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"The International Conference of New Horizons in Education-2013 (INTE-2013)" is an international educational activity for academics, teachers and educators. It promotes the development and dissemination of theoretical knowledge, conceptual research, and professional knowledge through conference activities, the conference proceeding book. This year, INTE-2013 received almost 830 applications. The conference academic advisory board accepted 760 applications.
The International Conference of New Horizons in Education-2013 aims to diffuse the knowledge and researches among academicians and lead to development in educational sciences.
We have lots of participants from 38 different countries. Some of these countries are Austria, Australia, Brazil, Canada, Croatia, Czech Republic, China, Egypt, Denmark, Finland, Germany, Greece, Hungary, Malaysia, Mexico, New Zealand, Philippines, Poland, Portugal, Romania, Russian Federation, Saudi Arabia, Slovenia, Slovakia, Spain, Switzerland, South Africa, Turkey, United Kingdom and United States

Should you have any enquiries regarding INTE conference, please do not hesitate to contact with us for any additional information you may require.

Finally, we would like to wish you all a pleasant stay in Rome and safe return back home. I hope that INTE-2013 will be a meeting you will pleasantly remember.

We hope we will meet again at the International Conference of New Horizons in Education 2014 in Paris/France.

Thank you...

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Information Literacy Workshop How To Equip Information Literacy Skills To Students?

4th International Conference on New Horizons in Education

Digital and interactive learning and teaching methods in descriptive geometry

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Abstract

During the course of "Fundamentals and applications of Science of Representation - Geometric drawing" (held at the Faculty of Engineering at the University of Palermo) we successfully tested the adoption of informatics tools to enhance the comprehension and the critical analysis of complex figures in the geometrical space. The peculiarity in the teaching methodology was the adoption of interactive software products (*Cabrì Géomètre* and *GeoGebra* concerning dynamic and geometrical constructions; the well-known *Rhinoceros* plug-in, *Grasshopper*, about generating algorithms; *Linceo* regarding implementing the graphic display of complex solids in augmented reality). According to our experience within didactic laboratories, the adoption of ICT allowed us to stimulate and interest students towards subjects of descriptive and projective Geometry and the expected results are very satisfactory. In this paper we show some of the most interesting examples of geometric constructions created by students.

Keywords: digital and interactive learning tools, dynamic geometry, generative algorithms, augmented reality.

1. INTRODUCTION

The integration of Information and Communication Technologies (ICT) in the field of teaching offers the opportunity to enrich and widen the learning environments, spaces where the structures of knowledge can be articulated.

In literature several experiences can be found, which describe the results and the possible developments of the couple education/technology in the learning/teaching processes.

At national level, over the last few years, the Ministry of Education, University and Research (MIUR) has promoted, financed and implemented, in partnership with the National Agency for the Development of School Autonomy (A.N.S.A.S.) and a network of associated universities, a teaching project of digital School called "Cl@ssi 2.0", aimed particularly to the development of the ICT applied in the educational field.

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The national project involved several schools in the area, connected with each other and provided with multimedia devices and technological equipment, with the aim of experimenting possible changes and innovations of the learning environment through the use of technologies in support of traditional teaching (Falcinelli & Laici, 2013).

At European level, the process of renewal of the teaching methodologies has developed a series of similar projects, for example "Escuela 2.0" in Spain and the Project "Capital" in England.

In our university context, the educational path started five years ago in the *Drawing* courses (in the degree programme of *Building Engineering – Architecture* and that of *Environmental and Territory Engineering* of the Faculty of Engineering at the University of Palermo) allowed us to experiment teaching strategies which employ new hardware/software technologies. During the development of the lessons it was found that the exclusive use of analogical – traditional procedures slows down the students' learning processes and limits the understanding of the objects of geometric space and, consequently, their encoding in a plane of reference.

On the basis of these critical issues observed during the development of the teaching laboratory exercises, it was decided to structure teaching/learning strategies allowing the synergic integration of traditional methods with new interactive procedures. The use of hardware (PC, tablets, IWB, graphics tablets, virtual and augmented reality devices) and software digital tools (dynamic geometry, modelling and programming programs) has significantly shortened the times of reception of educational contents, contributing to an active and conscious participation of the students.

The purpose of this paper is to describe a possible renewal path for the teaching/learning processes of the subject, moving on three levels of investigation:

- Organizing and structuring of the didactic educational environment;
- Identification of the most effective methodological – digital tools for the acquisition of the subject contents, aimed at the achievement of certain skills;
- Verification of the cognitive and practical abilities to apply the acquired knowledge, through the creation of digital models and their virtual display.

The main aim is to investigate the innovation and enhancement dynamics, which can be triggered in the learners, without focusing on the technologies in the strict sense (Fig. 1).

2. A DIGITAL CLASSROOM/LABORATORY FOR THE TEACHING OF DESCRIPTIVE GEOMETRY

Before reporting some significant applications elaborated by our students, which summarize the teaching innovation process, we propose an ideal and desirable configuration of a university classroom adopting and promoting the integration of the digital and traditional teaching methods.

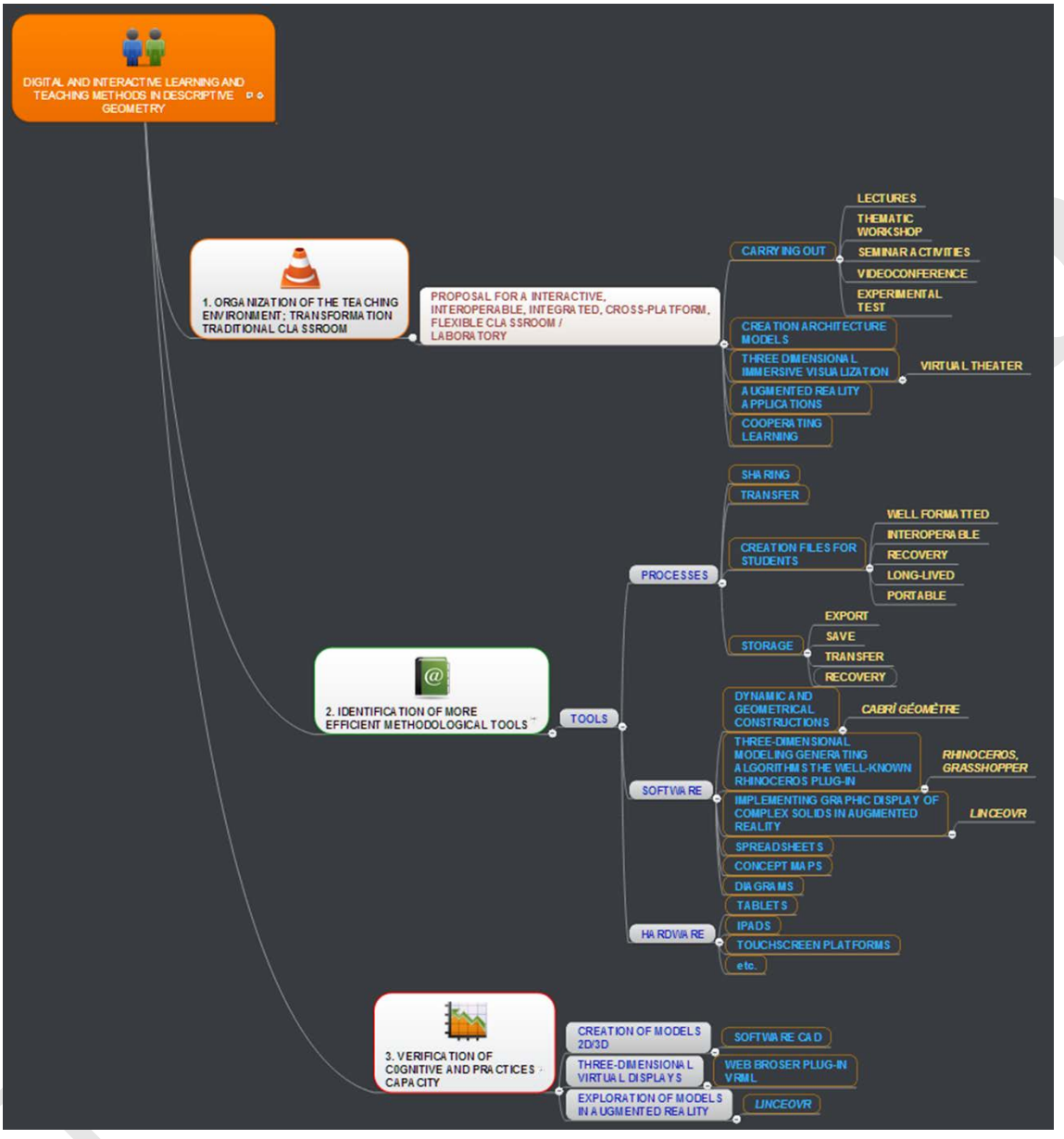


Fig. 1. Conceptual Map about digital and interactive Learning and Teaching methods in descriptive Geometry.

The classroom/laboratory, not yet existing at the University of Palermo, would create a structurally flexible environment, which facilitates the teaching/learning of interdisciplinary contents, and which is provided with hardware/software digital and interactive devices and equipment (Fig. 2 a,b).

In order to start and strengthen the teaching innovation process, it is necessary to change the traditional learning environments and to design new suitable educative spaces. The current spatial configuration of a traditional style classroom, structured in a random and undifferentiated way, should be more functionally redesigned for the logistical needs required by the technological – digital equipments.

In our investigation path, the multimedia digital classroom we propose is conceived as a laboratory becoming classroom, an original and versatile learning place where to develop interactive way of teaching, which allows the involvement of an even high number of students.

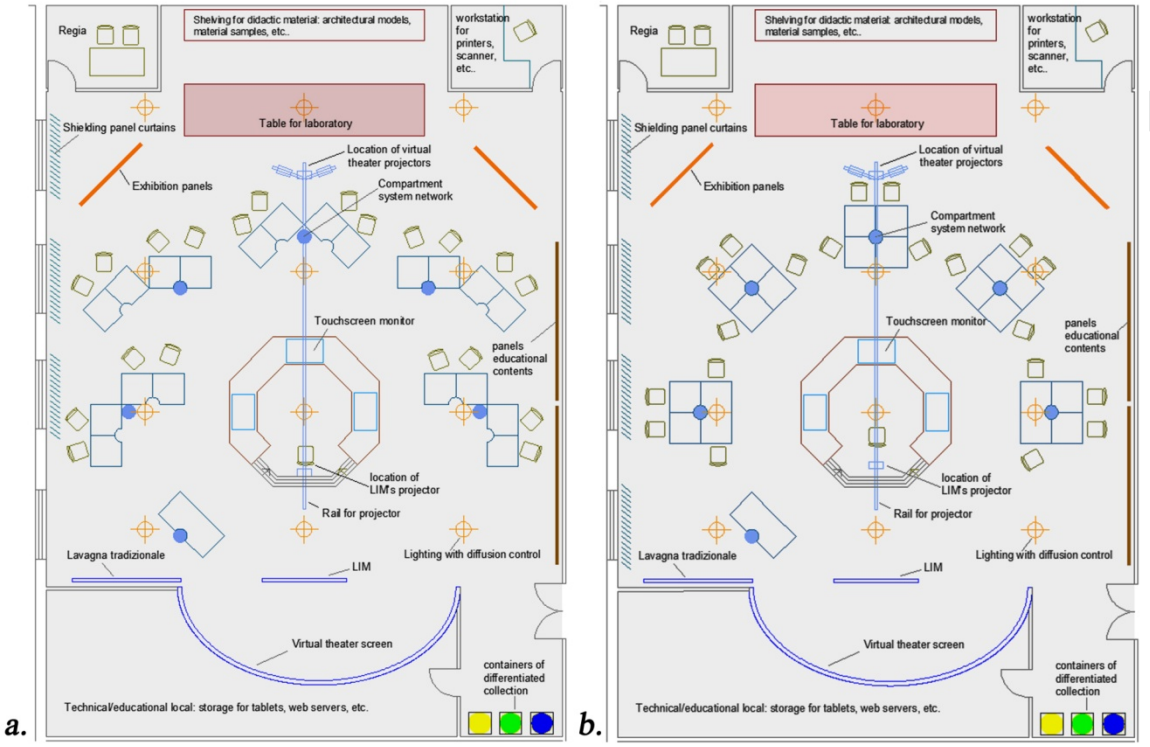


Fig. 2. A proposal of modular configuration for a university classroom/laboratory facilitating the integration of the digital and traditional teaching methods of descriptive Geometry.. a Configuration for laboratorial activities, videoconferences, thematic workshops, experimental tests; b. Configuration for interactive lessons, cooperative learning, seminars.

A classroom/laboratory with instrumental interoperable equipment, that can be integrated with already existing multiplatform devices, in which architectural models are created, virtual scenarios are opened, project experiences are shared with other universities. The proposed technological platform aims to create an environment in which technologies and services, useful for education and computer science culture and technological innovation diffusion, are integrated and available.

The teaching space is designed as an interactive environment, in which it is possible to experience also the immersive three-dimensional displaying techniques for the exploration of geometric models, through the installation of a "virtual theatre" properly set up (an virtual reality environment where, wearing special glasses, viewers can experience immersive environments, thanks to stereoscopic vision). In order to raise the quality of

learning/teaching, particular attention has been paid to the arrangement of the classroom layout, conceived as a highly flexible space, capable to rapidly adapt according to the purposes of the educational moment, to the different activities to be carried out (interactive lessons, cooperative learning, seminars, laboratorial activities, videoconferences, thematic workshops, experimental tests). The interactive lessons, created with open source applications, can be shared using tablets, iPads, touchscreen platforms related to 3D models and to the graphic constructions within the classroom.

3. INTERACTIVE DYNAMIC GEOMETRY APPLICATIONS AND GENERATIVE ALGORYTHMS PROGRAMMING

The subject contents of the educational programme are presented to the class with the support of two well-known *dynamic geometry* software: *Cabrì Géomètre and GeoGebra. Particularly, the latter, developed in JAVA script (Hohenwarter et al., 2009), over the last few years has widely spread among the academic institutions, because it has some peculiarities which guarantee multiplatform operability and consultation through the most widespread browsers. In order to allow the students to consult and browse the geometric constructions made, an e-learning link with private access has been created on the web page of the Library of our Faculty of Engineering. On the course web page, in a dedicated section the html files of the graphic constructions are stored together with the synoptic tables about the handled themes, in order to facilitate the student to highlight and examine in depth some fundamental properties (Fig. 3).*

In the explorative study of the geometric figures, the use of the above mentioned software proves to be a very useful exploratory investigation tool. The controls made available to the user allow to deepen the intrinsic relations among the geometric entities through the manipulation (repositioning, rotation, expansion) of control points in the created constructions (Figg. 4, 5, 6).

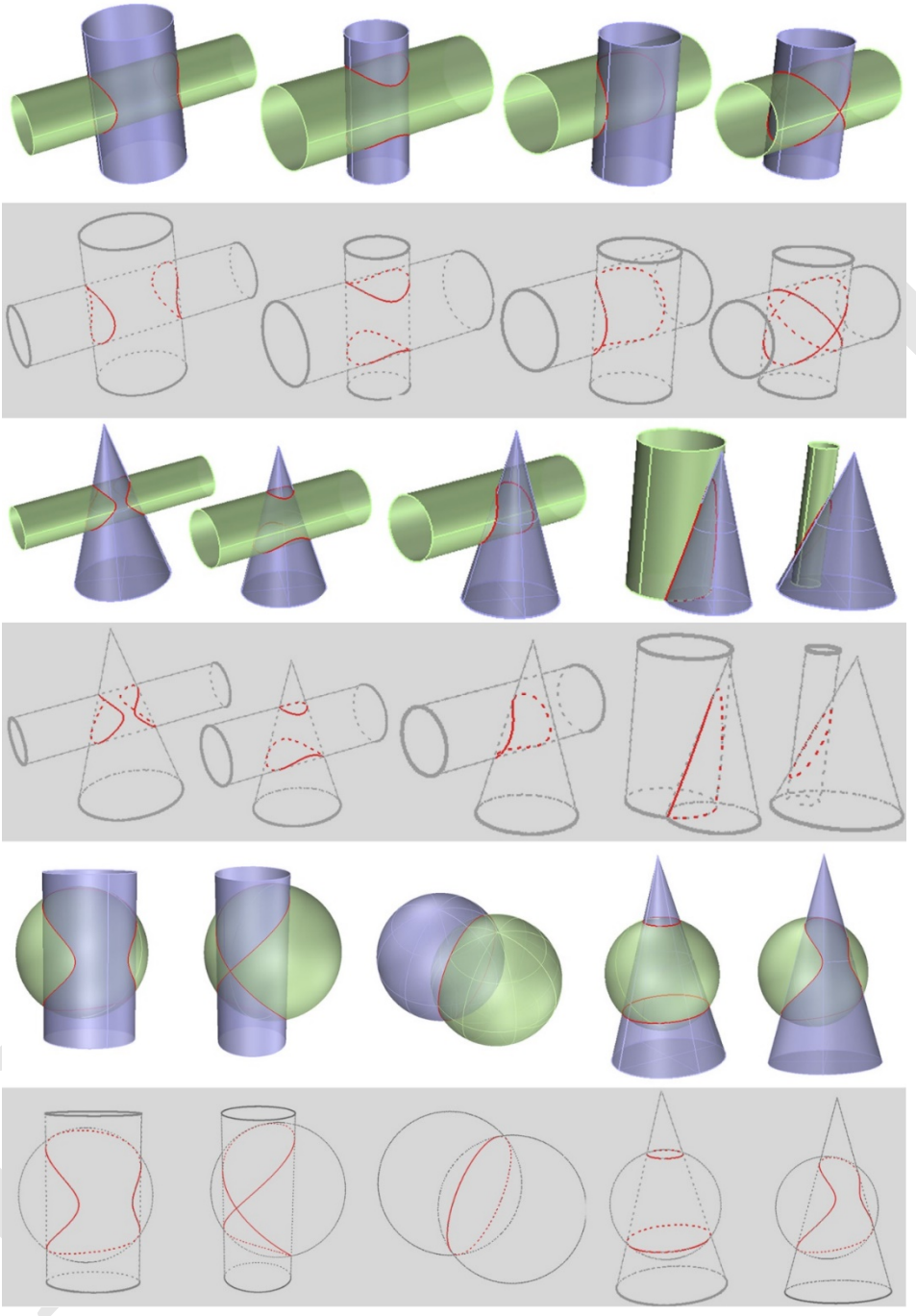
During the construction process, it is possible to validate the initial hypothesis, speculate and verify the properties and the relations which remain unchanged or vary during the geometric transformations.

Compared with the traditional paper and CAD digital drawing, the students are allowed to change the position of the starting geometric entities, configuring, in this way, dynamic displays. For the understanding of the sequence of the graphic operations generating the geometric figure, important and effective interactive modalities are highlighted: the “step by step” reproduction of the graphic process; the display of the construction protocol with the list of the executed controls; the construction of “geometric places” of points, which satisfy certain conditions.

The use of these tools has allowed us to enhance the interaction between the theoretic – conceptual and the figurative component in the reasoning of descriptive Geometry, offering reflection occasions to sharpen the cultural and educational knowledge of the Science of Representation.

For example, a structured table is reported, which introduces the perspective reference system and the representation of the fundamental entities. The analysed figure shows the geometric layout of the perspective reference system simultaneously in 3D, according to a scheme in oblique axonometry at 45° (to the left) and, in 2D according to a two-dimensional scheme directly on the squared plane □□□ to the right□□Whilst remaining unchanged the construction process (executable “step by step”, operating with the buttons of the control bar at the bottom), the geometric entities can be manipulated modifying the visual perception of the entities image, on the squared plane and simultaneously in space (Fig. 7).

In the subject teaching planning, particular attention is paid to the study of surfaces (ruled quadric, developable quadric, of revolution, interpolation, helical, free forms) and of curves, generatrix and directrix, which compose them. The procedures adopted to construct them are structured parametrically and controlled within a *Grasshopper*, plug-in of the well-known generative modelling software CAD *Rhinoceros*. The use of generative algorithms for the modelling of a geometric shape is an approach (Tedeschi, 2011) which has enabled us to: automate the procedures; generate parametric models that allow changes to the initial geometries; investigate on of several spatial configurations of intersection between different kind shapes (Figg. 8, 9).



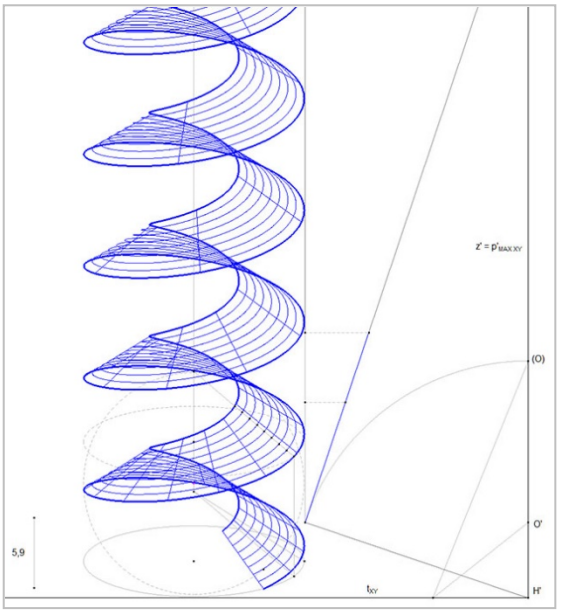


Fig. 3. Synoptic tables about the intersection of quadrics, in order to facilitate the student to highlight and examine in depth some fundamental properties.

Fig. 4. Direct orthogonal axonometry representation of a right helicoid ruled surface. The interactive dynamic construction was made with Cabrì Géomètre.*Géomètre.*

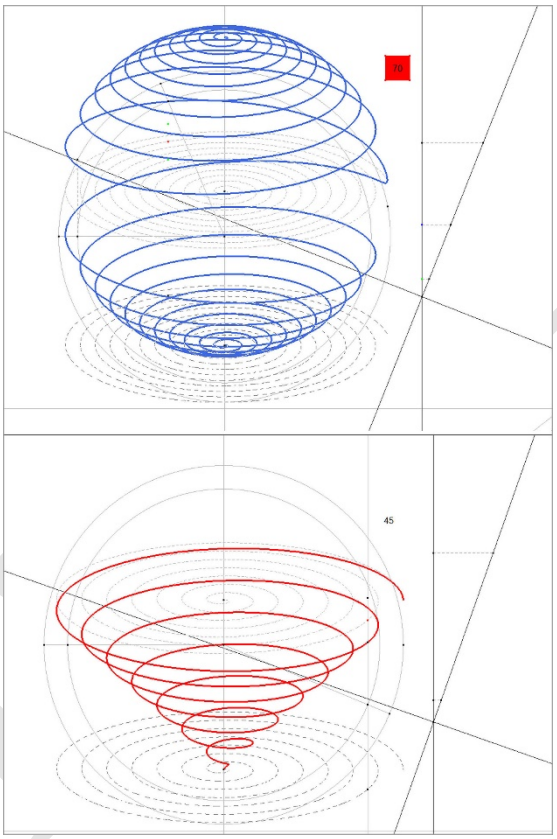


Fig. 5. Direct orthogonal axonometry representation of crooked spiral curves: at the top, a spherical spiral and, at the bottom, a conic spiral. The interactive dynamic constructions, made with *Cabrì Géomètre*, allow to set the helixes pitch, coil changing the visual perception of their image.

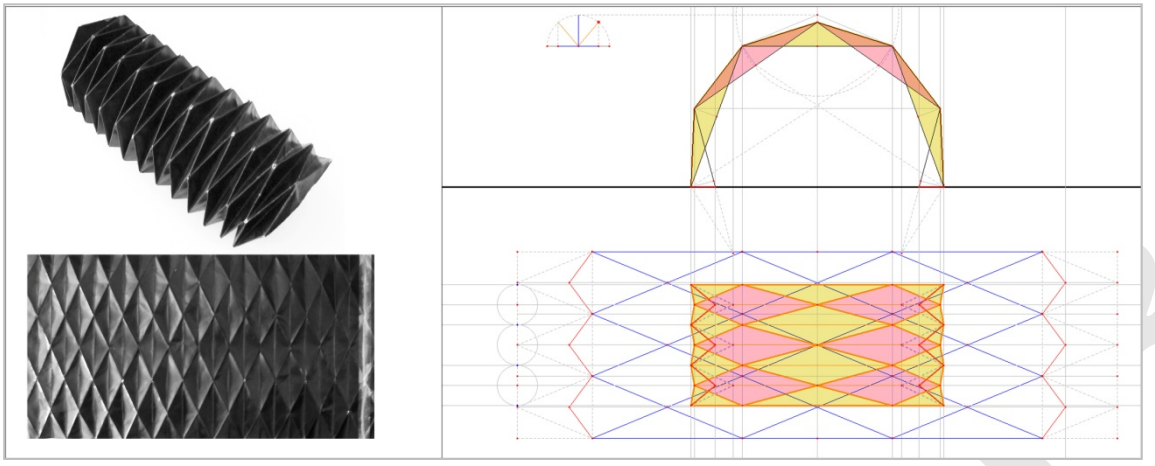
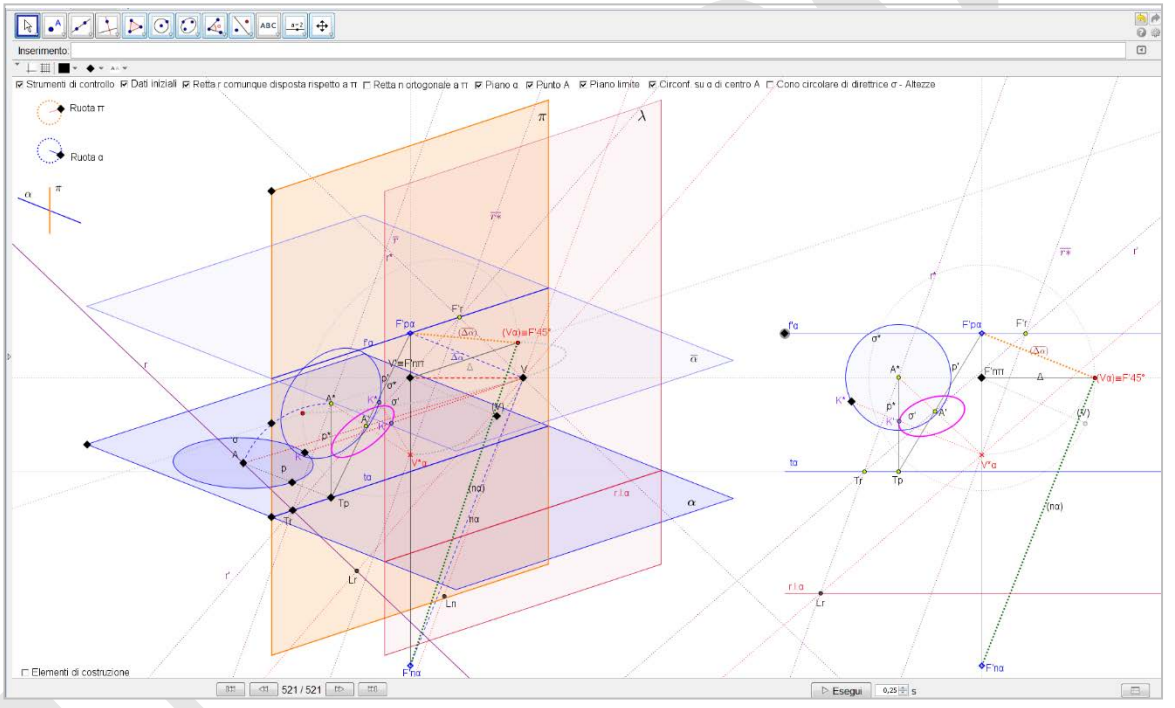


Fig. 6. Pleated prismatic surface resistant in form and its development on a reference plane; to the left, cardboard scale model and, to the right, interactive dynamic construction made with Cabrì Géomètre.



4. INTERACTIVE DYNAMIC GEOMETRY APPLICATIONS AND GENERATIVE ALGORYTHMS PROGRAMMING

During the exercises in class, the students study and represent significant examples of existent architectures, which present geometric-spatial complexities handled during the course.

Geometric and architectural models created in class are exported into VRML format (Virtual Reality Modeling Language) for the display in a common Web browser and made available for the whole class in a single multimedia storage.

To better understand form, geometry and structure of the realized architectural models, our course employs also the Augmented Reality (or AR) technology. The AR, the set of technologies which allow to "augment" a real scene (Primavera, 2010), is a young computer science discipline at experimental stage, pertaining to "computer graphics", that deals with the overlay of digital contents to the observed real world. It integrates new ICT and communication forms, showing a representation of an augmented reality in which, to the normal display perceived through our senses, artificial/virtual sensorial information is added.

In our context the AR is an excellent teaching aid, as it allows the students, through marker identification tracking procedures, to display in real time the constructed three-dimensional models.

With the simple movement of the selected marker it is possible to explore in all directions three-dimensional objects not actually existing (Fig. 10).

The technology using dedicated software (the one we used during the course is *LinceoVR*) is structured into three simple steps:

1. Object *identification* (the object usually consists of a printable marker, as link between the real and the virtual world) observable by means of a fixed or mobile viewer (video-camera, smartphone, tablet), with data processed by a computer.
2. Real time *tracking* in the space of the observed object.
3. *Mix* of the support (i.e. the 3D model) with the marker.

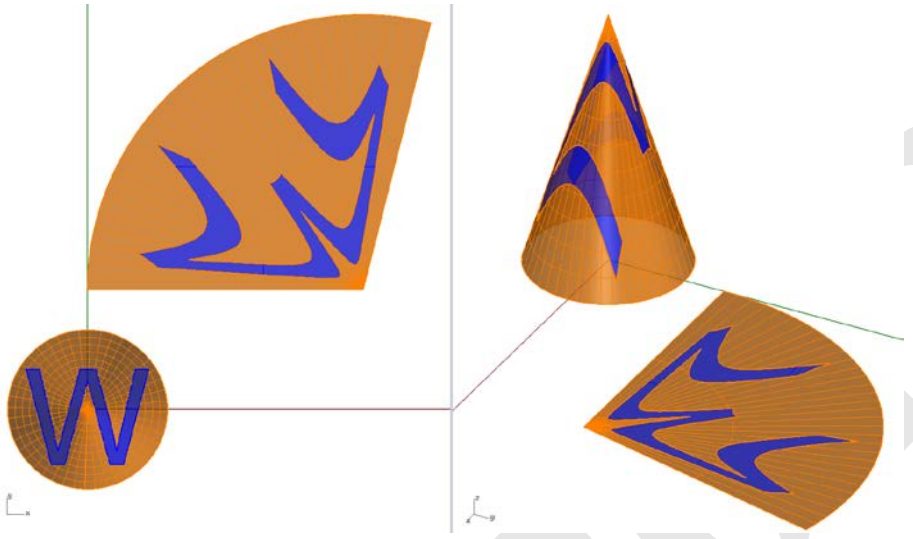


Fig. 8. Example of anamorphic projection of a plane figure (letter “W”) on a conic ruled surface and development of the system on a reference plane.

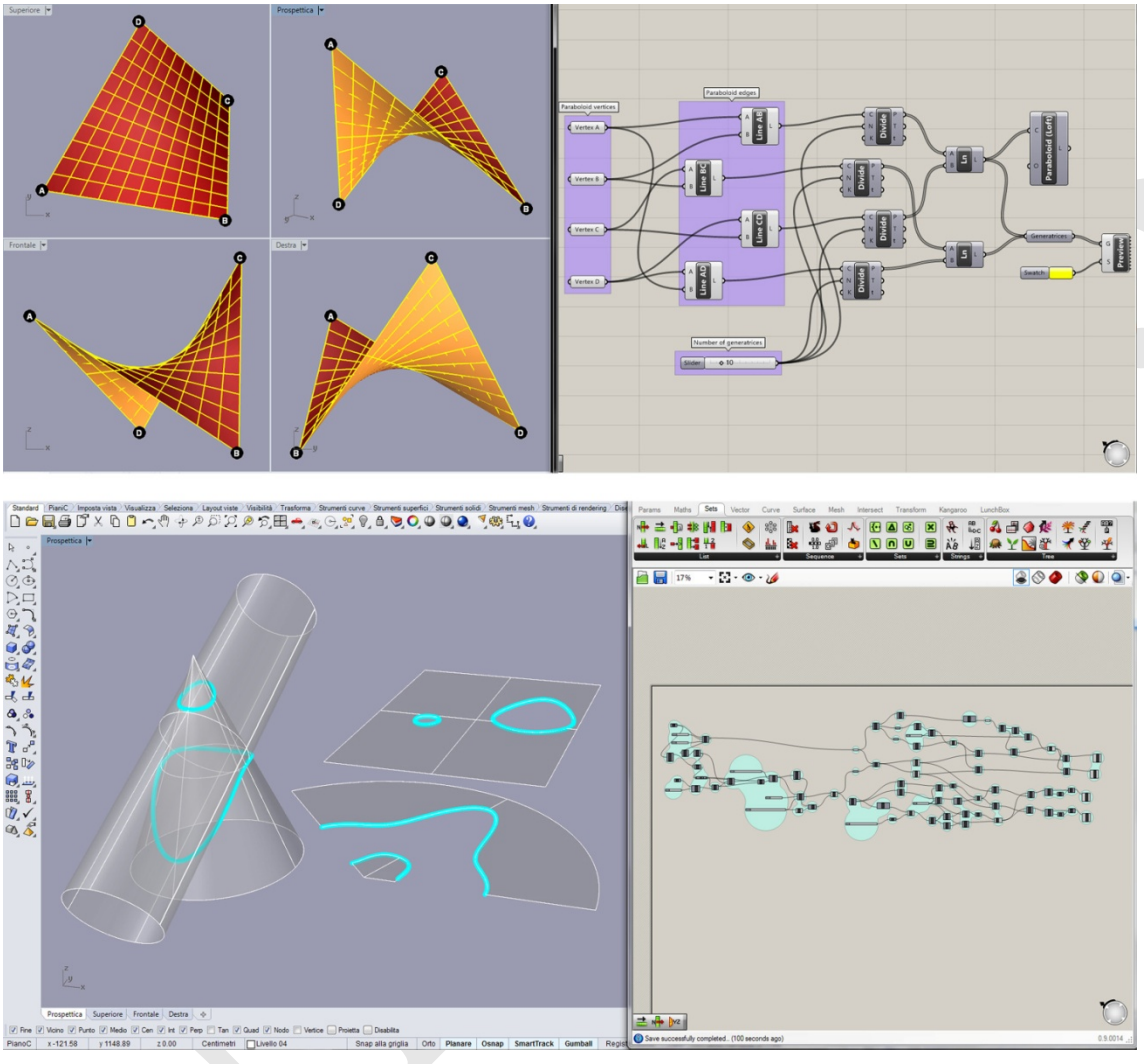


Fig. 9. Two examples of generative algorithms for the modelling of structured surfaces parametrically controlled within *Grasshopper*, a plug-in of the well-known CAD software *Rhinoceros*. At the top, a crooked rectangle with a portion of hyperbolic paraboloid subtended to it; at the bottom, intersection of a cone and a cylinder anyhow organized between them, and development of the surfaces.

5. CONCLUSIONS

On the basis of our teaching experience, structured and shared with the students through the introduction of technological solutions for communication, management and access to the discipline contents, we strongly believe that teaching cannot overlook the smart integration between ICT and knowledge anymore.

Innovation implies the acquisition of digital skills by the professors and their training to be in step with the new media languages, in order to effectively and consciously integrate them in the teaching of their discipline.

Pier Cesare Rivoltella, professor of Teaching and Learning Technologies at the Università Cattolica of Milan, well summarizes the necessary change of the teaching approach. In a recent speech given at the Pontificia Università Lateranense, he says: *We live in a circumstance in which didactics seems not to be a professional skill for the professors anymore. This is proved by the fact that the new recruiting procedures will evaluate only their research activity. At the same time, didactics is nevertheless one of the main requirements to work in a context in which practices and behaviours of young people are increasingly marked by the presence of the new languages and meaning construction forms and more and more distant from the traditional lecture model.*

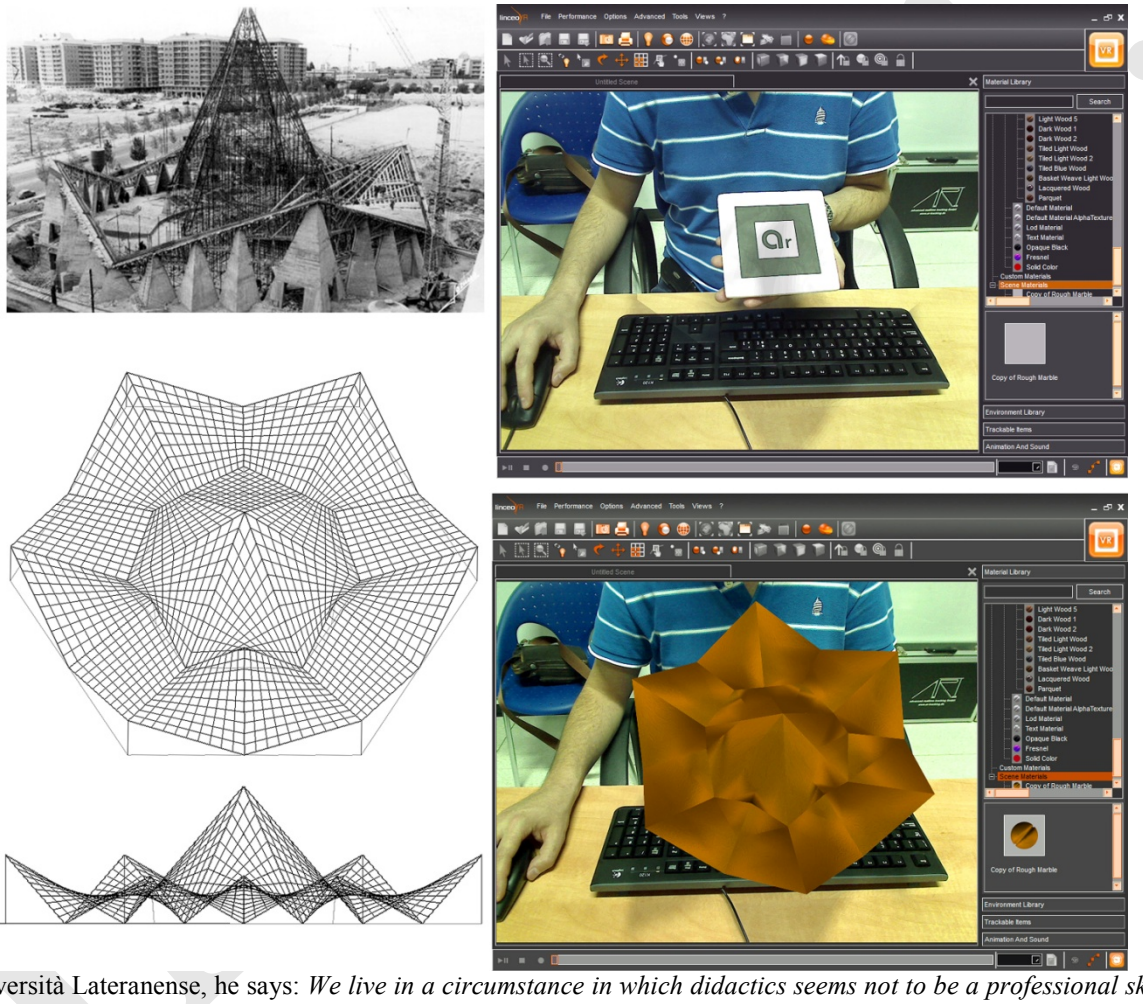


Fig. 10. To the left, orthogonal projections drawings of a composition of hyperbolic paraboloid surfaces (Iglesia Nuesra Señora de Guadalupe, Madrid, architect Felix Candela). To the right, two freeze-frames of a real time display of the three-dimensional model in augmented reality within the software LinceoVR, which show the three steps of the procedure: identification, tracking and mix.

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Appendix

Some references of sitography are reported, which are significant but not exhaustive, regarding the couple education/technology in learning/teaching processes.

http://www.cremit.it/

(Centro di Ricerca sull'Educazione ai Media all'Informazione e alla Tecnologia. Il CREMIT nasce nel novembre del 2006 come centro di ricerca che affianca le scuole, a livello di formazione degli insegnanti e di intervento nelle classi, sui problemi dell'educazione mediale e dell'ICT).

http://www.istruzione.it/innovazione_scuola/default.htm

http://www.scuola-digitale.it/classi2.0

(MIUR, progetto Cl@ssi 2.0)

http://www.sero.co.uk/capital.html

(progetto "Capital").

http://www.ite.educacion.es

(progetto "Escuela 2.0").

http://www.scuola-digitale.it/editoria-digitale/il-progetto/editoria-digitale-scolastica

(MIUR, azione "Editoria Digitale Scolastica", strumento di supporto per docenti e studenti nel processo di innovazione degli ambienti di apprendimento).

http://www.igi-global.com/chapter/ict-classroom-new-learning-environment/72056

http://www.igi-global.com/chapter/geogebra-institute-torino-italy/72094

http://www.learningforall.it

(L4ALL è un progetto triennale di ricerca FIRB (Fondi di Investimento per la Ricerca di Base) 2007 finanziato dal Ministero dell'Istruzione, dell'Università e della Ricerca (MIUR). Il progetto mira a indagare come un utilizzo consapevole delle tecnologie possa contribuire ad innalzare la qualità della didattica, in specifico per gli allievi con necessità particolari. Il risultato concreto del progetto sarà un Repository online in cui verrà raccolto un ampio numero di buone esperienze didattiche basate su tecnologie.

http://www.lacasadegliinsegnanti.it/PORTALE

http://ec.europa.eu/digital-agenda

(The Digital Agenda is the EU's strategy to help digital technologies).

http://dera.ioe.ac.uk/6347

(2020 vision: report of the Teaching and Learning in 2020 Review Group)

http://www.indire.it

(Sito dell'Istituto Nazionale di Documentazione per l'Innovazione e la Ricerca Educativa)

http://www.scuolab.it

(servizio del Politecnico di Milano, nel quale sono raccolti numerosi progetti di didattica multimediale).

http://www.aace.org/pubs/default.htm

(Association for the Advancement of Computing in Education).

http://www.mediamente.rai.it/HOME/bibliote/biografi/m/maraglia.htm

("La nuova didattica multimediale", intervista a Roberto Maragliano, docente di Tecnologia dell'Istruzione all'Università di Roma 3, presso il Dipartimento di Scienza dell'educazione).

www.triangle.co.uk/jit/index.htm

Sito della rivista internazionale Technology, Pedagogy and Education, dedicata agli educatori e tesa a supportarli nell'integrazione dell'Information Technology all'interno dei processi d'insegnamento e d'apprendimento. http://www.aace.org/pubs/default.htm

Sito dell'Association for the Advancement of Computing in Education, la quale patrocina diverse pubblicazioni sul rapporto tra tecnologie ed educazione.