in relation to each other, you can combine spatial analysis for temporal analysis (eg, comparing successive images to highlight the elementary cells, pixels, which differ from their predecessors or certain thresholds).
GIS, in short, are used by students at a basic level, considering that they often lack basic knowledge and therefore it must be matured in the time of the Course, doing the following calculations:

- dynamic management of the thematic layers multiscale/multiprecision for onscreen viewing and printing on paper;
- queries of alphanumeric, geometric and topological type: selection based on attributes of entities, based on the absolute and relative position in space, depending on the combination of the two methods;
- creation of thematic layers on other levels;
- weighted thematic overlaying of layers for the understanding and predictive evaluation of certain urban phenomena;
- connecting to relational and objects oriented databases;
- export of static information system on the internet.

The geographical information system generally produced (particularly in recent years, as the basic knowledge of students, as we find, is annually more and more fertile and culturally and operationally equipped with regard the use of a personal computer, though often based on the qualities of each one, amount that varies widely and randomly within each year of the Course) may intervene in all phases of the project, at the different scales of intervention, as a instruments to support:

- the analysis, because it allows the acquisition and representation of data using tables, graphs and cartograms;
- the assessment and decisions, because it allows multiple simulations in a short time and with several variables simultaneously;
- the implementation, because it allows views at different scales and from different points of view, the rapid transition from one scale to another, the interrogation of the displayed maps;
- monitoring, because the data can be updated continuously and they update the thematic mapping.

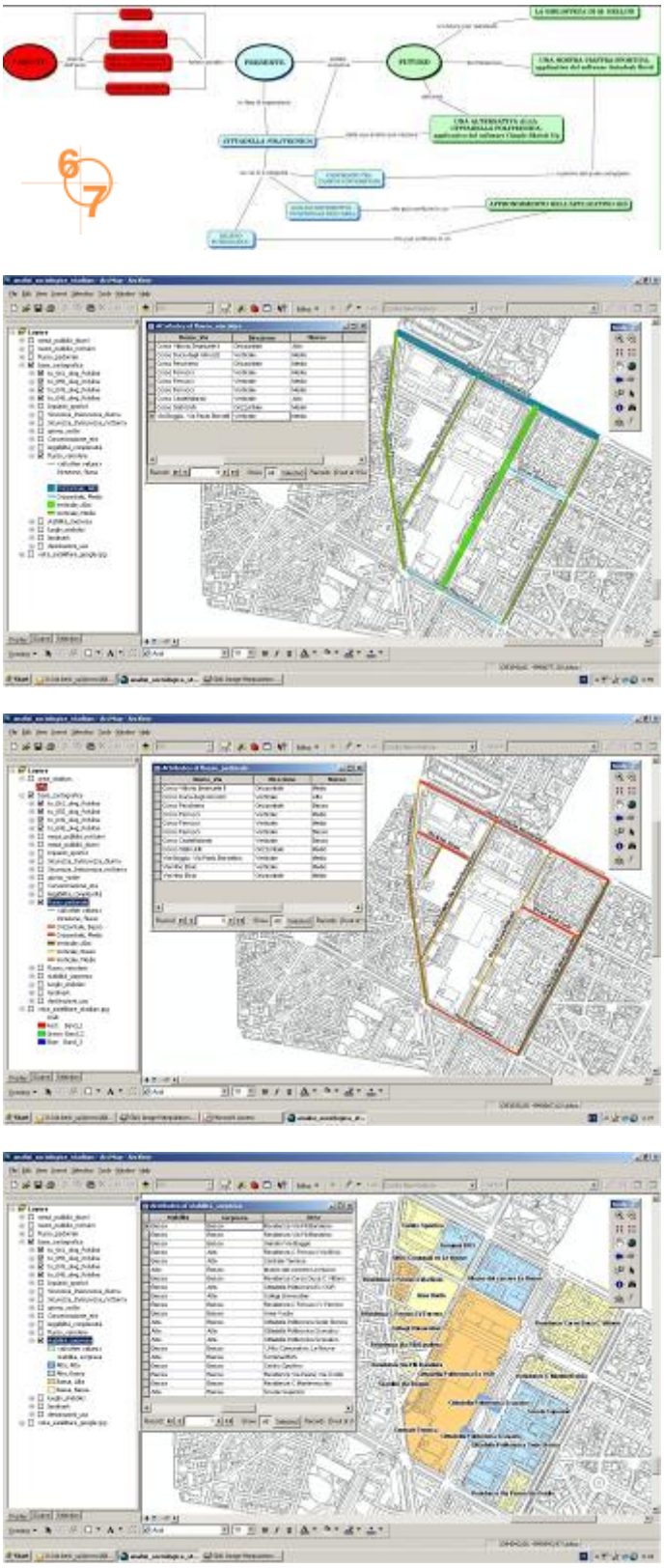

Fig. 1 Conceptual map and GIS analysis: group of work "6+7" of the academic year 2009/2010 of TDR&GD, area of enlargement of Politecnico di Torino. (students: Valentina Gaja, Gianluca Gallo, Claudio Lana, Silvia Magnano, Valerio Marinaccio, Paola Mathieu, Andrea Mirabile, Giovanni Murano, Alberto Ottino, Barbara Pellandino, Stefano Rabaglino, Paolo Sassi, Amelia Saulle).

4 Conclusion (gnm, mmb)

The idea of treating the analysis and design realizing a alphanumeric-graphics database operating in space and time can be extended to allow automatic calculation of a series of combinations of attributes [9]. The characteristics of economy and mathematical simplicity of a relational data model mean that at first glance appears to most students as something external and foreign to the design. Instead, it is a very useful conceptual framework to development planning and design: the relational database, including geometric entities, can become an extremely powerful tools. In a project, after all, nothing is more important than the definition and discovery of spatial and temporal relations that exist between different parts of a whole composition.

The structure of multi-scale and multi-precision data allows representations from the database: as noted above, the management of data using the existing tools of information technology, especially applied to GIS and BIM, requires that data must be structured into classes of objects, whose instances have shared properties. Any representation of certain spatial objects, urban or building, must be completely defined (shape, size and location in space) through its spacial, alphanumeric, and topological quality components.

One of the fundamental choices that students must make concerns the representation and the properties of objects at different scales to view and print: their database of graphics data has to provide a variety of metric precision and detail in relation to the scale of representation required by queries.

The job that awaits them as designers, managers of complex processes, should be aimed at developing the wealth of existing knowledge to draw awareness of the main aspects of the case studies and then organize and use, in a timely and dedicated tools, readings of the different parts of the territory: the result for the Course is a local information system that places the material found in a geo-referenced environment (offering the possibility of space exploration in order to territorial emergencies) and its cultural, historical, developmental charachteristics (values that we need to explore in a temporal, dynamics and layered mode).

Particular importance is assumed by reporting and dissemination of data and any relevant information arising from the design intentions [10], already outlined in the preliminary design.

The most difficult part for the students is to abstract the design process for its schematic, and equally critical to them is to collect data with different accuracies (from small to large scale), depending on the methods of acquisition (and the costs, broadly assumed, related to them) and, through selection, generalization,and sintesi operations, filter the entities that will be handled and associated with these symbolic representations.

The data is the key for the connection of different abstractions, information derived from different contexts and with specific purposes from time to time. The vocation to the integration of the relational approach, which is well suited to the nature of design information, it is assumed as structural. The data can be used in different processes. Hence comes the need to organize local information system to govern the tendency to provide redundancy and reuse, to stimulate the production of quality representations.

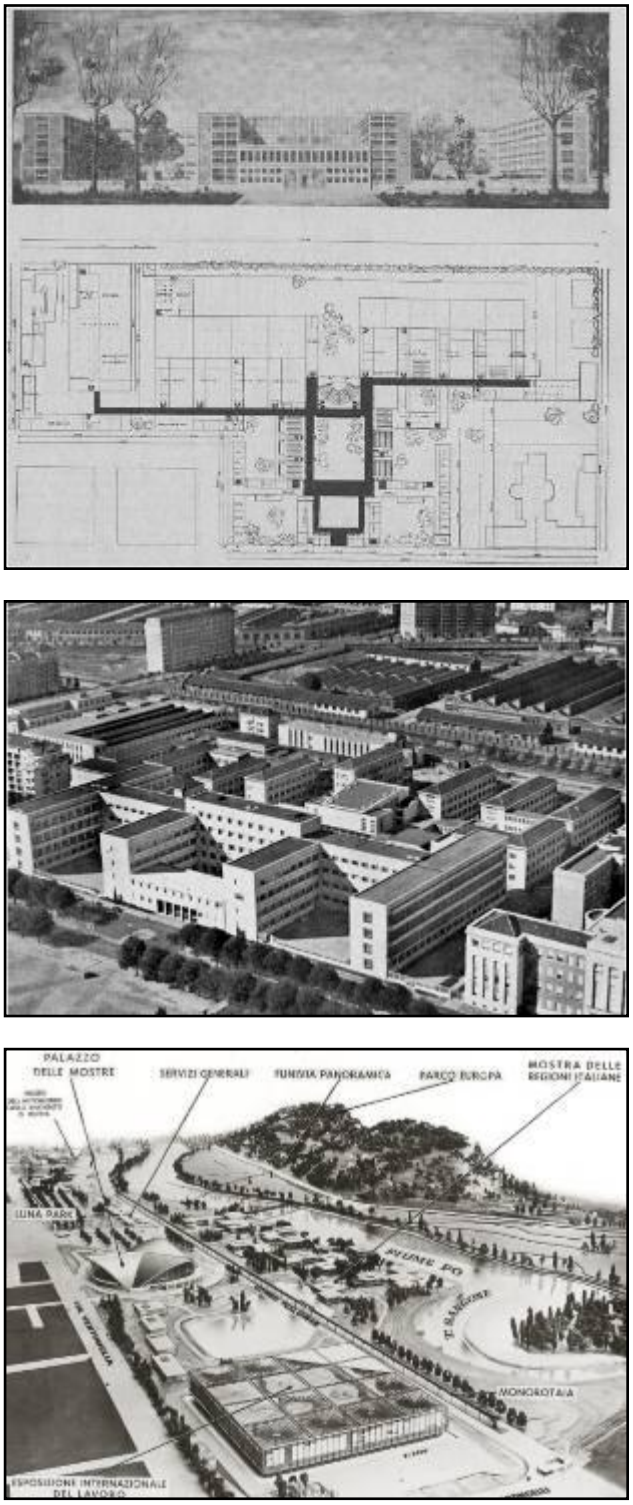

Fig. 2 Two project themes for TDR&GD: enlargement of Politecnico di Torino (academic year 2009/2010) and Italia 61 area in Torino (academic year 2008/2009). From on high: design of the plant at the zero level floor and of the front of Politecnic di Torino, 1950 (source: Atti e Rassegna tecnica della Società degli Ingegneri ed Architetti in Torino, anno IV, n°12, dicembre 1950, p.172); Aerial photograph of Politecnico di Torino in 1959 (source: Atti e Rassegna tecnica della Società degli Ingegneri ed Architetti in Torino, anno 13, n°8, agosto 1959, p.267); a bird eye view of the articulation of works for the International Exposition 1961;

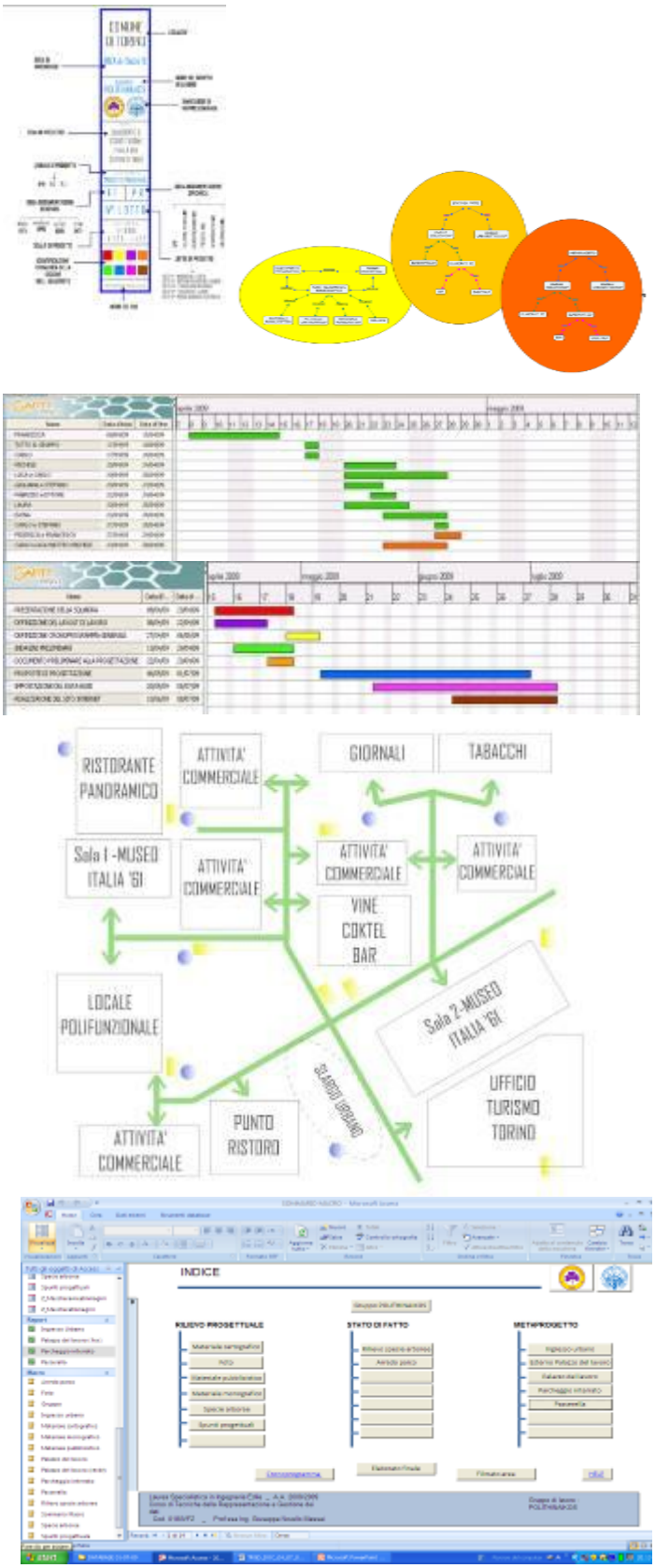

Fig. 3 Organization of the documentation, conceptual map, timetable, database, design hypotheses, excerpt from video of hypothetical interventions: group of work "Polithinaikos" of the academic year 2008/2009 of TDR&GD, area Italia '61 in Torino. (students: Francesca Massa, Federica Garis, Carlo Balduzzi, Elena Serazio, Fabrizio Sanna, Giuliana Bianco, Stefano Baitone, Laura Ferrera, Michele DI Lorenzo, Luca Ferrarese, Matteo Fumagalli, Ettore Varoni).

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