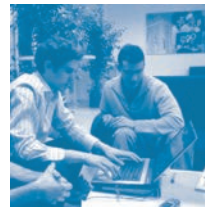
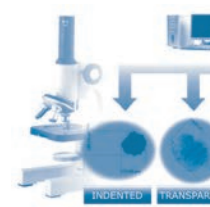
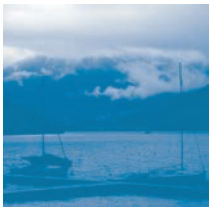




Multidisciplinarity and innovation ASP projects **2**



POLITECNICO DI MILANO
POLITECNICO DI TORINO

**Multidisciplinarity
and innovation**
ASP projects **2**

Preface

It was during a meeting in 2005 that the Alta Scuola Politecnica started as an attempt to find an idea to merge the experience of the two Politecnico (Politecnico di Milano and Politecnico di Torino) through a different way of making education.

Our universities are known for giving students a strong scientific culture and deep knowledge in engineering, architecture and design. Our graduates are placed in the job market after only a few months after their graduation.

But the challenge was more than this. We knew that it was not enough to focus on specific disciplinary fields, as the vast majority of graduate education does, even if our level of education is very high. We wanted to explore new fields, to experience new ways of educating young people.

Suddenly, after a long brainstorming, we realized that there was only one way to make a change: the creation of a career institutionally located outside a specific graduate program based on an interdisciplinary approach and innovation.

The program was called ASP, Alta Scuola Politecnica.

We were aware that the chances of creating innovation depended on our capability of fostering cooperation between different experts and professors, and that we had to work hard to achieve our goal.

Many questions were asked: how students that simultaneously attend different disciplinary programs can also have the time to work together in an additional program like the ASP? How can they work together, as they are in campuses in two different regions? How can we explain to them the interdisciplinary value? Will they succeed in cooperating? Will they understand each other? Will they value the contributions of professors that are coming from completely different backgrounds, and whose contributions will make sense in the long term? How can we provide interdisciplinary capabilities without losing focus? How can we enforce (and not dilute), through interdisciplinarity, the core competence of polytechnic universities, that is capable of envisioning new possibilities and implementing them, regardless of the specific field of activities? In the end we were persuaded that ASP could be the right answer.

Besides, we knew that the ASP was inherently an experiment and that it would remain a living experiment for a long time to come. The ASP, with its flexibility and independence from common norms and rules is a territory where we can continuously experiment new educational routes.

At the end of their ASP experience, students prepare a multidisciplinary project which represents only one half of the ASP program (the other one consists of lectures). The projects, however, are the educa-

tional context where everything conveys. That's why this book is a concrete example of how students who normally are quite never exposed to a multidisciplinary way of designing and all belong to the same graduate program, can work together, merging their disciplines and their different approaches in team work.

Of course, creating ASP required the support and work of many different institutions - the Ministero dell'Università e della Ricerca first of all made this project possible through a significant investment - and investors: Camera di Commercio di Milano, Compagnia di San Paolo, European Patent Office, Fondazione Cariplo, Enel, Ferrovie dello Stato, Luxottica Group, McKinsey&Company and The Boston Consulting Group.

Our investors have the possibility to meet our students while they are in their educational process, to discuss with them about innovation and to challenge them with new projects. Being confronted with the needs of manufacturing, industrial and public administration sectors is therefore a fundamental requirement of our students' training and make them enough capable to face complex and multifaceted problems.

While looking through the projects the reader also has the chance to "sample" our multifaceted community formed by teams of students, teams of professors from different disciplines and external institutions.

We encourage students to remain in contact after their training period through the ASP Alumni Association, a network organized to help them to build strong, productive alliances within the community - alliances that will enrich them throughout all stages of their careers. Thanks to this association alumni have the opportunity to stay connected to ASP and to each other, upgrading their careers through events, career resources, networking, and late-breaking faculty research.

The ASP, however, is mostly an experience not only for the students but also for the professors, the firms and institutions involved, and – last but not least – for the participating staff. The ASP is a community rather than a series of lectures and projects, a real place where visions, challenges and aspirations can be shared.

Prof. Giulio Ballio, Rector, Politecnico di Milano

Prof. Francesco Profumo, Rector, Politecnico di Torino

The Investors

ASP has been funded by external institutions supporting and sharing our vision of educating talented students and promoting interdisciplinary innovation. The main contributor – to whom we are particularly thankful – is the Italian Ministero dell’Università e della Ricerca, who provided endorsement and financing for this unique initiative. Other institutions soon joined in, becoming Investors who provided financial support, educational guidance, a ground for developing projects, and opportunities for future career development of our students. The ASP Investors, whose precious support is hereby acknowledged, have the opportunity to meet our students while they are in their educational process, to discuss with them about innovation and to challenge them with new projects.



MILAN CHAMBER OF COMMERCE

Higher education is one of the cornerstones of activity of the Milan Chamber of Commerce. The main goal is to support the capitalization of knowledge and the definition of educational paths to excellence aimed at encouraging a constant increase in highly qualified foreign human resources who decide to study in the area. This perspective includes the Milan Chamber of Commerce's commitment to promotion of the Alta Scuola Politecnica, which represents a valuable model of integration within the macro-regional reality of the North-West, contributing key elements to the territory such as, for example, innovation and interdisciplinarity.

Over the years the Milan Chamber of Commerce has actively supported the birth and development of this School, helping to reinforce its internationalism through intense valorization started up in strategic areas and stimulating projects with incentives for young foreign students admitted onto its courses. Scholarships are however only an initial support tool for the students involved.

The aim of the Milan Chamber of Commerce is in fact to actively involve this selected human capital in the process of analysis of areas and topics of importance for the Lombardy and macro-regional socioeconomic milieu. In particular, the Milan Chamber of Commerce promotes the elaboration of ideas and projects born out of the application of specialist interdisciplinary competences to traditional educational paths and the integration of students at the School in prominent businesses in the macro-regional area.

www.investinmilan.com

www.mi.camcom.it

www.promositaly.com

COMPAGNIA di San Paolo

The Compagnia di San Paolo, founded in 1563 as a charitable brotherhood, is today one of the largest private-law foundations in Europe with assets of approximately 9 billion euros.

It pursues aims of public interest and social use, in order to foster the civil, cultural and economic development of the community in which it operates. The Compagnia is active in the sectors of scientific, economic and juridical research; education; art; preservation and valorization of cultural heritage and activities and of environmental assets; health; assistance to the socially deprived categories.

In 2007 the Compagnia awarded 1,122 grants in its areas of activity, amounting to 167.4 million euros. 238 grants were awarded in the Research sector, amounting to 38.5 million euros, and 84 grants were awarded in the Education sector, amounting to 18.2 million euros.

The Compagnia pays particular attention to advanced research and to the development of scientific and technological centres of excellence, seen both as catalysts and multipliers of research and higher education initiatives. It supports the reinforcement of Torino's university system, especially through the promotion of excellence at Politecnico di Torino and the University.

The commitment of the Compagnia in the field of Education is focused on university and post-graduate education, starting from the growth of human capital, internationalisation and the provision of infrastructures, with special attention to the conditions that assure equal access.

www.compagnia.torino.it



Cariplo Foundation, established in 1991 as a nonprofit organization with the purpose of furthering the common interest and the public good in various fields, is today – thanks to the sheer size of its assets (over 8 billions euro) - one of the world’s leading philanthropic entities annually making grants to organizations for projects and initiatives it judges worthwhile. In 2007 Cariplo Foundation awarded 1.174 grants in its various areas of activity, amounting to 196.8 millions euro. 181 grants were awarded in the scientific research and technology transfer area, totaling 48.5 millions euro. Between 2001 and 2006 the scientific research sector of Cariplo Foundation received about 2.000 applications, appraised 1.500 projects, and funded 450 projects. Cariplo Foundation pays particular attention to the support and promotion of human capital development, particularly by focusing on a limited number of projects whose purpose is to start activities capable of achieving excellence in university and post-university studies. Furthermore the Foundation is also firmly convinced that actions in support of “excellence human capital” must entail a close connection between training and teaching activities, on the one hand, and research and exposure to an advanced international scene, on the other. These are the motivations underlying Cariplo Foundation decision to support the ASP, an advanced international Faculty able to attract the best young foreign students and able to educate Italian high profile graduates.

www.fondazionecariplo.it



Enel is an international group that produces, distributes and sells electricity and gas in 21 countries over four continents. Among listed utilities companies in Europe, Enel is the second largest in terms of installed capacity with around 80,000 MW and is one of the leading companies by number of customers, with almost 50 million families and companies living and working with our energy every day. Enel is also the second largest distributor of natural gas in Italy and it sold 5.5 billion m³ of gas in 2007, in the national market and abroad. Listed since 1999 on the Milan Stock Exchange, Enel is one of the biggest European companies in terms of shareholder number (approx. 1.7 million) and current market capitalisation of around 43 billion euro. 76,548 people work for Enel. The Group’s principal companies are: Enel, the leading operator in Italy; Endesa, leader in the Iberian peninsula and South America; OGK-5 in Russia; Slovenské Elektrárne operating in Slovakia; Enel Energie, Enel Distributie Dobrogea and Enel Distributie Banat in Romania; Maritza in Bulgaria; Enel North America in the USA and Canada; and Enel Latin America in South America. Enel is also present in France, Greece and Morocco.

www.enel.it

McKinsey&Company

McKinsey&Company is a management consulting firm, operating on a global basis and serving many of the world's most successful corporations.

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We take pride in serving and building enduring relationships with leaders belonging to 70 percent of Fortune magazine's most admired list of companies.

As part of our mission, we help our clients make distinctive, lasting and substantial improvements in their performance by assisting them in the key business challenges they have to face, such as – among the others – turnaround programs, growth strategy, international development and change management plans. In order to meet this objective, we need to constantly build a firm that attracts, develops and retains exceptional people.

We are therefore looking for talented resources: we seek individuals with leadership potential, integrity, a sharp analytical mind, and the ability to work with people at all levels in an organization. We are committed to caring for our resources, contributing to their career development as professionals and providing them with the skills they need to acquire client-oriented leadership.

McKinsey is proud to be an ASP Partner and cooperate on talents' development through workshops and initiatives dedicated to students. Today's new hires are tomorrow's leaders.

www.mckinsey.com

BCG

THE BOSTON CONSULTING GROUP

The Boston Consulting Group is a global management consulting firm and the world's leading advisor on business strategy. Founded in 1963, BCG has 66 offices in 38 countries.

We partner with clients in all sectors and regions to identify their highest-value opportunities, address their most critical challenges, and transform their businesses. Our customized approach combines deep insight into the dynamics of companies and markets with close collaboration at all levels of the client organization. This ensures that our clients achieve sustainable competitive advantage, build more capable organizations, and secure lasting results. In our client work, we aspire to make a difference, and we succeed because we are different. We help our clients change the rules of the game, not just play better.

The BCG difference lies in the power of individuals: challenged by mentors, supported in teams, motivated by results. We look for outstanding talents and people who have the curiosity and drive to find innovative solutions. Our consultants work with clients to define the problem and determine the best approach. BCG offers to all its employees to grow further challenging their mind, partnering with leaders, making a difference and ultimately charting a career that fits them.

Our goal is therefore to help ASP students better understand the challenges and opportunities of a consulting career. We are highly committed to develop initiatives to meet, interact and support ASP students in their growth.

BCG. Grow Further! Shaping Your Future. Together.

www.bcg.com

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ASP Status and Perspectives

Prof. Roberto Zanino, Director, Alta Scuola Politecnica

Prof. Stefano Ceri, Vice-Director, Alta Scuola Politecnica

Introduction

Alta Scuola Politecnica (ASP) is entering its fourth year of activities: two generations of students have completed the ASP educational program, while two other generations are actively working and the call for the foreign applicants to the fifth cycle is open.

ASP was established in the Spring of 2005 as a joint venture between Politecnico di Milano (PoliMi) and Politecnico di Torino (PoliTo). It provides an additional (i.e., not alternative) parallel track to the Master of Science (MSc) programs of the two institutions, selecting 150 exceptionally talented students per year among the applicants to the MSc in Architecture, Design and Engineering at PoliMi (contributing up to 90 students) and PoliTo (contributing up to 60 students). ASP emphasizes multidisciplinary and interdisciplinary (horizontal) skills and team work, as a complement to the disciplinary (vertical) skills and mainly individual work pursued in the MSc track. The official ASP language is English.

ASP is governed by an Executive Board made up of four PoliMi and four PoliTo professors, as seen in *Fig. 2*. Each of the Board members is responsible for a particular sector of the ASP activities (student careers, courses, multi-disciplinary projects). The Board is chaired by the ASP Director. After three years, the Direction of the School moved from Milano to Torino. The new Board was established in October 2007 and will be in charge for three years.

Although still partial and statistically not very significant, we



1a Politecnico di Milano main campus

1b Politecnico di Torino main campus



Sergio Benedetto,
*Professor of Digital
Communication, PoliTo
(courses)*



Stefano Ceri,
*Professor of Information
Technology, PoliMi
(vice-director)*



**Franco Bernelli
Zazzera,** *Professor of
Flight Dynamics, PoliMi
(careers)*



**Costanzo Ranci
Ortigosa,** *Professor
of Economic Sociology,
PoliMi (courses)*



Paola Bertola,
*Associate Professor of
Fashion Design, PoliMi
(projects)*



Agata Spaziante,
*Professor of Urban
Planning, PoliTo
(careers)*



Marco Cantamessa,
*Professor of Mana-
gement Engineering,
PoliTo (projects)*



Roberto Zanino,
*Professor of Nuclear
Fusion Engineering,
PoliTo (director)*

2 The ASP Board members

have also collected some indicators of the ASP performance, including feedback from students of the first two cycles. Thus, we are in the position to start a thorough process of discussion and revision, which is still ongoing, confirming the global validity of the ASP program foundations and the central role of the students as its major asset. At the same time, we are renewing several important features of ASP - like its keywords, enrollment mechanisms, course and project management and their linking, relationships to investors, and so on.



3a A view of Milano



3b A view of Torino

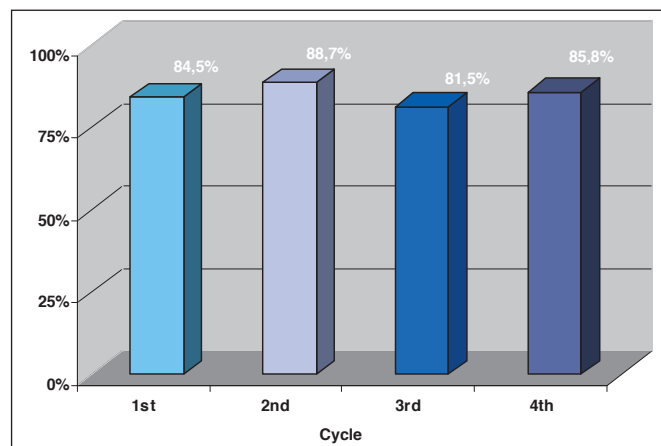
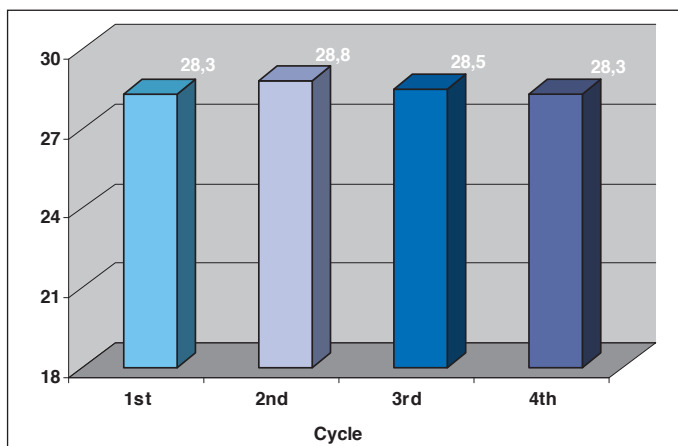
PoliMi and PoliTo are the largest and oldest technical universities in Italy. Altogether, they award each year about 25% of the Engineering BSc's and about 40% of the Architecture and Design BSc's in Italy. They are located in Milano and Torino, the capitals of Lombardia and Piemonte respectively, two neighboring Italian regions among the most advanced and industrialized in Europe.

While ASP is not the only initiative of “Alta Formazione” in our Country, as shown in *Fig. 4*, it is the only one at the MSc level, while all others are either at the BSc level and/or at the doctoral or post-doctoral level. Another major peculiarity of ASP is the decision, that was made from the beginning by our Rectors and Government Boards, to **remain inside the founding Universities**, while other initiatives that were started in the same period, e.g. “Istituto di Studi Avanzati” in Lucca, decided to become autonomous. This confirms in principle the joint and symmetric role of PoliMi and PoliTo in supporting the ASP initiative and implies in practice an increasing involvement of different University services in the ASP life, notably in the fields of enrollment, internationalization, promotion, placement etc., for which we are very grateful.



4 “Alta Formazione” in Italy. BSc and MSc level (red), ASP (green), PhD level (blue)

The focus of this article is to **report about the early performance indicators and new aspects of the ASP program**, while for a more detailed description of the ASP organization, we refer to the ASP Web site, www.asp-poli.it. A separate contribution, authored by former ASP students, concerns the **ASP Alumni Association**, which was recently founded in the fall 2007.



5 Average mark in BSc track (left) and fraction of 110 + 110L in BSc degrees (right) among Italian students admitted to ASP

ASP Mission and Keywords

The **mission of ASP** is to contribute, together with other actors, to the education of a community of graduate professionals who will be leaders in producing and mastering innovation. ASP starts from an elite - exceptionally talented students - and produces added value by creating a community of interconnected people with different backgrounds, by providing them with interdisciplinary skills, and by exposing them to multidisciplinary via complex problems, which require a combination of approaches and are intrinsically rooted into multiple disciplines.

The **ASP keywords** have naturally evolved from (Talent, Interdisciplinarity, Innovation), trademarks of the first three years of ASP life, into (Passion, Multidisciplinarity, Innovation); while a contribution to innovation via the work of our students remains in the keywords and the mission of ASP, the change in the other two keywords deserves some explanations.

While the talent of our students is taken for granted after admission, in view of the tight selection criteria adopted (see below) we consider **passion** as the element which should be the strongest motivation for attending ASP, *a conditio sine qua non* for obtaining good results and at the same time having fun at it.

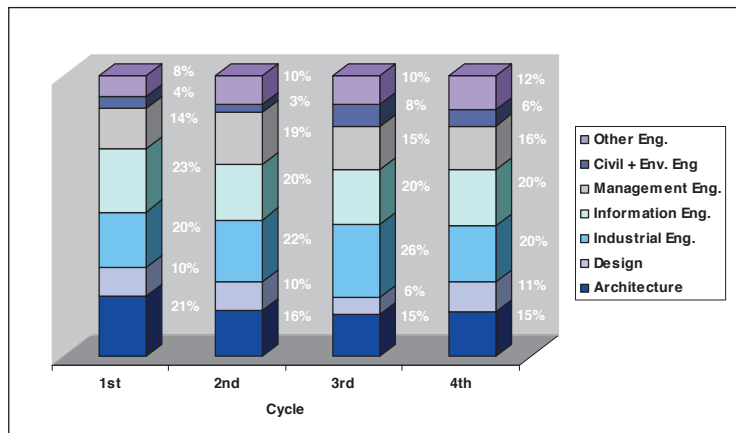
Similarly, while the interdisciplinarity of ASP courses is taken for granted, in view of the very different backgrounds of our students, we have decided to emphasize **multidisciplinarity**, because we realized that this is for a trademark of all interactions within ASP. The need of “merging” disciplines is intrinsic of the work performed within the projects and of all educational events - from the ASP inaugural speech, this year, e.g., dedicated to nanotechnology applications for medicine, to the final project presentations, where students present cohesive results from their disciplinary perspectives.

ASP Student Enrollment Process and Benefits

The commitment to excellence of ASP is guaranteed by the selectivity of its **admission criteria**:

- 1 BSc obtained by October of the year of application,
- 2 Average mark of at least 27/30 in the BSc courses.

If we consider the starting population of the BSc program as reference, the two criteria are satisfied by the top 5-10% of the students of PoliMi and PoliTo, i.e., only 1 or 2 out of 20 studen-

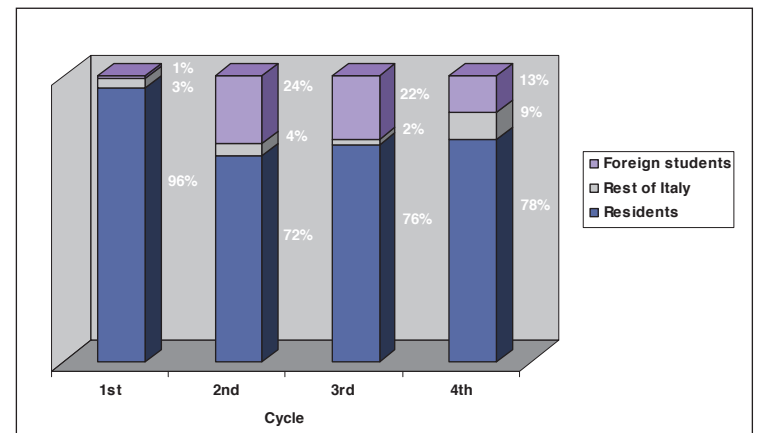


6 Distribution of MSc majors of ASP students

ts starting the BSc program will become eligible for ASP three years later. The major difficulty for the student is the need to be both good and fast. It should also be noted that, for all cycles so far the actual minimum average mark of the students then admitted to ASP was always above 28/30, and that more than 80% of them obtained the BSc with 110/110 or more (cum laude), as shown in Fig. 5. We may therefore conclude that ASP is very successful in selecting exceptionally talented students.

The **motivation** of the students (i.e., their understanding of and interest in the ASP program, as well as the sharing of and possibility to contribute to its objectives) must be expressed in a letter which is included into the application and must be defended in the course of an interview (possibly on the phone for foreign applicants); motivation and compliance with the ASP mission contribute to the final admission decision.

The population of ASP admitted students covers all MSc majors of PoliMi and PoliTo, as documented in Fig. 6; this contributes to the richness of the ASP community. Furthermore, the distribution across MSc majors is roughly uniform and constant in time. About 1/3 of the ASP students are women and also this



7 Distribution of the ASP students by origin during the first four cycles: Lombardia + Piemonte (blue), rest-of-Italy (gray), foreign students (purple)

number did not significantly change in time so far.

As far as the **geographic distribution** of enrollment, the ASP target is as follows:

50% from Lombardia and Piemonte,
25% from the rest of Italy,
25% from abroad.

While this (ambitious) target has not yet been reached, as shown in Fig. 7, it should also be noted that the overall figures of PoliMi and PoliTo, albeit increasing in the recent years, still fall below the 25% value for both the rest of Italy and abroad. In particular, with the exception of the ASP 1st cycle, which - due to contingent reasons - was limited to students already enrolled in the PoliMi and PoliTo, in the successive three cycles the rest-of-the Italian population appears significantly below target, while the population of foreign students was close to the target in the 2nd and 3rd cycle, but it is again relatively far from target in the 4th cycle. While each of these populations originally had its own call, the total number of ASP calls was reduced this year from three to two, for a simplification of the procedure, and the further reduction to a single call is being planned.



8 ASP international promotion: covers of the new ASP flyer

In view of the above figures, significant work is being pursued first of all concerning the **internationalization of ASP**, in collaboration with the corresponding services of PoliMi and PoliTo, as well as with targeted recruitment campaigns in macro-regions identified as possible ASP desired student-sources, e.g., China and Latin America. For making foreign applications easier, the opening of the 4th ASP call, reserved to foreign students, was significantly anticipated (by several months) with respect to the past, and the selection is currently being done on a first-come-first-served basis. ASP flyers in Chinese, Portuguese and Spanish were printed during the last year, as shown in *Fig. 8*, based on a recently and completely revised version of the English master, and they are being distributed in the major universities of these macro-regions.

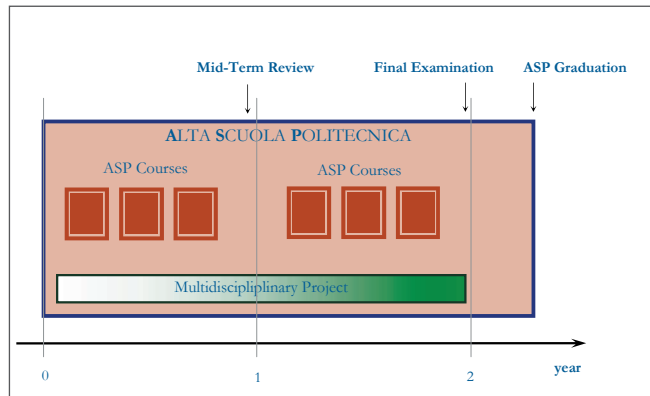
Concerning the **rest-of-Italy population**, the use of the Alma Laurea services was attempted last year, which possibly contributed to the little improvement reported in *Fig. 7*, but still far from the target. Here we believe ASP suffers for the generally diagonal nature of the mobility matrix between the BSc and MSc levels in Italy and we hope that the situation will improve with the growth of the ASP “brand” on national communication channels. On the other hand, also providing some BSc level roots to ASP could be important. On the same line, a connec-

tion of ASP with the PhD level, taking advantage of the already ongoing collaboration between PoliMi and PoliTo (and Politecnico di Bari) within the framework of Scuola Interpolitecnica, could naturally complete a full excellence track, while keeping with the original main target of ASP, namely providing exceptionally qualified architects, designers and engineers with additional inter- and multi-disciplinary know-how directly to the job market.

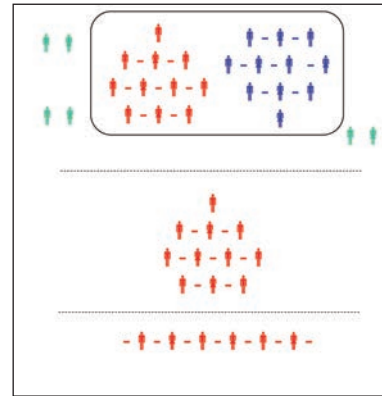
ASP students face some **challenges**, due to several non conventional obstacles, which may create problems even for very smart students. First of all, even after admission a high standard has to be maintained during the whole two-year track (a minimum number of credits must be obtained within the first year, while still keeping the average mark above 27/30); this has caused so far some problems especially to foreign students. Second, some topics and problems proposed by interdisciplinary courses may appear vague and/or ill-posed as compared to disciplinary studies, because of their truly inter- and multi-disciplinary nature. Finally, ASP requires cooperation among students, therefore students unable to work in teams, as is sometimes the case among exceptionally talented students, may face adaptation problems within ASP. For the first two cycles overall, about 15% of the students enrolled in ASP did not complete the program.

As a final note, it may be worthwhile to mention that the list of **benefits** for ASP students is quite impressive and namely:

- Tuition fee waivers for both MSc and ASP programs;
- Free travel and accommodation during ASP Courses;
- Budget for developing the ASP Multidisciplinary Projects;
- Free accommodation on campus, for both foreign students and Italian students who are not residents of Lombardia or Piemonte;
- Double MSc degree, from both PoliMi and PoliTo;
- ASP Diploma.



9 Time development of ASP educational activities



10 A football analogy of the ASP course track in three steps (see text for an explanation)



11 ASP Investors

The first three benefits alone amount today to roughly 7500 Euro per student; non-resident students have the additional benefit of free accommodation on campus.

ASP Program: Courses and Projects

The ASP program runs from an inaugural event, typically in January of the first year, until the final exam, typically in December of the second year. In this time frame, ASP students work for an additional 30 credits, equally divided between ASP courses and ASP multi-disciplinary projects. The plan of ASP activities in the two years is shown in *Fig. 9*; the first semester of the second year is left free of ASP activities to allow students to participate in other programs, e.g., Erasmus. Originally, courses and projects were designed more or less independently. However, we now believe that **courses and projects should be more and more linked together**, so as to mutually benefit from this communication. Thus, the ASP program is progressively reshaping towards greater interaction between projects and courses.

ASP courses face the **challenge of addressing a broad, heterogeneous audience** involving students from all the majors in ar-

chitecture, design and engineering. For a professor, being able to be understood – and to be interesting – while talking at the same time to computer scientists, designers, nuclear engineers, urban planners, telecommunication engineers, ... is a very hard task. Six ad-hoc courses are presently offered throughout the program, typically in the format of (full-immersion, week-long) Summer or Winter Schools at different Italian locations away from both PoliMi and PoliTo. This **residential format** is particularly suitable to the purpose of fostering the ASP community.

The course plan, as consolidated through the first three years of ASP, may be read as an ensemble of three sets of two courses each. The first two courses are dedicated to studying the **context** in which innovative projects take place, looking at the economic drivers that may facilitate their development as well as the (explicit or implicit) consequences that innovation may induce upon society, when it raises ethical issues. The next two courses are dedicated to studying **management strategies** for innovative projects, by looking at how projects should be organized taking full advantage of dedicated resources and by studying/structuring decision-making processes within them. Finally, the

last two courses are dedicated to studying the different **approaches to problems** which are offered by a top-down, analytical approach (which is typical of the engineering schools) and by a bottom-up, synthetic approach (which is typical of the schools of architecture and design). It is then possible to see these ASP courses as steps of an outside-in track, represented in *Fig. 10* by means of a “football analogy”: first study the boundaries of an innovation project (focusing on its external determinants, or “outside the stadium”), then the dynamics inside a project (focusing on its actors, or “how to play in a team”), and finally focus upon the methods to be used by actors in addressing problems (or “how to play soccer”). Note that this approach, albeit unconventional from the point of view of the standard, bottom-up approach of the disciplinary MSc track, appears on the contrary quite natural in view of the unconventional, inter- and multi-disciplinary nature of the ASP track, whose emphasis is on merging disciplinary skills for addressing complex problems; hence a natural progression goes from understanding the problem boundaries to understanding the methods for managing interactions and for designing solutions. The six courses offered to the 3rd ASP Cycle are listed in *Table 1*.

As opposed to classical disciplinary courses of the parallel MSc track, ASP Courses favor **students’ participation** by means of “active” afternoon sessions, with intense question-answering and brainstorming sessions, team-work, and final discussion, which typically follow more standard “passive” morning sessions. Also, the relationship with the ASP projects is increasingly reinforced by suggesting that afternoon sessions be inspired by project-specific case studies. Students are asked to prepare three individual papers on a subset of the courses. These papers are then evaluated and contribute to the yearly assessment of the student’s career.

In parallel to the concentrated effort of the courses, students undertake work on multi-disciplinary projects. They are typically system-level and they focus on **problem-setting within a com-**

Professor A. Szokolczai Ethics and innovation	March 2007	Bardonecchia <i>Winter School</i>
Professor C. Antonelli Drivers of innovation	May-June 2007	Torino <i>Two-day seminars</i>
Professor M. Calderini Management of innovation	July 2007	Venezia <i>Summer School</i>
Professor B. Dente Decision making	March 2008	Lignano <i>Winter School</i>
Professor S. Rinaldi The logic of modelling	April 2008	Bardonecchia <i>Spring School</i>
Professor A. Balducci The dynamics of creativity	September 2008	Torino <i>Summer School</i>

Table 1 List of ASP courses, coordinators, dates and locations for the III cycle

plex situation, as well as on **conceptual design** and **feasibility analysis**. Projects can be roughly divided into three big categories as follows, with typical examples for each category taken from the first four cycles:

A: Development of complex systems

- Italian high-speed railway lines: safety, performance and environmental impact - FERROVIE DELLO STATO S.p.A (1st Cycle)
- Sensor-vision-enabled autonomous robotic helicopter for civil applications in urban environments - AUGUSTA WESTLAND (3rd Cycle)

B: Development of interdisciplinary issues

- Smart drug delivery - SOLVAY, BRACCO (1st Cycle)
- Home textile for tomorrow - ZUCCHI (3rd Cycle)

C: Integration between architecture and engineering

- Expo 2015. Towards a polycentric Milan - CAMERA DI COMMERCIO DI MILANO (3rd Cycle)
- Engineering and architecture for supporting sustainable development in Ecuador: the case study of Guayaquil’s barrios - UNIDO (3rd Cycle).

Projects are developed according to the following steps. A list of projects is proposed each year by the PoliMi and PoliTo faculty in response to a call; projects must be multi-disciplinary, involve tutors from both PoliMi and PoliTo, and address a practical

problem presented by an external organization (industry, companies and/or public administrations). The ASP Board evaluates the proposals and selects a subset of them, which are then presented to the students. The students rank their preferences among the projects and one to two teams of 5-6 people each are assembled by the board according to the students' preferences (as an example, in the IV cycle, ~ 75% of the students were assigned their first choice and ~ 20% their second choice), as well as for the need of creating multidisciplinary teams as much as possible. The work on the projects continues for the entire two years of the ASP program and ends with the presentation of a project report during the final examination.

We have introduced frequent check points at which the project **teams report their work to the Executive Board**, so as to assess their development and the coherence with our expectations as it has been consolidated through a three year experience. Specifically, we force the project teams to present progress reports every six months and to perform a mid-term review after one year of work.

It should be noted that some of the projects completed in the first two cycles have reached quite remarkable results in both terms of exploitable technology (e.g. the BioFluor project of the 1st Cycle, for which a patent has been filed) and notoriety in Web news (e.g., the WoMan project of the 2nd Cycle, which has achieved a wide visibility on Internet), thus constituting a tangible ASP contribution to innovation. Other results were the subject of international publications (e.g. again the Biofluor project and the Goods Tracking and Risk Management project of the 1st cycle, or were used in industry (e.g. Luxottica & the Glasses Production Evolution of the 2nd Cycle).

ASP Investor Policy

The ASP start-up was financially supported by MUR for its first three years of life (until the end of 2007). The future perspectives of the ASP venture are therefore increasingly based upon the support that we will obtain from institutional investors, like the Regions (Lombardia and Piemonte), Bank Foundations, Chambers of Commerce, etc., as well as from other investors, see *Fig. 11*.

The ASP investor policy has been recently redesigned in collaboration with the two services (Career Service and Stage&Job, respectively) which bridge PoliMi and PoliTo to external companies. The packages offered to potential investors include the opportunity to directly propose a multi-disciplinary project and to organize meetings with ASP students at Summer or Winter Schools as well as the access to students and Alumni CV's. In particular, the new concept of "fellowship", inserted in the package, provides an opportunity of direct interaction between the investor and a specific student. The "fellow" is selected by the investor out of a set of interested candidates, and the relationship is strengthened by offering the opportunity of a short stage at the investor's premises.

Conclusions

The ASP baby enters its 4th year with enthusiasm and awareness of the difficult challenges ahead. While we confirm the overall validity of the ASP program foundations, we are critically revisiting many of its features based on the experience made in the first phase, so as to keep this project as lively and exciting as it was so far. More time will be needed to assess the real added value of ASP in the job market, although preliminary indicators at the end of the 2nd cycle appear encouraging.

The major asset of ASP is its community of passionate and exceptionally talented architects, designers and engineers. Such a collection of talented young fellows is supported by an equally engaged, multi-disciplinary and strong body of professors and tutors.

ASP Alumni: the citizens of Aspamnia

Stella Barchiesi, Nicola Francesco Dotti, Alessandra Pandolfi, Arturo Petrozza, Giulio Sovran

The Alta Scuola Politecnica is a unique experience: 150 students from all the Masters of Science from Politecnico di Milano and Politecnico di Torino meet, to share ideas and to develop multidisciplinary skills, essential for their vocation and training. The uniqueness of the Alta Scuola Politecnica is also the possibility of meeting with experts and established professors. Furthermore, the courses offer, through weekly sessions in the schools, the promotion of solid relationships, based on friendship and respect, among the students, professors and the ASP Staff: these relationships and the will to keep them alive are the main drivers which led us to create the Alumni Association.

The ASP Alumni Association was therefore created to uphold the community spirit generated among the ASP students: at the end of the 1st Cycle, ASP graduates decided to keep in touch, not only because of the friendships that were made during the School experience, not only by gathering a list of contacts for friends and acquaintances, but also by creating a stable network of contacts and relationships formalized in an official Association, to form an organization that would be the point of reference for all the students and graduates of all the present and future Cycles of the Alta Scuola Politecnica.

The ASP Alumni Association is, then, a sort of city and as a city it was created and it will be developed by its citizens: this organization will be the basis from which friendships among members and relationships between the associated and the external stakeholders will be developed, and it could be the grounds from which knowledge and awareness could be widened and shared. In this sense, the ASP Alumni Association is like the “invisible



Prof. Giulio Ballio, Rector of the Politecnico di Milano, Prof. Roberto Verganti, former ASP Director, Prof. Francesco Profumo, Rector of the Politecnico di Torino



city” of Italo Calvino, that could be called “Aspamnia”: like “Anastasia”, because its citizens feel as if they were a part of a whole and the residents’ wishes become the city’s collective will; it is like “Eufemia”, where, at night, all the inhabitants and welcomed guests tell their stories and share their knowledge; it is like “Armilla”, the city with no walls, floors and ceilings, transparent as the air, living as the water that constantly flows and inhabited at every hour; finally, it is like “Octavia”, which is conceived as a spider’s web used for passage and support.

When

The ASP Alumni Association was formally created on the day of the graduation ceremony of the 1st ASP Cycle, the 28th June 2007. However, the Alumni Association is almost a consequence of the concept of community created in the ASP experience: the idea of an Association was already part of a discussion of the School Board (together with the students) during the last year of the first cycle. During the ASP diploma ceremony, in front of

the former ASP Director, prof. Roberto Verganti, the executive board, the Mayor of Milan, Letizia Moratti, and the two Rectors of Politecnico di Milano and Politecnico di Torino, prof. Giulio Ballio and prof. Francesco Profumo, the ASP Alumni Association turned into “a dream come true”.

Francesco Profumo, together with the ASP Director, Prof. Roberto Zanino, and Vicedirector, Prof. Stefano Ceri, also took part in the first ASP Alumni Event at the Politecnico di Torino on the 6th October 2007. The first official presentation of the Association was also the first ASP Alumni meeting, and on the same day, the present members proceeded with the candidacies to the Directive Board of the organization and elected the first Board. As community and networking are the two main keys of this experience, the elections were also carried out on the ASP Alumni website, to allow absent members to express their preference, in the full correspondence to the will of favoring the on-site and online participation of students in discussion, sharing, and improvement of ideas that is at the base of the Alta Scuola Politecnica experience.

Several students from the first cycle ASP were soon involved in developing the Association, its concepts and ideals, and, above all, its community of people. As previously said, the first election for the President of the Association was a good example of participation of the ASP’s students: 13 candidates were available for the six places in the Directive Board and, finally, Arturo Petrozza was elected the first President of the Association.

In the following months, the people on the Directive Board developed the Association during their free time: the collaboration with the ASP’s Staff and Board has become a very important element in order to manage the complexity of the organization of a newly born association. From that first official meeting, the students of the first cycle tried to keep in touch with each other (and to increase the networking with the students of the other cycles), by inviting people from the new cycles, who answered positively, to create a web of young and collaborative talents.

Why

The word ‘Association’ means the choice of a group of people, who share common interests and goals, to develop their common targets. In this case, the students wanted to continue the experience they shared during the two years of the ASP courses. What makes the ASP experience so strong is not only the quality of its professors, students, board or organization but the School concept itself that is based on the relationships among all these people, in terms of know-how, deep interest in different subjects, and ability in “networking”. Community and networking are the two main concepts of the School and, of course, of the Alumni Association: community because students, professors, staff and board are working all together on innovation through a multidisciplinary approach.

What could be felt as weakness, or rather the cultural differences between the ASP’s students, is contrary to its strength: different backgrounds, such as Engineers, Architects, Designers and Planners, are merged together in a condensed melting-pot of students with a great passion for their subject matters.

Finally, the network becomes wider and wider, because the ASP’s students are already distributed both in the best Italian and foreigner companies, in the academics in one of the two polytechnics or in other important universities in Europe and in the United States. This way, the ASP network and mentality go beyond the Italian boundaries: working in larger and multinational teams is, for many of us, in continuity with the multicultural spirit of innovation that ASP has taught us.

Who

The ASP Alumni was organized as an Association, with its Statute and Directive Board (the “Consiglio Direttivo” – CD). The President and the CD are elected by the ex-students and they are in charge for 2 years. The CD is made up of the President, the Vice President, 6 Members as representatives of the 1st cycle of ASP students (3 from Politecnico di Milano and 3 from Politecnico di Torino), 2 professors who represent the ASP Board, and 6 representatives of the 2nd cycle’s students, who will join the Board after their graduation.

The President is **Arturo Petrozza**, management engineer, consultant at Roland Berger Strategy Consultants. He represents the Alumni ASP and is charged of the placement activities, institutional relationship and events in Milan area.

The Vice President is **Stella Barchiesi**, architect, Phytec consultant at Azimut Yachts. She is in charge of the internal communication and event coordinator.

The Directive Board is composed by :

- **Carlo Ballerini**, mechanical engineer, energy project engineer at MWH, responsible for the website and event promoter for the Milan area;
- **Nicola Francesco Dotti**, urban planner, PhD student at Politecnico di Milano, secretary in charge of the administration and the institutional relationships;
- **Giuseppe Gazzilli**, aerospace engineer, researcher at Powertrain Research and Technology, FIAT group, treasurer;
- **Daniel Guzzafame**, aerospace engineer, Quality Manager at FIAT group, event promoter for Turin area;
- **Silvio Barbieri**, building engineer, Asset Manager at Pirelli RE, event promoter for Turin area;
- **Giulio Sovran**, architect, Architect at dvarchitectes & associés, in charge of the internal communications.
- **Agata Spaziante** and **Franco Bernelli Zazzera** represent the ASP Board.

Other former students participate in the activities of the Association: **Alessandra Pandolfi** (urban planner, researcher at Politecnico di Milano), **Luciano Raso** (Environmental Engineer, trainee at ENEL group), **Francesco Sivo** (Management Engineer, consultant at McKinsey and Co.), **Davide Mazza** (Computer Science Engineer, PhD student at Politecnico di Milano).

There are also some ASP students who are giving substantial support to the Association: **Anna Lottersberger** and **Federico Bonacina** for the newsletter and **Alice Bertola** for the logo design.



Arturo Petrozza

Stella Barchiesi

Carlo Ballerini

Silvio Barbieri



Nicola Francesco Dotti

Giuseppe Gazzilli

Daniel Guzzafame

Giulio Sovran

What

The Association plans to organise two main events each year, the ‘ASP Alumni days’ and six aperitifs as ‘ordinary events’. These events are shared between the Milan and Turin areas to continue the cooperation between the two cities.

The first ‘ASP Alumni Day’ was held the 6th October 2007 in Turin for the official presentation of the Association and the election of the Directive. After this institutional part of the day, the students had lunch together and visited the Cinema Museum at the Mole Antonelliana. The day ended with an aperitif in the historical centre of Turin.

The first aperitif event was held in Milan on the 15th of December 2007, together with the students of Unitech. The second one was in Turin on the 1st of March 2008, held on the same day as the CioccolaTò events (the fair of chocolate). Through these aperitif events, the different cycles of ASP students were able to have a chance to get to know each others.

The second ‘ASP Alumni Day’ will be on the 10th May 2008 in the “Reggia di Venaria”. It is one of the best royal residences of Piedmont and is considered a “World Heritage” site by UNESCO. It is completely restored and was recently reopened. This site was chosen because of the great amount of work that was



Prof. Agata Spaziante

*Prof. Franco Bernelli
Zazzera*

done on it, which covered many of polytechnic fields of study, such as architectural landscaping, restoration, the engineering aspects concerning all the new technologies adopted for the control and preservation of the building, and the communication design for the reopening. It represents the interdisciplinary spirit of the ASP.

A monthly newsletter was set up and is sent to each member, summarising the Alumni ASP activities, what has been done and what will be done. The first issue contains some interviews of Alumni and of external people, for understanding the options offered to ASPers in the professional life. We also prepared a questionnaire to be filled out by the ASP Alumni in order to keep track of their current occupation; it will be nice to know what the former students are doing or have done since the Graduation Ceremony, as this can be useful information to inspire others. The community website is organised to support networking: students will maintain contact information enabling all kinds of interaction. Furthermore, the Alumni ASP Association intends to support the ASP school, by contacting investors, and the ASP students in the placement activities.

One year later: the first Aspers' results

A preliminary indication of the performance of the ASP students of the first cycle in completing their studies and of their current employment comes from the analysis of a questionnaire, prepared by Nicola Francesco Dotti (Secretary of the ASP Alumni) in cooperation with the Career Services of both polytech-

nic. It was submitted online during the Spring 2008; we collected 64 replies, roughly 50% of the 1st cycle of graduates from ASP. The 88% of the students interviewed completed the MSc with 110/110 or more (59% cum laude) and 22% of them now working or studying in a foreign country. Most of the Aspers (73%) found a job in less than 1 month after graduation, nobody needed more than 2 months, and 17% of them had already started to work before graduation. Half of them work for a private firm, while 28% started a PhD, 19% works in a professional studio and only 3% work in a Public Administration. Among ASP students who have chosen private companies and professional studios, 31% work in the field of business services, while 13% are in the automotive field while the others are in 10 different fields (including bio-medics, finance, communication and TLC). Among PhD students, a significant fraction (22%) have been admitted to universities abroad. In the companies, Aspers are employed mainly in 3 sectors: R&D (19%), design (19%) and IT (13%), which are typical activities for graduates from Politecnico di Milano and Politecnico di Torino, but some of them (34%) are also employed in non-strictly "typical roles", such as human resources, administration, finances, and retail. The survey gives only a first image of the results of the ASP School; it highlights the great capacity of the Aspers to find good and stable jobs, mainly in R&D or design sectors. The ASP's close contact with enterprises help ASP students to relate to them, and the first reports on how ASP students are appreciated by companies and universities seem to be equally positive.

Where

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Email: alumni@asp-poli.it

website <http://alumni.asp-poli.it>

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PROJECT



WoMan



WINDOWS ON THE MAN



WoMan Window on the Man

PRINCIPAL ACADEMIC TUTOR

Andrea Bonarini

Electronics and Information, Politecnico di Milano

ACADEMIC TUTORS

Luca Mainardi

Biomedical Engineering, Politecnico di Milano

Raffaella Mangiarotti

InDACo, Politecnico di Milano

Matteo Matteucci

Electronics and Information, Politecnico di Milano

Roberto Merletti

Electronics, Politecnico di Torino

EXTERNAL INSTITUTIONS

DreamHex

Istituto di Ricerca Farmacologia

Mario Negri

EXTERNAL TUTORS

Simone Mangano

Istituto di Ricerca Farmacologica Mario Negri

Graziano Ravizza

Interactive Toys

TEAM A

Alberto Guarino [Team controller]

Computer Engineering

Antonio Aricò

Industrial design

Arianna Bosco

Mathematic Engineering

Guido Parissenti

Space Engineering

Alberto Piccinelli

Architecture

project
1

Designing new products, where computers could be easily interfaced to people to interpret their emotions and improve their performance

TEAM B

Daria Casciani [Team controller]

Industrial Design

Luca Albertalli

Computer engineering

Rawad Choubassi

Urban Planning and Policy Design

Alfio Sorbello

Management, Economics and Industrial Engineering

TEAM C

Mirko Iaconisi [Team controller]

Computer Engineering

Laura Mata García

[Project Communication Coordinator]

Environmentally Friendly Product Design

Giovanbattista Basile

Design & Engineering

Riccardo Bombarda

Design & Engineering

Andrea Malagoni

Computer Engineering

Andrea Vaccari

Engineering Computing Systems

PROJECT DESCRIPTION

Cutting edge technologies make it possible to open a Window on the Man by interfacing non-invasive devices directly into the human body to perceive signals related to people's emotions. Affective computing is the key to the success of new devices, no longer technological slaves, but partners involved in everyday life.

The aims of this project were conception and design of new products, where embedded computers could easily interpret emotions of the users, to make innovative applications feasible, or just more appealing.

The implementation of such e-devices (emotional devices) required the joint work of different experts: product designers, market experts, biomedical and computer engineers.

The main philosophy of the project was declined in different ways by the three groups of students who focused on different applications involving different sharing of emotions: one to many, many to many and one to one, respectively.

The first group (**Sensiblog**) envisioned the possibility of getting emotions from physiological signals detected by a bracelet. It was designed to be technological jewelry targeted to young people. The recorded emotion could be shared on one of the most fashionable media: a blog, where people usually share content in terms of only words, pictures and sounds. SENSIBLOG gives the possibility to share emotions as detected and recorded at the exact moment they are being felt. Other possible applications of the technology explored in this project are related to capturing emotions in particular moments of ones life, e.g., while watching a movie to evaluate its emotional impact or when interacting with particular people, such as the boss, the girlfriend, a professor during exams.

The second group (**Window on Lambrate**) moved the emotion detection activity from the single, to a dynamic community: people passing in a public space leave a trace of their emotions, which would be detected by environmental sensors. Emotions are reported elsewhere in the space and so shared with other people.



The group chose a place in Milan (the Lambrate Station Square) as their case study: here, commuters pass during rush hour, commercial activities are held in other moments, where other people live there at night. Emotional traces are picked up from furniture, parts of the pavement, and interactive panels. They are used to modify the aspect of the place, by sharing the emotional trace with the other “users” in the same public space.

The third group (**Laura**) designed a hybrid between a hammock, a sofa and a chaise longue, able to capture, from sensors embedded in the fabric, the emotional state of people using it. The product was able to give feedback to the users about their emotional state, by producing coloured patterns on the fabric or other signals. It may be used either in a home environment to induce “personal relaxation” or in public spaces such as restaurants, bars and wellness centres to achieve what can be called “entertainment relax”.



Sensiblog

TASKS & SKILLS

Antonio Aricò was responsible for the design of the bracelet and dealt with technical constraints to create a fashionable gadget.

Arianna Bosco gathered information about the diffusion of blogs and the characteristics of bloggers and worked on the pre-processing real time analysis.

Alberto Guarino gathered information about the state of the art in emotion detection from biomedical parameters and took care of the blogging platform and interface.

Guido Parissenti took care of the sensors, detecting the most suitable for our purposes and cooperating with the designer to optimize their integration into the object along with the whole electronics.

Alberto Piccinelli analyzed the phenomenon of social networking and worked on the visual representation of emotions on the web interface.

ABSTRACT

The last steps of evolution of the web culture tell us that there has been a deep shift in what the users are interested in. Web phenomena like the huge increase in the number of blogs, or services like Second Life, YouTube or, more recently, Facebook, should make us reflect about what changes the web has gone through in the last few years. It seems that people want to “humanize” the spaces of the web, by expressing the real themselves. While in the past normal web users preferred to hide behind anonymity, current users are not afraid of showing their faces, their names and maybe even their emotions in front of the web audience.

Web studies experts have created many expressions to describe such multiple shifts, like social networks, web 2.0 and so on, but perhaps they are all part of a bigger phenomenon, which mainly embraces larger artistic and social meanings: pseudo-modernism. Among the above mentioned activities, blogging stands out as an attempt to open a window on people’s experiences, thoughts and feelings: in order to do so, a typical blog combines text, images, links and other media related to its topic.

The main purpose of Sensiblog is to further open that window, by allowing the users to record their emotions in all their shades and publish them on a blog.

A technologically advanced bracelet, which is both a product of modern design and an assembly of sensors and electronic devices, takes care of the emotion recording, while an intelligent software is responsible for emotion recognition and publishing. This modular approach can also pave the way for future scenarios in which the same bracelet could be used for a variety of applications, taking advantage of the knowledge about users’ emotions.

In our vision, the Sensiblog project is a small step towards a world where electronic devices can be aware of emotions and react to them, enhancing the interaction between product and user.

moody
Sensiblog
Human window on the man

1 Logo + woman windows on the man

2 This board it shows how the state of emotions recorded during the day life of the user, could be represented on the web



3 Graphic representation used by the designer as inspiration mood to design the product

UNDERSTANDING THE PROBLEM

The first part of our work, which took about six months, consisted of understanding the aim of our project and collecting ideas and useful information to define the field in which we would operate. A series of meetings with our academic and external tutors was organized to gather information on the state of the art in external sensors and their reliability; in fact, the main constraint for our project is to be non-invasive while collecting biomedical parameters.

Once the amount of collected information was considered sufficient, a long period of brainstorming took place and different ideas were taken into account: it was soon clear that all the objects we proposed used the same technology and sensors (Skin Galvanic Response (SGR), Heart Rate (HR), accelerometer and microphone), applied in different fields. With the help of our tutors and members of the board, we decided to focus on the field of entertainment and create a device which would be suitable for both sexes and targeted at teenagers and people aged 20-25.

EXPLORING THE OPPORTUNITIES

The technological issues we had to face during the Sensiblog development concerned both software and hardware. While from the software point of view the main problems were related to emotion classification and recognition on the basis of the acquired data, on the other hand the hardware design had to face necessities of miniaturization and reliability.

The aim of building a nice and wearable object created an exciting challenge from the electronic point of view. First of all, the limited available space did not allow to use a large battery nor to add too many sensors. In addition, one of the commitments of the project was to use existing technologies, so that no futuristic data processing techniques and components could be employed. Complying with these boundaries, the elements we chose for our device are the smallest available on the market and with the lowest power requirements. This way all the electronic parts, including batteries, could be fitted in a bracelet that can be worn everyday.

GENERATING A SOLUTION

The object we designed is both an electronic device, able to read biometric parameters of the user, and a web application, because it is capable of communicating the collected emotion through a web page. In addition, a particular care has been put into the design phase in order to create a product that would be attractive to our target: the so-called blog generation.

The hardware part of our Sensiblog, similar in shape and weight to a bracelet or a watch, could be worn by the user for the whole day.

Sensors integrated into the bracelet continuously record the biometrical parameters. The collected data are roughly analyzed in real time, so that when a change in the signals occurs a micropho-



4 Graphic selection of inspirational drawings concepts and evocative images that will bring to the design of the product



6 Product style associated to possible users, the iconic drawings represent the utility of the bracelet connected to a blog on the web



5 Graphic representation of the product architecture



7 Product style and its connection the idea of emotions

ne is turned on and the sounds around the user are registered for about one minute. The audio files, combined with the corresponding detected emotions, could help the users identify what changed their emotional state and provide them with a nice “souvenir” of particular moments in their everyday life.

Whenever they wish, users can download all the recordings from their bracelet to their computers through a standard USB interface. A dedicated program will then process the data, detect emotions and upload a selection to the chosen blog, enhanced with our Sensiblog technology. Thanks to it, users can publish their posts and complement them with the related emotional representation.

The main elements that compose our Sensiblog are briefly described here:

Sensors

- A **microphone** to register sounds and noises in accordance with a sudden variation of biological parameters.
- An **accelerometer** to detect which variations in the parameters are due to physical efforts.
- A **SGR sensor** to recognize changes in the electrical properties of the skin, due to the activity of sweat glands.
- A **HR sensor** to collect the behaviour of heart rate, that results from activity level of the autonomic nervous system, which is in turn dependent on emotional stimuli.



8 Product views and electronics

Other hardware components

- An **amplifier** to amplify the signals from analogic sensors.
- A **Flash Microcontroller** to elaborate signals, activate the microphone and store data.
- A **SD Card** where data are stored.
- A **Serial/USB converter** to connect the device to a PC through a USB port.
- A **mini USB** Socket to connect the bracelet to a personal computer.
- A **battery** to provide power for the whole system.
- A **board** to connect all the components.
- A small **display** to show essential information.

Software

The Sensiblog blogging interface is a plugin to Wordpress (www.wordpress.org), a widespread, open-source blogging platform, based on the PHP language. Thus, integration with existing blogs may be almost effortless.

Design

The minimal solution to the idea of a bracelet connected to a blog would have been a simple stripe of rubber containing sensors and electronic parts. The attention to the shape and details such as the buckle and superficial treatments confer on the product a fashionable uniqueness, that sets it apart from the crowd of popular gadgets, giving it a sober, modern and fashionable image.

This solution gives a sense of quality and modernity at the same time.

FUTURE DEVELOPMENTS

A further development of the proposed work is the use of the same technology in different fields for different purposes. These are the objects that we analyzed during the brainstorming phase and that we called the “Sensi-series”.

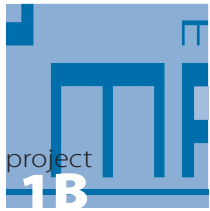
The same bracelet can be worn by people in a cinema (who would get a discount on the tickets) to record their reactions to different sequences of the movie, or in a supermarket to study a strategy for a convenient disposition of products on the shelves, or to evaluate tourists’ feelings during a sightseeing tour. The list of applications can be endless.

Finally, a future goal of our project is to create a sort of emotional-bank to collect anonymous data recorded by all the users over the years and use them to optimize emotion detection or for special queries and surveys.

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Window on Lambrate

Giving and taking emotions in public spaces

_WoMan_WINDOW ON THE MAN

TASKS & SKILLS

Daria Casciani worked on research the state of the art, proposed a new furniture scheme and designed all physical elements within the piazza.

Rawad Choubassi studied the activities in the social environment, focusing on the problem setting and visual rendering of the proposed solution.

Luca Albertalli dealt with the problems of technological feasibility and defined the overall software and hardware architecture of the system.

Alfio Sorbello analyzed the stakeholders' requirements and the economical and financial aspects of the project.

ABSTRACT

This project is an experiment on the application of sensors in a public piazza. This study is part of a larger project entitled, “WoMan - Windows on the Man,” that aims to design products able to interpret the emotional state of people from mechanically and chemically acquired data. While other applications of the same theme focused on applications that occur in the private environment, individually acquiring data and giving personal feedback, our project takes place exclusively in the public space acquiring data from and feeding back to a collectivity of users.

From the very beginning the intention of the project was to react to the social passiveness and the lack of communication in public places which continuously renders the piazza a space of discomfort and mistrust.

As often happens in today's applications of sensors technologies, devices are designed for private use. Our idea came out with the purpose of abandoning, for a moment, the luring opportunity of building a device for stand-alone use, and suggesting, on the contrary, a system of sensors that addresses a wider array of public users.

This project, aside from serving as a public excitement device, establishes an experimental base for further studies where computer and electronic technologies merge with social concerns and spatial studies. This match between the social aspect of space and the impact of technological applications constitutes the core concept of this project. The use of Information technology allowed us, moreover, not to limit our study to the physical assets of the given space but to experiment with various virtual platforms that overlap the existing physical space, constituting an intermediate interface between the user and the piazza.



1 *Parasite*
moodboard.
General
moodboard of the
design concept
“Parasite”

The proposed graphical, physical and virtual representations of the piazza within the piazza would eventually propose a new landscape that is continuously shaped and re-shaped by its users according to the various activities and changing patterns of use.

The project entails new sensor-equipped urban furniture, platforms and paths, alternative schemes for existing public waiting spaces, interactive panels that allow the user to manipulate some of the visual outcomes in the piazza, rendering the user a proactive element in the formation of the various representations. Furthermore, intervening on existing systems allows re-thinking the modes in which different systems operate, such as signage, advertisement, furniture, shop systems, etc. The internet website serves as an additional layer that increases the visibility of the project to the public and a virtual platform that allows the remote users to experiment with and manipulate the collected data.

UNDERSTANDING THE PROBLEM/ SETTING CHALLENGES

The primary challenge we came across, on the technical level, was how to use technology that is so often used in controlled environments and put it in a public space addressing a wider collective group of people. Moreover, and on a different and more complex level, we questioned the way in which this technology could give a social benefit/ value to the largest possible number of people. The problem took different technical, theoretical, ethical and financial facets as we tried to respond to a social concern using state-of-the-art electronics and information technologies.

Still beyond these problems lies the core problem that our project confronts. It regards people's relation to their public living environment, the degeneration of urban landscape, the deterioration

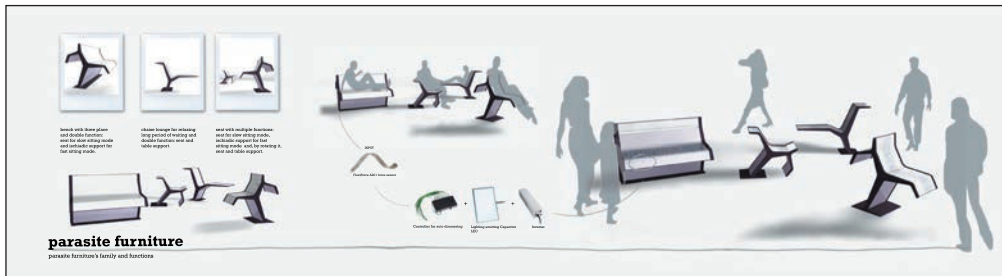
of public communal life, etc. Through the use of various technologies and mixing disciplines we propose a project that responds to the problems and constitutes a starting point for a more serious study on using sensors as a tool in communication and letting people who share the same space to share and compare opinions and probably emotions as well!

EXPLORING THE OPPORTUNITIES

The initial phase of the research was dedicated to collecting examples that describe the various state-of-the-art applications in different disciplines that involve such technologies: they range from artistic performances, new media arts, socially related applications and other similar technological applications. We found a wide array of applications of such technologies in the market with various aims, intentions and objectives. All the examples analyzed have a different nature but still they retain a set of common characteristics as they occur in public spaces, they have common social aims and use a similar type of technology.

We focused on themes like the lack of communication in the social space, the theme of privacy and surveillance analyzing the design process that architects, artists and designers experience in the making of similar products.

The research was based on non-invasive ways to use technology, in many cases very simple, such as infrared sensors, cameras, projectors, recorders and speakers. In addition, we observed examples of how digital artefact, in their simplicity, can positively change our lives by creating more pleasant settings and more exciting simple additions to our daily routine.



2 Parasite furniture functions.
Explanation of the different elements of the furniture with an overview on the function



3 Parasite furniture explore.
Overview on the materials and components of the furniture elements

GENERATING A SOLUTION

The project was designed to:

- be generic and flexible so that with minor modifications and add-ons would adapt to any other public place,
- gather and respond to the complexity of people's activities in a common environment,
- take into consideration the multi-cultural public user, providing a new language that makes communication easier among multilingual actors,
- encourage people to be active, share emotions (giving and receiving) without being invasive in nature.

It is a "network" of nodes which are connected to each other and react not only to direct stimulus but also to information gathered from other elements. Our system is composed of four major elements related to activities that take place in the piazza:

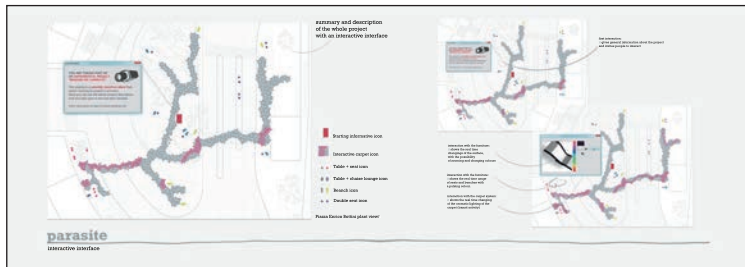
- Sensorized furniture (benches and seats),
- Flows-sensitive paving,
- interactive communicating panels and,
- a website as an extension to the piazza in the virtual world.

The design concept is based on the parasite metaphor. All the

elements are conceived as organisms that grow, feed, inhabit the piazza. Coming from the ground, attaching to the walls they parasite on the existing piazza and interact with the activities of their host. They grow as the piazza is exploited and they capture the place as more data is accumulated.

Sensorized Furniture

A very iconic system was designed, made up of simple outdoor objects such as seats, benches and tables that interact with both the users and residents of the piazza. With a simple system of piezoresistive force sensors, the furniture recognizes the presence of the seated and moving users and interacts with them by leaving a trace on the surface. Depending on the duration of waiting and the movements of people on the furniture, a system of LEC (lighting emitting capacitors) is activated in order to create a lighting pattern on the surface that grows as a parasite and then fades out when people leave. The furniture also reacts to the signals coming from the carpet, depending on the movements and speed of the activity.



4 Parasite interactive interface. Design of the projected interactive interface

Flows-sensitive paving

The flow-sensitive paving is made of pressure-sensitive tiles that record people's footsteps from which they record people's movement. The system occupies a part of the piazza capturing the flows of transit and the speed of the movements. It then responds with some light and sound feedbacks effects. As one walks in the piazza some light streams on the carpet turn on in the carpet following the people's movements, leaving a luminous trace of people who pass by. We chose the Penrose pattern for tiling as it allows for a large number of various fractal paving patterns with a wide array of imprints on the ground.

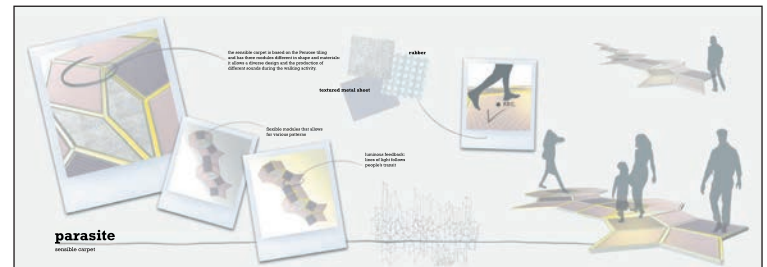
Interactive Communicating Panels

The third element is the communicating interactive nodes/ panels, a system that is anchored to the walls of the piazza and is linked to the whole system. A laser range finder captures people's hands gestures on the graphic plant of the piazza projected on the touch wall: people can see the feedback of the project, monitoring what is going on in different parts of the space in real time.

www.windowonlambrate.net

This website is intended to be an extension of the piazza into the virtual world. It gives people the opportunity to remotely watch detailed activities that occur in the piazza. Moreover, the website wide-spreads the idea and seeks other public and non-public bodies that might be interested in implementing the project in other places.

The behavior of each element is programmed to perform simple reaction to gathered stimulus; the complex behavior of the in-



5 Parasite sensible carpet. Design of the sensitive system of carpet modules that interact with walking users

teractive piazza is the results of interaction between all various components of the system. Nonetheless, the gathered data are saved and used to tune some free parameters of the reaction algorithm implemented in each node.

In order to provide enough computational power and to make the system flexible and easily extensible we chose to use a real computer tailored for embedded use instead of a simpler integrated circuit even if some PICs are used to gather signals and do preliminary operations.

The project was tested in a real site, (Piazza Bottini, Milan) in order to give more concrete proof of the reliability of the project where the idea was conceived to be easily adaptable to other public places.

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Laura

A window for your emotions

_WoMAN_WINDOW_ON_THE_MAN

TASKS & SKILLS

Giovanbattista Basile researched e-textiles and smart clothing. Developed the product concept and its visual representation.

Riccardo Bombarda: Project manager. Developed the product concept and design. Modeled and rendered the 3D model.

Mirko Iaconisi: Team Controller. Gave his contribution in market analysis, evaluated technological solutions and scheduled team activities.

Andrea Malagoni performed the emotion analysis determination process through sensors, tested low invasive approaches & designed the HW/SW system for the processing of data.

Laura Mata García developed the product concept and design scenarios. Researched lighting textiles and future developments. Organized and classified the material.

Andrea Vaccari analyzed state-of-the-art applications, reviewed the feasibility of available technologies, and coordinated test-and-tune sessions.

ABSTRACT

Modern lifestyle, especially in big cities, can create frenetic daily rhythms and stressful work conditions. Stress is one of the strongest emotional and physiological states of a human being. It is useful in critical situations, but it is really dangerous if it continues for long periods in our life. Relax is what millions of people look for after a long day of work. Our team chose to open a “window on man” within this topic, looking for an innovative product that could detect and show users their relax or stress condition.

Laura is a hybrid between a hammock, a sofa and a chaise longue. It is first of all a fascinating object and an interesting example of furniture design: because of its structure it does not limit the position of users to sitting but can stimulate them into using it in various ways. The innovative core of the hammock is the set of non-invasive piezoelectric sensors embedded in the fabric. Signals coming from sensors, in our concept, are collected and analysed by an elaboration unit integrated in the hammock support structure.

Following results obtained by different medical research groups a specific software was developed. It is able to classify the user’s relaxation condition comparing actual values with reference values. The system is then able to give him/her a defined feedback according to the specific scenario.

We suggested both a private scenario (home usage) and an entertainment scenario (public places or promotional campaigns). In the home environment the body of the hammock can graphically display a “relax thermometer” that shows the user his relax state at the present moment, while in the second scenario the piece of furniture can light up when touched, when one or more people sit in it and can reflect the mood and emotions of all of those sitting on it. This can also be used to generate an enriched user experience.



1 *Laura, the hammock in a modern house setting*

UNDERSTANDING THE PROBLEM

Opening a window on man to shed new light on the interaction between humans and their environment through the technological lens of sensors is one of the most fascinating problems that is currently being studied in a variety of fields, from computer engineering to interaction design and even psychology. The very same idea of understanding the emotional information that human beings naturally provide generated a new breed of research that goes under the name of Affective Computing. However, it is not clear how to collect the data that characterize this information, and therefore many questions remain open. Among them, we considered particularly important the necessity of capturing this information in a way that is transparent for the user, and of transforming the data into information that is really useful. These two requirements were the two main criteria that drove our analysis of the problem. We then decided to look around and see where the use of sensors could effectively improve the quality of everyday life. Existing applications have often obtained promising results but in highly specific contexts. Instead, we decided to propose a new application: we decided to create a device that can be both fun to use and useful to improve the day to day quality of life.

EXPLORING THE OPPORTUNITIES

The opportunity to integrate sensors inside a product, led the team to study in depth e-textiles and smart clothes. Many research

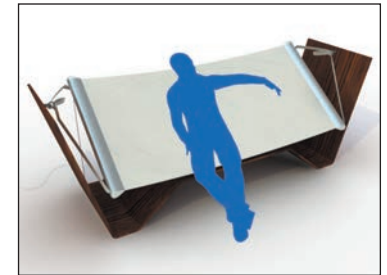


2 *Project logo*

3 *The product and its features: cloth and structure*



4 *Relax at home: sitting position*



5 *Relax at home: laying position*



6 *Relax at home: detail of the blocking system*

ch labs have already developed special smart shirts that can monitor parameters like ECG, EMG, breathing patterns and temperature, in order to monitor a patient's health. These products required the sensors to be directly in contact with the human body. Some of them required embedding them into tight shirts or special gels to be applied on the skin. These conditions were in clear opposition to the idea of non-invasive monitoring, whi-



7 User consciousness of his quality of relax



8 Distribution of the sensors inside the cloth



9 Displaying of the incremental levels of relax

ch was a fundamental requirement for consumer products. After much consideration we decided to pick, as our subject, the physical and emotional stress of everyday life, which, from a different point of view, can be defined as the level of relaxation and quality of living. Looking for a concrete solution, the answer came from the generation of just scenarios that helped to put the technology in a proper context.

GENERATING A SOLUTION

LAURA is a system of seats for both indoor and outdoor purposes, which proposes a reinterpretation, in a modern and technological way, of the traditional garden hammock. The product has two possible configurations: the classic one, with the fabric hooked to the wall, and the most innovative, self-standing one, supported by a curved multilayer plywood structure that includes space for magazines and other things. Another element of innovation is given by the possibility to use the hammock, either as a swaying bed or as a couch. This is achieved thanks to a lateral blocking system that blocks the main textile element.

The textile body of the product is made of a multilayered fabric that incorporates the sensors and electrical wiring. The heart of the project is made of its “invisible” technological part. With a symbolic inspiration in the concept of the aura, the energetic

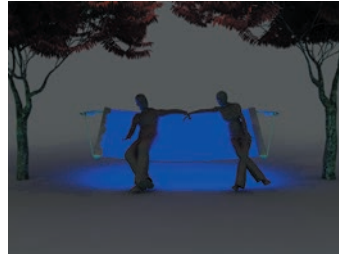
invisible field that surrounds every person, discovered that only through training and awareness, LAURA can open a window on man and make him aware of his emotional and physical state: the “energetic level” is visualized in the form of luminous graphic patterns emitted by the fabric of the hammock body.

Stress is a constant of our way of living, and everyone manages stress in his/her own way. Consequently, the answer given by LAURA, will be different depending on the scenario and the context where it will be used:

- 1 Entertainment Relax: public spaces such as restaurants, bars and hotels will use the hammock as a system not only for sitting but for entertainment: relaxing means to spend quality time in the company of friends, having fun and talking. LAURA can perceive the movements of who ever is seating on it, by means of movement sensors and interprets the impulses retrieved, generating luminous graphic patterns, creating a climate of playfulness and entertainment that becomes peculiar to that place.
- 2 Home-personal and Intimate Relax: Relaxing at home, in a comfortable non invasive environment that satisfies ones own sense of comfort: first and foremost LAURA is a piece of furniture, a modern chaise longue on which one can rest, read, listen to music or talk. LAURA will always speak in terms of



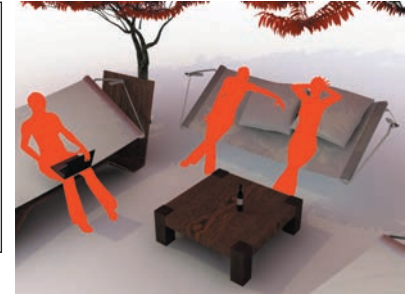
10 Relax in clubs: entertainment and pleasure with friends



11 Relax in clubs: light patterns generate enjoyment atmosphere



12 Exploded view of the hanging system: the plastic cap, the elaboration unit, wires, the extruded aluminium component, the cloth



13 Possible scenario and setting

quality of relaxation rather than stress and will not propose “miraculous” solutions like other products available on the market. It will propose, through the use of intelligent consolidated technology, a vision of life that is more human and close to natural rhythms.

From the technological point of view, in order to accomplish both the ambitious goals previously mentioned, we designed specific hardware and software system architectures. More in detail, for each of the identified scenarios, we defined a system composed of a set of sensors connected to a central elaboration unit that carried out the tasks of acquiring the data obtained from the sensors themselves.

Since most of the information, useful in detecting a person's state of relaxation, is contained in the HRV signal associated with cardiac activity and respiratory rate. In the Home-personal and Intimate Relax scenario we designed a system able to collect this kind of information by means of a set of piezoelectric sensors integrated in the fabric of the hammock. We used this approach based on the encouraging results obtained in the related performed laboratory tests.

In the aforementioned architecture, the signals produced by the sensors are acquired by the central elaboration unit that can be built with off the shelf components and that is integrated in the hammock support structure.

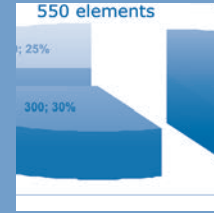
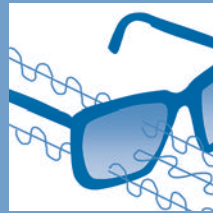
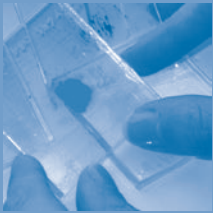
The software then proceeds with a classification of the user con-

dition of relaxation by means of comparison with reference values, that have been defined as standard values. The results of this interpretation are presented to the user at the beginning, during or also at the end of the period of relaxation spent on the system by means of coloured light indicators embedded in the structure of the product. In this way, the user himself can evaluate the quality and efficacy of the relaxation time on the hammock as previously underlined. In the Entertainment Relax scenario a system architecture very similar to the previous one is adopted. The difference lies on the fact that the data coming from the sensors integrated in the fabric is used to determine the level and the quality of the movement of the users.

The advantages of the proposed technological approaches rely on the very low level of invasivity, on the simplicity of the interpretation of the results presented by the system and on the fact that, for this reason, these approaches can be applied in the most different contexts of application.

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PROJECT

2

F.L.A.G.



FUTURE OF LENSES AND GLASSES



F.L.A.G. Future of Lenses and Glasses

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project 2

*Luxottica & the Glasses Production
Evolution: SmartVision, Flexible
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PROJECT DESCRIPTION

THE CHALLENGE

The sponsoring company Luxottica suggested two separate streams of research: developing new products or improving the current production process located in Lauriano (To).

Thinking about such broad themes as emerging technologies, product features, changes in society at large and consumers' behaviour was required. Research on the improvement of the current production process led students to focus on specific topics.

Students focusing on new products (groups A and B) mainly considered lenses as parts of glasses, i.e. of the final product. On the contrary, students analysing production processes (groups C and D) mostly focused on the lens itself.

THE TEAMS

Rich variety of skills and backgrounds allowed designing truly multidisciplinary projects.

Groups A and B initially joined brainstorming on new products, concepts, functionalities and technologies. Two most promising new product options were finally selected with the decisive contribution of Luxottica.

Group A investigated the opportunities stemming from self-cleaning lenses, and their functionalities have been analyzed. Focusing on water removal, technologies and physics were investigated and the market for such products was selected, thus ranging from management to more traditional engineering fields.

Group B has investigated the opportunities stemming from flexible lenses. Performed activities ranged from technology scouting, suppliers' selection and market analysis. Students leveraged on their respective backgrounds to perform both technological and business analyses.

Group C challenge was to investigate a strategic option for Luxottica: buy vs make polarizing lenses. Currently Luxottica buys these lenses from supplier and is considering to in-source this process, thus challenging students to properly set decision making problem.



Group D was asked to improve the quality of the production process at the Lauriano production plant. Students collected and analysed production samples. They employed mathematical and technological skills to analyse production processes through statistics and materials science.

THE RESULTS

Groups A and B designed new options for launching new products. Group A designed new product positioning the company is actually considering to implement. Group B strived to develop glasses prototype with ultra-flexible lenses. Both groups have performed interesting marketing analyses. In both cases customer needs and technologies proved to transcend initially conceived targets.

Group C broadened the landscape of classical make/buy decisions by merging technological analyses with consumers' interviews to estimate the potential trends in demand for polarizing lenses.

Group D has identified the root cause of a large portion of defects in the production process through both statistical and chemical analyses. Students suggested changes in process and materials to avoid these problems. Some suggested solutions were actually implemented by the company.



SmartVision

TASKS & SKILLS

Antonia Sabina Andriani and **Silvia Francesca Notaro** focused on the definition of a competitive self-cleaning product concept within Luxottica brand portfolio, the definition of product launch, the marketing strategies and the communication process.

Eugenio Lettieri participated in running the market analysis and contributed to defining the business scenario for self-cleaning lenses.

Xuefei Liu participated in defining the technical features and the technological feasibility of the proposed self-cleaning concept.

Jessica Nora was responsible for market analysis which particularly focused on user requirements definition and brand portfolio analysis. She worked in close relationship with Antonia Andriani and Silvia Notaro in defining the product concept and marketing strategy.

Luca Sironi was responsible for defining the state of the art in self-cleaning theories and technologies. He decided on the technical features of the proposed self-cleaning solution.

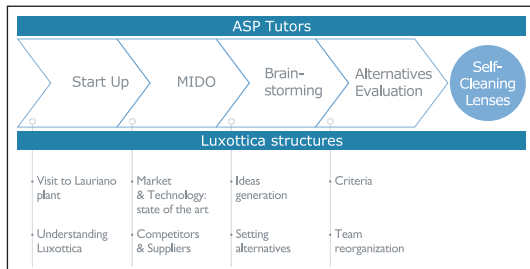
ABSTRACT

Our team's work was focused on research for new and innovative products, with the aim of helping Luxottica Group outline the next generation of lenses. After initial phases of ideas generation and screening, self-cleaning lenses were selected among multiple possibilities.

Through desk analysis we explored existing self-cleaning solutions and best market practices. To identify users' requirements and to outline opportunities for marketability, we conducted consumer and retailer surveys. Collected data clearly indicated that most people ignore the self-cleaning notion; nevertheless, the vast majority of them showed interest in its benefits (i.e. anti-fingerprint functionalities).

From a technical/technological perspective, two main concepts of self-cleaning coatings were identified: hydro-/oleophobic films, which repel water/oil droplets and so called hydro-/oleophilic films, which cause water/oil droplets to form sheets. To meet detected users' requirements, the hydrophobic route to self-cleaning was chosen as it seemed to be the most favourable for applications on eyeglass lenses. Moreover, fine control of the nano-structure of hydrophobic surfaces and the accurate tuning of titanium dioxide nano-dispersions allow innovative performances in respect to other products on the market.

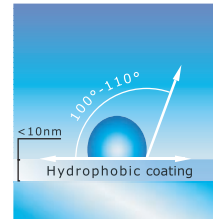
Regarding the self-cleaning product launch strategies, the survey confirmed the results coming from the desk analysis. Communication plans on self-cleaning lenses have been addressed only to retailers to push them to buy these products (push strategy). Best practice cases like Transitions® photochromatic lenses show how investments in orientating marketing strategies towards the consumer can increase market demand and retailers' selling power. Therefore, our final proposal requires a communication process more focused on consumers to stress the advantages they can get from the self-cleaning feature (pull strategy). Besides, we recommend the creation of a specific brand for self-cleaning lenses to be sold with specific existing Luxottica sunglass brands.



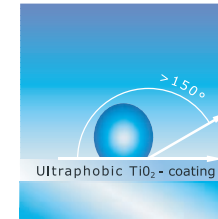
1 *Early phases of the New Product Development process (NPD)*



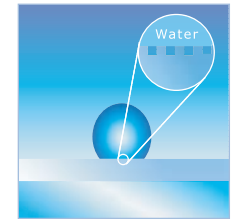
2 *Different features underneath the self-cleaning notion to be explored*



3 *Contact angle on easy-to-clean hydrophobic surfaces*



4 *Contact angle on ultrahydrophobic surfaces with TiO2 nano-dispersions*



5 *Surface roughness must be accurately designed on ultrahydrophobic surfaces.*

UNDERSTANDING THE PROBLEM

The aim of the project is to think about the next generation of lenses for the eyewear market.

Since at the very beginning of the project objectives, stakeholders and requirements had not yet been specified nor well defined, most of the activities that were carried out refer to the problem setting, rather than to the problem solving. This also explains why we organized early activities by performing only the first steps of the New Product Development process (NPD): among these, we started with ideas generation and ideas screening.

To generate ideas, we started by analysing current products and technologies. This desk analysis was carried out by using books, magazines, journals and internet research, as well as by visiting fairs (Mido). Starting from such analysis, together with our personal experience as eyewear users and by collecting information via informal interviews, we identified some of the user's needs and from there decided on some possible ideas.

Regarding the ideas' screening, we worked in close connection

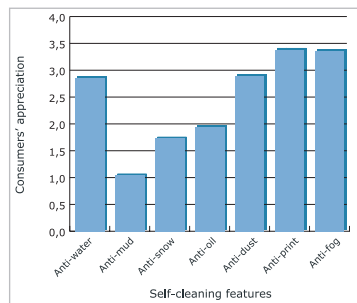
with our Luxottica tutors, attempting to capitalize on their knowledge of the market. Ideas screening was mainly based on two criteria: the coherence with Luxottica's vision and the exploration of the most promising future paths from both the technological and marketing points of view. Moreover, as Luxottica lenses production strategies will continue focusing on sunglasses, only solutions for this segment were taken into consideration.

Nowadays new technologies and product differentiation are the main stimuli for continuous replacement of current products by consumers. The frames market is already mature; the lens market, on the other hand can still offer a wide margin of action for innovation. That is why we concentrated on lenses on the exploration of their possible new functionalities. Among multiple generated ideas, self-cleaning lenses were selected.

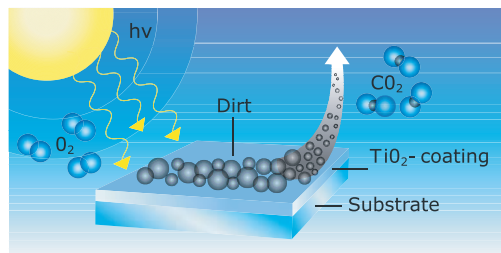
EXPLORING THE OPPORTUNITIES

Once the aim of the project was defined, our work entered a new phase. Thorough market analysis in self-cleaning applications was performed to outline the state of the art in terms of existing products, users' requirements and current technologies.

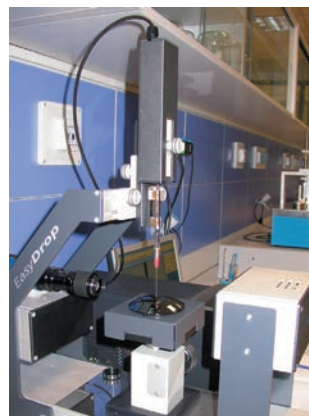
Existing Products Desk analysis indicated that two sectors for self-cleaning applications already exist: the household and leisure commodities sector and the eyewear industry. Regarding the eyewear sector, it is worth mentioning that most applications have an easy-to-clean system, rather than a true self-cleaning one.



6 Customer survey results reveal that most people show interest in self-cleaning properties, especially in anti-fingerprint and anti-fog



7 TiO₂-induced photocatalysis on ultrahydrophobic transparent thin films



8 Hydrophobic coating testing machine

9 Luca Sironi measuring contact angles in Luxottica plant in Lauriano



Users' requirements The analysis of existing products reveals that “self-cleaning” can have different meanings. In order to understand needs and define the project requirements, a questionnaire-based survey was developed at this stage.

Questionnaires indicated that the replacement cycle had shortened and consumers often owned several pairs of sunglasses. Furthermore, they demonstrated that not only sports activities give rise to interest in self-cleaning. Finally, they suggested that users do not have a clear conception of self-cleaning and tend to underestimate the benefits connected to this notion. Nevertheless, users expressed a very positive interest towards specific self-cleaning-like properties. This can be interpreted as a lack of clear communication of this functionality.

Self-Cleaning: theories and technologies Desk analysis indicated that two main concepts of self-cleaning coatings have been developed so far: the so called ‘phobic’ films that repel liquid droplets and the so called ‘philic’ films that cause liquid droplets to form sheets. Terms hydro-/oleophobicity and hydro-/oleophilicity should be used when the liquid deposits are water-based or oily. Hydro-/oleophobicity and hydro-/oleophilicity are closely related to the contact angle that liquid droplets form on the surface. The higher the contact angle above 90°, the more ‘phobic’ the response (180° for so-called ‘ultra-phobic’ surfaces); the lower

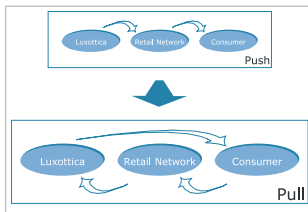
the contact angle under 90°, the more ‘philic’ the response (0° for ‘ultra-philic’ surfaces). Regarding the hydrophobic route to self-cleaning, dirt removal may also be enhanced by nano-dispersions of TiO₂ particles. However, various challenges arise when self-cleaning surfaces have to meet strict optical requirements rather than just a cleaning performance.

GENERATING A SOLUTION

Technical solution From the technical point of view, the hydrophobic route to self-cleaning lenses seems overall more advantageous. The ‘phobic’ response is preferable as it is the most competitive on the small size of eyeglass lenses; furthermore, hydrophobicity still allows higher oleophobicity, while maintaining high optical standards.

No real ultra-hydrophobic solution already exists in the eyewear market. Hence, the final solution for innovative and competitive-in-the-market self-cleaning lenses is to be found in the so-called ‘ultraphobic’ surfaces.

Ultraphobicity requires fine control of the nano-structure of the surface. This can be accomplished either by plasma-enhanced chemical vapour deposition or by plasma etching techniques. In addition to this, the combination with the oxidizing effect of TiO₂ can drive it to a high-performance innovative solution. By accurate tuning of TiO₂ nano-dispersions in fact, improved



10 To increase the market demand it is recommended to capture consumers' attention switching the commercial strategy from push to pull



11 Essilor's demonstration addressed to retailers to push them to buy easy-to-clean Cleargard lenses



12 Luxottica's campaign Never Hide fascinates customers through Ray-Ban values and pull them to buy sunglasses



13 Advertising with logo and payoff: Be Smart. See Smart

hydrophobicity and direct degrade of organic deposits by photocatalytic effect can be achieved, while maintaining very low scattering and high transparency. Finally, it was demonstrated that such TiO₂-treated surfaces exhibit high performances with respect to life-fatigue and UV-resistance.

In conclusion, TiO₂-enhanced ultraphobic surfaces prove to be more innovative and reliable when it comes to self-cleaning lenses in the market.

Marketing strategy We approached the communication strategies adopted so far, both to present existing self-cleaning lenses and to launch new ones.

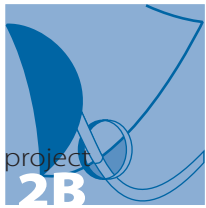
The analysis of survey results indicated that most consumers ignore the existence of the self-cleaning feature. This lack of information may be due to an ineffective way of presenting opportunities for existing products. The communication plans are addressed to retailers to push them to buy lenses (push strategy), but this kind of approach doesn't seem to be able to adequately stimulate the user's sensitivity. Therefore, to increase the market demand, a more efficient communication process should be developed to capture consumers' attention (pull strategy), employing images from everyday life and stressing the benefits of self-cleaning lenses.

Regarding the launching strategy, we detected a variety of possible patterns. The most promising one being to create a dedicated brand self-cleaning lenses and to propose them with some existing sunglass brands only.

Although this is probably not the best option with respect to commercial feasibility, in the short term it seems to be the most suitable to create value for both the users and Luxottica Group. Starting from this choice, a new brand for self-cleaning lenses was developed: SmartVision. For its launch into the market, we associated it with the existing brand Ray-Ban and we designed a communication strategy whose aim was mixing the technical roots of the self-cleaning product with the inspirational content of traditional Ray-Ban campaigns.

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Flexible sunglasses

TASKS & SKILLS

Matteo Agostino worked on the technical features of flexible lenses. He studied the manufacturing processes through which traditional lenses are realized.

Marco Chino analyzed the existing flexible sunglasses and the eyewear new product development process. He prepared and evaluated the online survey. He was directly involved in the development of prototypes.

Gizem Kaya worked on customer needs and development of the use cases. She prepared the online survey and analyzed the results. She assisted the preparation of prototypes.

Fausto Pelanti prepared the online survey and analyzed the results. He was directly involved in prototype development. He managed team work and communication with academic and external institutions.

Edoardo Prina worked on the technical features of flexible lenses. He worked on the material of the lenses and contacted the technical tutors and factories. He took part in for the realization of prototypes.

ABSTRACT

The goal of this project was to help Luxottica to imagine what future glasses will look like. This meant thinking of new functionalities, new ideas and possible unexpressed consumer needs: in other words trying to imagine the new generation of eyewear products.

The initial phase of the work challenged our creativity. In order to come up with really innovative concepts we had many brainstorming sessions, while also keeping an eye on the market's latest development both as a source of suggestions and as an alert showing the already existing products. Many ideas were generated, but two of them had to be selected. One of the two ideas that survived this screening phase was the ultra flexible sunglasses that became the concept our group went on to developed.

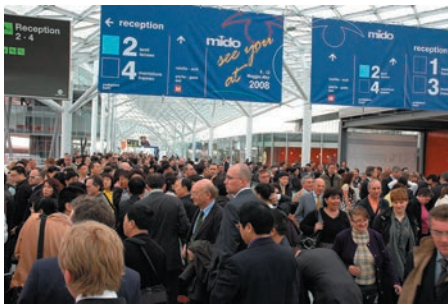
At the start of this new phase our work consisted mainly of exploring the technological possibility to create such an object: the aim was finding out which materials and technologies would have allowed for such a flexibility both in the lenses and in the frame. In the meantime we also started to investigate what the market offered in terms of flexible sunglasses. By doing this, we got to know the state of the art of lenses and frames, shedding light on the cutting-edge technologies available.

Regarding lenses, our research effort led us to the new generation polymer NXT, while regarding frames, the titanium based and silicone rubber ones were the two best options we had. The prototype was developed exploiting these possibilities.

While the technical features of the sunglasses were studied, we also began exploring the economical side of the issue, trying to figure out how the market would respond to the product and the new meaning of flexibility embedded. We launched an online survey dedicated to our target customers. This survey helped us not only to better understand the market but also to estimate the demand and the price customers were willing to pay.



1 Some examples of typical eyewear advertisement. Sunglasses are presented referring to design and style concept



2 Mido International Optic Fair in Milan

UNDERSTANDING THE PROBLEM

The very initial goal of the project was to generate new ideas regarding sunglasses. The concept of ultra flexible sunglasses was one of the ideas Luxottica was most interested in, considering the trade off between innovativeness and feasibility.

Our studies and market research showed that, the supply of flexible sunglasses was very limited, with just a few examples in the sport segment. Moreover, when flexibility was present it was showcased only as a safety oriented feature, aimed at avoiding cuts resulting from the broken glasses or from hitting the lens. The target group was also quite narrow, being made up of just sportsmen. The flexibility was never advertised, and was never taken as a core concept.

In the meantime we started to examine the materials that could provide flexibility to both lenses and frames. The flexibility, especially regarding the lenses, required the latest technology available and was not very easy to find the suppliers, since this concept is not asked or for advertised very much.

Characteristics	Glass	CR39	Polycarbonate	NXT
Density gr/cm ³	2,53	1,32	1,22	1,11
Refractive index	1,52	1,50	1,59	1,53
Abbe number	58,4	57,8	29	45
Chemical resistance	Good	Good	Poor	Good
Stress cracking	Fragile	Fragile	Sensitive	Not Sensitive
Photochromic	Yes	Yes	No	Yes
Suitable for Sports	No	No	Good	Excellent

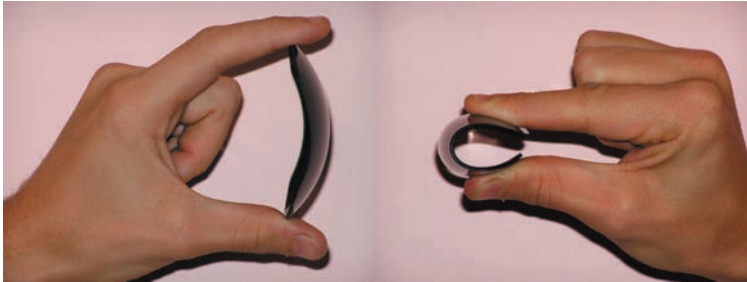
3 Features comparison between NXT and other traditional materials

EXPLORING THE OPPORTUNITIES

We felt that innovative results could be reached only by rethinking the interaction between frame and lenses, the two main subsystems of the product. Aiming for this result, we started exploring how the concept of flexibility has been implemented in eyewear products so far, what could be the major threats coming from substitute products and what opportunities state-of-the-art technologies offers.

Products already available that embed the concept of flexibility are mainly: foldable glasses, flexible frames and goggles. Actually foldable glasses do not have flexible-material components but foldable capability is achieved with a system of hinges that allows them to be bent and put into a pocket. Instead, flexible frame glasses are made of silicone rubber or metals, mainly titanium, with elastic and memory shape properties but lenses remain rigid. Conversely sport goggles are flexible in their monocular lens, mainly to provide safety, but are not suitable for the everyday use.

The technological state-of-the-art scenario offers three different materials for lens manufacturing. The most classical one is glass, which is also the only material that can originate 100% optically correct lenses. Moreover glass offers good scratch resistance but nowadays it is an expensive and lens are heavy. Polycarbonate

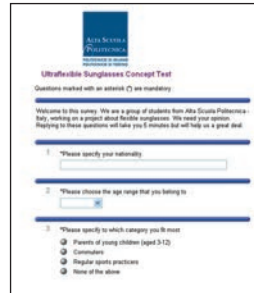


4 Flexible capability of an NXT soft 54 lens

(PC) and CR-39, are cheaper alternatives. The first is a transparent thermoplastic polymer with high resistance, even to strong load and stiffness. PC can split and crack, but it will not shatter. Although it is shatter-proof, it is the most easily scratched of all lens materials: indeed surface coatings are added to PC lenses to protect them from being scratched. The second, CR-39, presents characteristics that are quite similar to those of PC, even if it is less likely to be scratched though still more than glass. It has the highest abrasion resistance of any uncoated optical plastic. In addition it is about half the weight of glass and almost as optically pure.

During the research, we found out that the only material that was able to achieve the goal of flexibility while maintaining good optical properties was an NXT variant. The NXT family consists of Poly-urea-uretanic polymers. This material is chemically resistant, and has excellent optical, mechanical and anti-scratch properties that last in time. Apart from these features, in NXT's latest version, Soft 54, the material showed the feature that we were most interested in and which was not considered before; i.e. flexibility. These NXT lenses could be even more flexible, but that would be useless as optical aberrations phenomena could arise. Moreover NXT lenses can undergo the same performance enhancing treatments as traditional lenses.

Another promising path for the future lenses will be the bio-ba-



5 Screenshot from Zoomerang.com, the website used to create and deploy the online survey



6 Prototype consisting of a pair of NXT soft 54 lenses and a silicone rubber frame

sed polymers, but this technology is at the very early stages, and they're not yet transparent.

Regarding the frames many choices exist however they limit the flexibility provided by the NXT lenses. Typical frames are very rigid, so when NXT lenses are combined with these rigid frames, we cannot benefit all the flexibility provided by the lenses but at least this combination provides safety against impact. With flexible frames, such as titanium or silicone rubber, the sunglasses provide safety and complete flexibility. Since every change in the shape of the lens produces a variation of optical properties, frames should flex under stress, but they should stay in their proper position when worn preventing optical distortions.

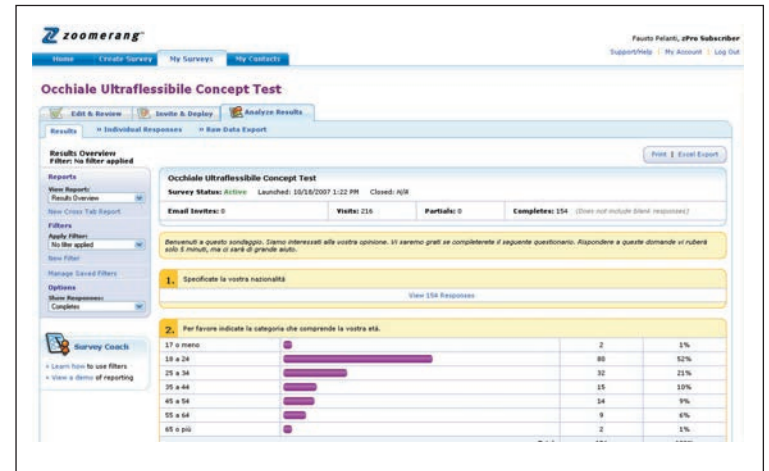
GENERATING A SOLUTION

The outcome was the result of two innovative moments. The first came in the idea generation phase, since the idea of flexible sunglasses was something we developed on our own. The second innovative moment was how to develop this idea, and we were the first to present flexibility as the main feature, the core concept of the product: this involved change in the product, as well as change in the meaning of the concept of flexibility, and as a consequence a change in the market base. Since we needed a product consistent with that vision, we realized that we needed to achieve total flexibility. This was something really unprecedented: even if



7 The team working

our product would be not the first to sport NXT soft lenses, nor the first to be equipped with a highly flexible frame, it would be the first ever that combines these two elements together. By combining these two features, we achieved total flexibility in a pair of sunglasses and this allowed us to put flexibility at the center stage of the product. The meaning we gave to the concept of flexibility was also different from what was advertised, even if marginally, in past sunglasses: flexibility was pushed as a safety enhancing feature, basically to avoid being hurt while doing sports. Instead in our product, flexibility, while still retaining its safety properties, would mean primarily freedom, freedom not to be constantly thinking about breaking or scratching your sunglasses while using them or while carrying them in your bag or backpack. As we stated before, this innovation involved a change and broadening of the market base: the target shifted from sportsmen only to potentially every user of sunglasses because of the “everyday use” approach of our sunglass. But we were conservative, and so we started to think of possible target groups that could have been particularly interested in our product. This was done mainly



8 Screenshot from Zoomerang.com, the website used to create and deploy the online survey. In the picture you can see the Analyze Results panel, and the results overview interface

through imagining possible occasions for using them: we identified three target groups, namely parents of young children, commuters, and sportsmen. We thought of parents of young children because of the possible risks of having their children hurt while playing with their sunglasses commuters because they are usually in a rush and often travel on crowded public transportation where being hit and compressed are very likely.

The quantitative market analysis got started after the realization of a preliminary prototype made of 0,8 mm thick NXT soft 54 lenses and silicone rubber frames. An online survey, with a picture of this prototype, was used to test our hypothesis, and also to get general indications about the product acceptance and the willingness to pay for it. The survey also gave us an indication of possible demand from the target customers, in the period following the launch. Another possibility we analyzed was mounting NXT lenses on a minimalist, titanium frames, to give as much freedom as possible to the lens.



Pro.Po.L. Production of Polarized Lenses

F.L.A.G. _ FUTURE OF LENSES AND GLASSES

TASKS & SKILLS

Franco Di Giacobbe was responsible for the understanding of technical aspects of the productive process and materials involved.

Claudio Andrea L'Abbate was responsible for the research, contact and knowledge gathering from potential raw-material suppliers.

Anna Maria Cristina Sanfilippo was responsible for the project schedule. She worked on the feasibility analysis, organized a market survey and was in charge in analyzing data from the market survey.

Carlo Pirola was responsible for the evaluation of the different processes. He analyzed the patents and related them to the quality of the final product.

ABSTRACT

Polarized lenses cover an emerging part of the market, because of their capability to reduce, and ideally eliminate, glare, whose persistence is a stressful condition for the human eye. This may seem to be unimportant, but this aspect becomes relevant, for instance, for people spending all day skiing or playing golf during a sunny day, or even driving a car or riding a bike when the sun is on the horizon.

Our partner firm in this project is currently buying polarized lenses from an external supplier and is now evaluating the opportunity of producing them in house. They asked us to find the best trade off among various possibilities to realize a new plant: materials, technologies, machinery and productivity.

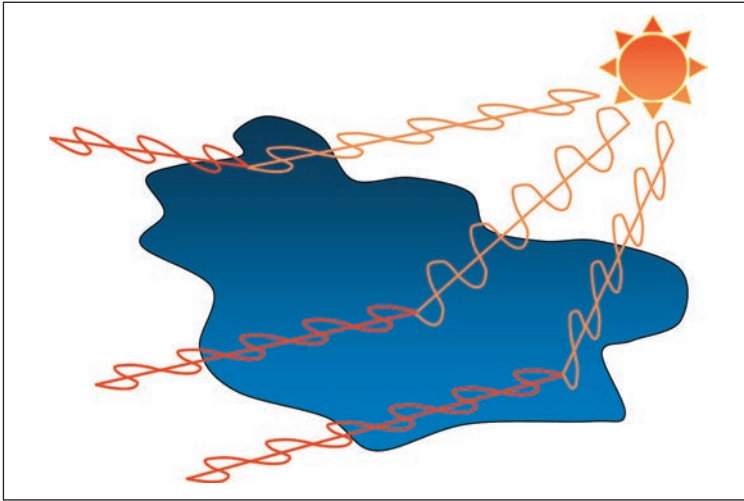
First we started approaching the world of sunglasses from a different perspective: that of the producer.

We started with several meetings at the Luxottica plant in Lauriano with R&D supervisors and manufacturing engineers to better understand the dynamics of typical lenses production. We also visited an international exhibition to understand the state of the art of sun lenses worldwide.

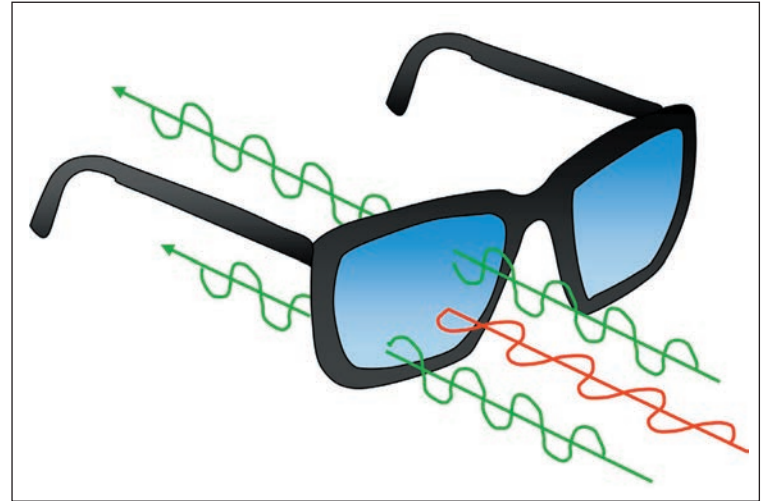
Then we went through some technical aspects in more detail, such as materials, machinery and workforce involved in the different possible manufacturing processes, and the possibility to integrate this production process with the existing one dedicated to ordinary sun lenses.

Eventually, we tried to answer the question “what will the polarized lenses’ market look like in ten years time?”. Our aim was to understand whether polarized lenses would be a good investment for our sponsor, and if the customers would be interested in this kind of product in order to set the productivity of a new plant.

The output of this project is to identify the best solution for our sponsor regarding this opportunity: make-or-buy strategies, materials, machinery and suppliers.



1 Sun light has random polarization, but is horizontally polarized after reflecting on a flat surfaces



2 Red waves, horizontally polarized, are filtered by polarized sunglasses. Green waves, vertically polarized, are not attenuated

UNDERSTANDING THE PROBLEM

At the beginning of this project none of us had any knowledge about production processes, so in the first days our main aim was to become aware of the techniques used in Luxottica to produce sun lenses. During our visit to the plant in Lauriano, we first became familiar with all the machinery required to produce sun lenses: extruders, dryers, washing basins and so on. We analyzed the several steps of the process, while understanding the various transformations of raw materials. We then focused our attention on the issue of the polarization of light.

Each ray of light has its own direction, and perpendicularly to this direction the electric field of incident light vibes in equal distribution on all planes. If this radiation is filtered in a single direction, we speak of “linear polarization”. This is possible by using a filter, a sheet of a polarizing material, that lets the radiation pass only in a single plane.

Even unpolarized incident light, such as natural sunlight, is polarized to a certain degree when it is reflected from an insulating surface like water or a highway. In such cases, the electric field vectors of light parallel to the insulating surface are reflected to

a greater degree than vectors with different orientations. This is the root cause for annoying glare, and in the long run it can wear out the human eye.

A polarized lens consists of a classical lens with a polarizing sheet inside it that allows linear polarization of light in a perpendicular direction compared to the insulating surface.

There are some features polarized sunglasses should have in order to be sold in the market. These features can be obtained through a good production process. Besides, the more these features are enhanced, the better the optical quality of the sunglasses. But different features entail different production processes, with different costs and benefits.

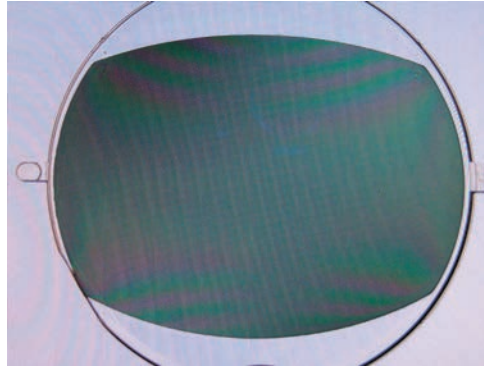
EXPLORING THE OPPORTUNITIES

Our group aimed at finding the best trade off in this regard, and we started to identify different processes for producing polarized sun glasses, each of them characterized by different costs.

Processes can be classified by several features: we classified by materials used for producing lenses, as both organic and inorga-



3 Machinery used to produce sun lenses



4 Polarized filter inside a white lens

nic materials can be used: in particular, glass lenses vs. polymer lenses. The former compensate higher costs with better quality, the latter gives a poorer quality, but has lower costs, in addition to a higher impact resistance. These materials require different kinds of manufacturing processes: glass lenses must be produced with a casting process, using a cast and a counter-cast in which liquid glass is cooled with the desired shape. This manufacturing process can be used even with thermosetting plastics. For both thermosetting and thermoplastic materials injection moulding is the main process used for producing lenses. Usually injection moulding involves a closed mould, in which molten plastic is injected at high pressure. Before the injection, raw material is stocked in pellets, and put into a heated dye, in which the plastic is liquefied and then pushed inside the mould. High temperature combined with high pressure can result in flaws, obviously undesired. This can be avoided by using injection coining: this technique is similar to the former, but in this case the two parts of the mould are not hermetically closed, but a little space between them allows for the lowering of the exercise pressure.

The real problem in our case was how to place the filter in the middle of the lens. This would be quite easy with the casting process: the polarizing sheet could be simply placed in the middle of the cast, and then the process could easily continue. In the other cases this operation is not trivial, and specially-designed tooling should be adopted. Even the position of the film (it must be as

“outer” as possible, near the external side of the lens) makes the crafting of the product difficult. These elements mean additional costs, together including labour costs, that should be evaluated because the casting process needs more manual labour, while other processes are more automated.

An important aspect we thought about was the kind of filter that could be used. A great variety of polarizing filters is available today thanks to applications in Liquid Crystal Displays (LCDs). There are some differences in the technical specifications of these filters - compared to standard filters for sunglasses - that should be addressed carefully, which we have started to evaluate, also by means of practical experimentation. However, in spite of these differences, the much wider availability of the former type (due to the recently booming market of LCDs) and consequently the much lower price that would be incurred when purchasing this type of raw material rather than the standard one make this option worthy of further detailed study and evaluation.

On the other hand we decided to gauge the relevance of this market and the opinion among customers and retailers about polarized sunglasses.

In order to better understand the polarized lenses market, our group decided to settle a qualitative market survey. More specifically the survey was not intended to determine market size and similar data, easily available from the Luxottica Marketing office, but to focus on final consumers and aimed to investigate more

qualitative information, like consumers perception on polarized lenses and the gap between their willingness to pay for normal-sunglasses and the willingness to pay for polarized sunglasses.

The market survey was organized in two main parts:

- survey involving different actors of the supply chain, conducted via e-mail: we proposed a questionnaire to polarized lenses manufacturers and distributors, in order to collect information on feedback from their clients: we developed a standard set of questions for each type of actor of the supply chain,
- survey involving consumers, conducted in person, through interviews to consumers,
- we developed a standard set of questions, simpler than those formulated for manufacturers and retailers,
- we identified a demographic sample, trying to make our demographic target as representative as possible,
- we conducted interviews in person, allowing people to try on 8 pairs of different sunglasses (with different kinds of normal or polarized lenses) and asking them their preferences and the price they would spend to get the one they preferred,
- we analyzed data, in order to better understand the consumers final point of view and if they actually appreciated the difference between normal and polarized sunglasses.

This second part of the market survey was more successful and showed that consumers actually feel more comfortable with polarized sunglasses.

GENERATING A SOLUTION

The output of our project consists in the definition of a framework that allows making strategic decisions based on a sound rationale.

We had to evaluate every aspect of this problem, including:

- fixed and operative costs,
- effects of the location of the plant,
- the possibility of automating processes,
- quality of final product,
- quality perceived from customers.



5 Sunglasses used during the survey

First of all we learned about technical aspects, so we read patents from principal producers of polarized lenses.

Concerning market analysis, we analyzed polarized sunglasses sales data from our sponsor firm. Then we carried out a survey among customers to estimate their opinion about different kinds of sunglasses and their willingness to pay a higher price for a pair of polarized glasses.

As to using other types of filters, we asked polarizing film producers for some information, but the results of the experimentations currently underway are necessary in order to more carefully evaluate this new opportunity.

Backed by this knowledge we are ready to meet the requests from our sponsor firm, and help it make sound decisions regarding this task.



Flaws Control & Reduction Strategies for Efficiency Improvement of Polyamide and Polycarbonate Lenses Production Process at the Luxottica Plant in Lauriano (TO)

TASKS & SKILLS

Alessio Courtial performed a technical role in describing physical aspects of the production process in Lauriano and studying mechanical properties of the materials used in lens. He organized, in collaboration with his team, several meetings necessary to the development of the project with the Chemical Laboratories of Politecnico di Milano and the Luxottica Technical Staff. Moreover he collaborated in the definition of a suitable solution for the flaws reduction.

Francesca Asteggiano and **Valeria Tringali** took care of the problem setting and solving. They developed methodological aspects in order to perform a statistical analysis suitable for the identification of causes for the “Black Dots” onset, after a careful observation and classification of the sample lenses. Moreover they studied the results coming from the chemical analyses performed at the Politecnico di Milano and collaborated to detect possible solutions for reduction of flaws.

ABSTRACT

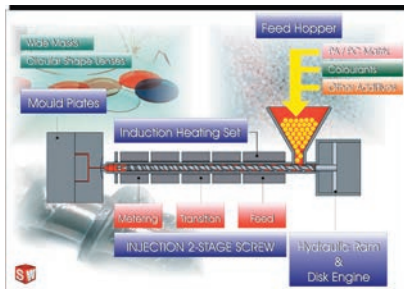
The main target of this project is to suggest efficiency improvement strategies for the Luxottica Sun-Lenses Production Process in Lauriano. Even if the ASP students original aim was the Innovation promotion through the application of “problem setting” approaches, the Luxottica Technical Staff in Lauriano focused mainly on short term problem solving. The resulting compromise evidences that “Innovation” means not only generating new instruments, but also improving technologies that still exist today. As a consequence, the Team had to study many technical aspects of the Injection Moulding Process for Lenses production, in order to understand what kind of improvements could be effectively made.

Even if Luxottica’s production is characterized by very high quality standards, a wide range of types of Flaws was identified. The so called “Black Dots” proved to represent the most significant and dangerous type of defects, because their opacity permanently compromises the lens transparency. Since they consist in “inclusions” beneath the surface of the lens, they cannot be erased by any further processing strategy, such as coatings, varnishing, etc. In order to arrange a valid strategy for “Black Dots” reduction, the mechanical re-engineering hypothesis, applied to the Injection Screw was immediately rejected because of its high cost.

The team focused on two different approaches. The first one was based on chemical analysis of the materials blend components, using Raman Spectrographic Tests. The second one was characterized by a statistical investigation of Flawed Lenses Samples. The influence of many factors, especially the presence of additives, on the “Black Dots” recurrence was evaluated. The outcomes of both these Analyses indicate this Flaws type as the principal cause for Lenses trashing.

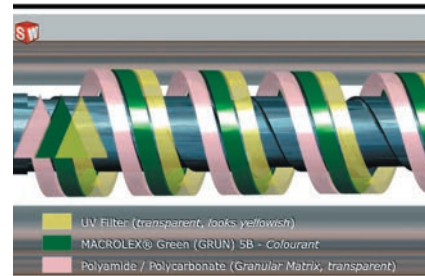
Some solutions were finally proposed in order to promote a better use of colorants within the Production Process. New dosage strategies, before the materials blend enters Feeding Hoppers, could be applied in order to reduce both the number and dimension of Flaws.

FLAWS CONTROL & REDUCTION_STRATEGIES FOR EFFICIENCY IMPROVEMENT OF POLYAMIDE AND POLYCARBONATE LENSES PRODUCTION PROCESS

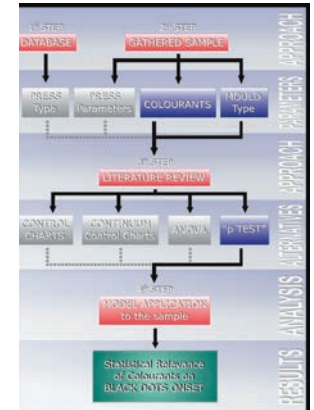


1 Main steps of the Injection Moulding Process

2 The Injection Screw design strongly influences the Materials blending efficiency. The Laminar Flow Model does not allow Materials correct mixing



3 The logical scheme of the “Problem Setting” Statistical Approach



UNDERSTANDING THE PROBLEM

Innovation means not only generating new instruments and satisfying new needs, but also developing and improving still existing technologies.

The Process for plastic Sun-Lenses production, set up in the Plant in Lauriano, is based on technological and economical complex dynamics. A complete understanding of it could only be acquired by direct multi-year experience. However, some particular steps from raw materials, to lenses quality control could be analyzed instead of the whole process.

The storage of materials was considered as a possible pollution source. Then an in-depth study on materials metering strategies and Feed Hoppers filling was carried out: the solid particles of the plastic blend enter the Injection Pipe and thanks to the Injection Screw, are melted and homogeneously mixed. The next steps were Mould filling and Lenses Extraction. The products were then controlled and selected, according to the Plant Management Quality targets; this step lead to discarding flawed lenses.

As it was suggested by the Plant Staff, a range of types of Flaws were identified, in particular:

- “Black Dots”;
- “White Dots”;
- Local Tensile Stress Accrueings;
- “Colourant Rings”.

Among all the causes for Flaws, “Black Dots” represent about 50% of the total number. Furthermore, a “Black Dot” usually appears as an opaque spot under the Lens surface, so it cannot benefit from the next processing activities, thus causing immediate Lens trashing.

Since Luxottica wanted to reach specific short term goals, the Team and the Plant Technical Staff reached a compromise between the initial aims of the ASP Project and the factory targets. A common goal, coherent with Innovation promotion, was first identified in the study of the “Black Dots” onset and then in the derivation of strategies and solutions suitable for the reduction of Flaws and Quality improvement.

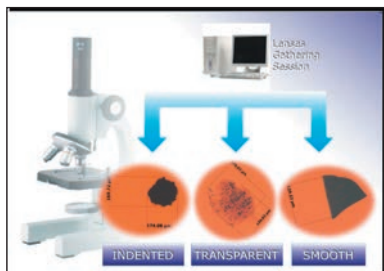
EXPLORING THE OPPORTUNITIES

In order to reach our goal in reducing “Black Dots”, the whole process was analyzed and some criticism was identified in the Injection Moulding phases.

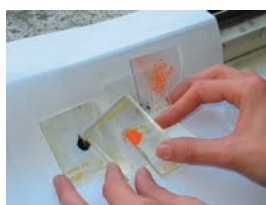
The team decided to approach the problem from chemical and statistical points of view.

Even if the Screw conformation determines the efficiency of materials mixing during the Injection steps, the presence of barriers on the Screw leads to stagnancy zones and local degradation of some blend components. Since a mechanical re-design of the Screw would result economically unacceptable, the Team focused on matrixes and additives such as colorants and UV Filters.

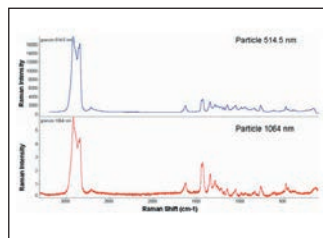
The spectrographic Raman Analysis is a technology used to determine the materials chemical composition and the molecules structure. The “Raman Effect” (i.e. a light emission induced by a laser monochromic radiation) can be successfully applied only



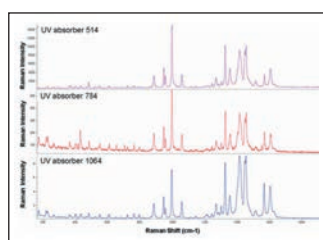
4 Lens Gathering and Flaws Classification



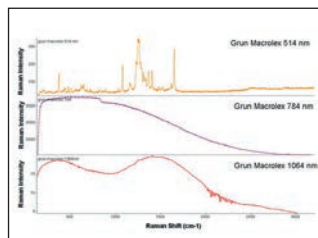
5 Colorant Powders and UV Filter Classification



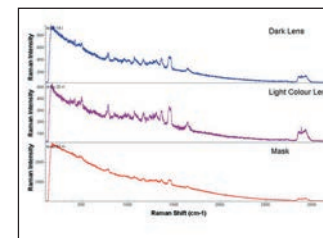
6 Raman Spectrums of Polyamide Matrix



7 Raman Spectrums of UV Absorber



8 Raman Spectrums of Green Colorant



9 Raman Spectrums at 784nm of the "Black Dot" area, of the Colorant Powder and of a Mask area which is not affected by Flaws

if the used wavelength keeps down the "Fluorescence"; there are three possible choices:

- 1064nm;
- 715nm;
- 514nm.

The Raman Effect allowed us to discover the chemical nature of the blend, and to define the materials that had the most significant role in the "Black Dots" onset.

The first step of Statistical problem setting consisted in a careful analysis of Luxottica's database in order to identify possible parameters useful in performing such a Test. Unfortunately, data were aggregated only according to the particular press from which the lenses were collected. So, the low impact of the Press Model on "Black Dots" onset could be detected, but no information was recorded about other parameters.

Therefore a new sampling session was necessary: it strongly depended on everyday factory production. Collected data allowed us to identify parameters concretely useful for a Statistical Analysis and to exclude those beyond control.

The last step consisted in evaluating the theoretical Statistical Approaches available in Literature. Considering collected data and the chosen parameters, the "p-Probability Test" proved to be the most suitable to reach Analysis goals.

GENERATING A SOLUTION

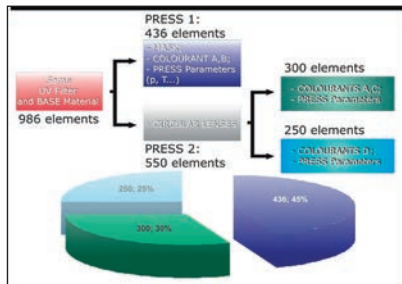
Regarding Chemical Analysis, the first steps consisted in the application of the Raman Spectrographic Test to:

- the Polyamide matrix, with clear spectrums using every wavelength;
- the Colouring component, called "YELLOW CIBA", which is affected by Fluorescence at 514nm;
- the Colouring component, called "Macrolex GRUN", giving clear graphs only at 514nm;
- the "UV Filter", showing clear spectrums at every wavelength.

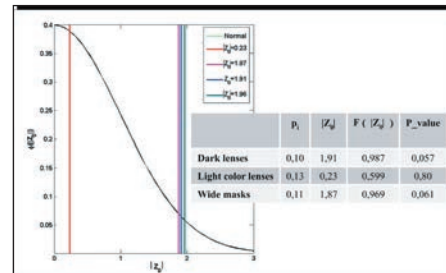
Since the 785nm wavelength is the only one that allows us to see Raman spectrums, and to analyze inner Flaws, it was chosen to perform the experiments.

The spectrums got from the area of the lenses without Flaws show no colouring component influence. On the other hand, those graphs related to flaws shape pointing underline the presence of Fluorescence, which strongly characterizes the colouring spectrum.

The above described Statistical Approach was first applied on a small sample (Figure), and then to a larger one.



10 Sample structure for Flawed Lenses Analysis



11 "P_TEST" results for the first examined sample

A time consuming probable analysis was performed as the sample, composed of 986 lenses, really represented the daily production of 6169 elements.

The defectiveness probability of each sub-sample (wide masks, light colour lenses, dark lenses) was computed and then compared, through the "p-Test" statistic value (Z_0), with the reference one, p_0 , that determines the Test hypothesis ($H_0: p \leq p_0$); it was set equal to the defectiveness percentage of the total daily production, i.e.14%.

If the level of significance of the Test, α , were set equal to 0.05, the "p-Test" would suggest a statistical similarity among all samples; the result was affected by a high level of uncertainty due to the small differences between the "p-values" (minimum α causing hypothesis rejection) of masks and dark lenses, and the chosen α . So let us set $\alpha=0.07$, in order to get a more reliable outcome, i.e. similarity between wide masks and dark lenses and difference with light colouring ones.

Since wide masks and dark lenses have some of the same pigments, this result strengthened by the chemical analysis, suggests "Black Dots" to be strictly linked to the colorant characteristics. However, to extend this outcome to Luxottica's entire annual production, it was necessary to collect other samples and subsequently to apply the "p-Test", with p_0 equal to the mean defectiveness probability during the whole sampling time (six months).

New data, with $\alpha=0.05$, support "Black Dots" dependence from the presence of colorant.

CONCLUSIONS

Since both Chemical and Statistical Analysis show a strong dependence of the "Black Dots" onset from colorants, the solution proposed to Luxottica involved two different aspects: the first one consisted in changing some of the materials blend components, especially the pigments.

The second one concerned the process and a new materials blend mixing method (before entering the Feed Hopper), i.e. to sip and mix smaller quantities of matrix, colorants and additives, thus improving metering efficiency.

Luxottica decided to apply this last suggestion, thus getting, as shown by a second sampling phase, a sensible "Black Dots" reduction both in terms of number and dimension.

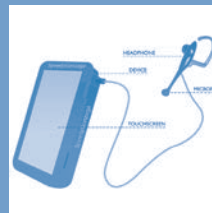
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PROJECT

3



BR.IN.A



CONTENTS AND TECHNOLOGIES FOR THE NEXT-GENERATION WIDE-BAND ACCESS



BR.I.N.A Contents and technologies for the next-generation wide-band access

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project **3**

*Analyzing innovative applications
and services based on broadband
connectivity, the enabling
technologies and economic impact*

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PROJECT DESCRIPTION

Wide-band technology is a “fact” which allows the present access to advanced telephone services, internet and video-on-demand. Meanwhile, the most quoted observers foresee that the present wide-band is just the beginning of a further evolution which will provide customers with an even larger bands, both to improve the present services and to offer new ones. What type of contents will be generated by this new technology whose uncertain boundaries lie in between telecommunication and computing? What type of challenge will it offer? And which kind of technologies will provide the most effective solution?

Speedy Gonzaga and **Smile with Simpatia**, the two Projects developed in the above general frame, are two examples of answers to the above questions.

Speedy Gonzaga starts from a perception: in our time tourists are left to decide between an “organized tour” and a “spontaneous tour”: in the former case tourists are asked a planning effort, not always desirable or possible; in the latter the result is often a superficial visit, frequently spent just in the commercial streets or in the “canonical” sites. The Project intends to bridge this gap by means of the development of a “context aware” solution which exploits/proposes a sustainable mobility (e.g. bike renting) together with an advanced wide-band wireless telecommunication infrastructure. The Project enters in detail for the solution by identifying a prototype town, Mantova, in order to analyze all the technical, logistic and economic aspects.

Smile with Simpatia aims to improve the “communication levels” in a place, **Simpatia** near Como, that was conceived not only to solve the health issues of differently abled people but also to offer them the highest possible social integration. The theme was: how to introduce, in an effective and “gentle” mode, the opportunities offered by wide-band telecommunication? The Project focused on video-telecommunication, a tool which offers



the potential to extend the social relationship of the **Simpatia** patients and to improve structure of the health services. The Project exploits/proposes advanced interactive solutions, like the use of **RFID** tags and purpose-designed software. The project is specifically designed to be used with the collaborative participation of the **Simpatia** patients.



SMILE with Sim-patia

TASKS & SKILLS

Pelin Arslan worked on all the aspects related to the system's design. She analyzed suitable symbols and interfaces to be used to interact with differently abled people.

Donato Barbagallo focused his work on software related matters. He developed the software Simple Talk and tested some user identification systems for the system's completion.

Giordano Brombin studied the problem from the communications point of view. He analysed the telecommunication facilities available in Sim-patia and the protocols needed for our application.

Pietro Gazzano conceived the business plan and the market strategy of the project. He supervised the entire development of the system in order to guarantee it could be marketable.

Fabrizio Guerrieri analyzed all interaction tools and hardware in Sim-patia and designed the hardware necessary to identify users and the simple tools to be used by users to communicate with our software.

All the members of the group studied UCD techniques, performed interviews and collected feedback from patients during visits to Sim-patia.

ABSTRACT

The project was aimed to develop a communication system for differently abled people living in a health residential home, called Sim-patia, using the wideband technology which provides a high quality connection to the external world.

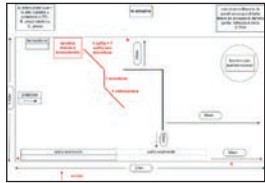
Sim-patia is a health residence, located near Como that provides accommodations for differently abled people with both physical and cognitive problems. The structure was built to accommodate 28 differently abled people with the intention of helping them to achieve the best life condition with primary and rehabilitation services. Sim-patia is managed by a social co-operative corporation and funded by the companies and non-organizational institutions. It is not only a place for solving health problems related to the differently able but also a social platform that attracts the highest possible integration. How? The structure invests in many other areas such as technology to control and adapt their environment and make life easier. It provides diversified laboratories like drama, art and a multicultural laboratory to encourage personal integration inside the community.

In a place where the communication in every sense is important, the project "SMILE with Sim-patia" aimed to improve the communication level of the differently abled people with their family, friends and in the future applications envisioning multi-communication scenarios with their doctors and medical services in a more user-friendly environment because it would allow possibility for a more functional interactive space.

The goal of the project was to encourage differently abled people to have social interaction and allow them to experience the freedom of advanced technology. The project was developed from a technical, economical and social point of view. The starting points were the analysis of the technological opportunities of wideband access, which allows high speed data transfer and a better quality to communicate with the external world, and then the application of the existing technology into a structure in a user-friendly atmosphere, which results in beneficial consequences for the differently abled people in terms of communication. During the development phase of the project, the team took into



1 Name and logo of the project



2 The plan of the video/ phone communication test room for disabled people



3 Understanding their problem, these are some difficulty of disabled people while using the communication tools in Sim-patia



4 The actual problem is the complexity of interaction tools and the task done. The integration of each instrument is done manually and is named with a piece of paper stuck on each instrument

consideration the economical analysis of the overall system and the social benefits that this project would bring to the residents of Sim-patia. The result were achieved by testing the prototype of the designed system inside Sim-patia on the differently abled residents by the staff.

UNDERSTANDING THE PROBLEM

Sim-patia is a structure that hosts differently abled people giving them a place to live where they can follow therapies, meet other people and do musical, artistic and technical activities. Sim-patia is a comfortable place for people who live there because they can try to solve their problems and have a normal everyday life. Communication is also a very important concern.

Guests in Sim-patia come from different cities, therefore their families live far away. Thus it is not possible for relatives and friends to visit the patients whenever they want. In the same way doctors also have problems as they cannot always be physically present in the structure.

One possible answer to that problem is the telephone: everyone in Sim-patia can use it. So probably there is no problem in communication between medical staff in Sim-patia and patients' relatives or between the medical staff and the doctors in the near-

by hospital; there is no problem because there is no need for a realistic communication.

Realistic communication becomes necessary when the doctor wants to see and talk to patients when he cannot leave the hospital or when a patient wants to talk with his friends or relatives. The difference is clear between having a phone communication with respect to a high-resolution video communication. The same system could also be employed for multiparty communications among patients, relatives, medical staff and doctors.

Some systems for high-resolution video communication are already on the market but none are specifically designed to be used by differently abled people. Following the example of Sim-patia, the system should be user friendly so that it can be easily by the patients. Hence, improving their self-confidence by breaking down their resistance towards technology as some patients do in Sim-patia.

EXPLORING THE OPPORTUNITIES

Before visiting the structure, we tried to imagine how to apply our communication system in Sim-patia. We generated several scenarios in which we described, using the User Centred Design (UCD) techniques, how a communication would be. These scenarios were divided in two groups: the former was about making calls; the latter was about receiving them. This work was useful



5 This is one of the concepts that are proposed to integrate an interactive screen where the disabled people can use whenever they want. This interactive tool provides not only the communication with their parents, friends but also provides communication inside the residence

6 The concept is furnishing the test room with the new technology and with a new interface rendering disabled people to understand and practice the system with a new experience

because we were able to choose which scenario to implement before the others. After doing this, we visited the structure where we were able to see how they lived and we met some potential candidates for the development of the system. We noticed that every patient has a wheelchair so we thought about designing a portable device to install on it. The main problem was devices' high current consumption; moreover only a few patients have an electric wheelchair so that we would have to install batteries where needed. In this way every patient could communicate whenever he wanted and wherever he was thanks to a complete WiFi coverage of the structure.

Another idea was to use a small room in which we could place our multimedia system. In this scenario a user, that needs or simply wants to communicate with someone, has to enter the room and through a Radio Frequency Identification Device (RFID) he is recognized automatically and the system enables the personalization depending on the patient entering the room; in this way we could have a single system that was able to self-configure without the need for any medical staff.



7 The user test is done by observing the behaviours of disabled people and their approach to the designed system. Five disabled people have tested the realized prototype



8 Romina with all group members in Sim-patia



9 The logo of the application



10 Giordano Brombin, Pietro Gazzano and Donato Barbagallo setting up the prototype in Sim-patia



11 Fabrizio Guerrieri and Pietro Gazzano recording the test experience in Sim-patia

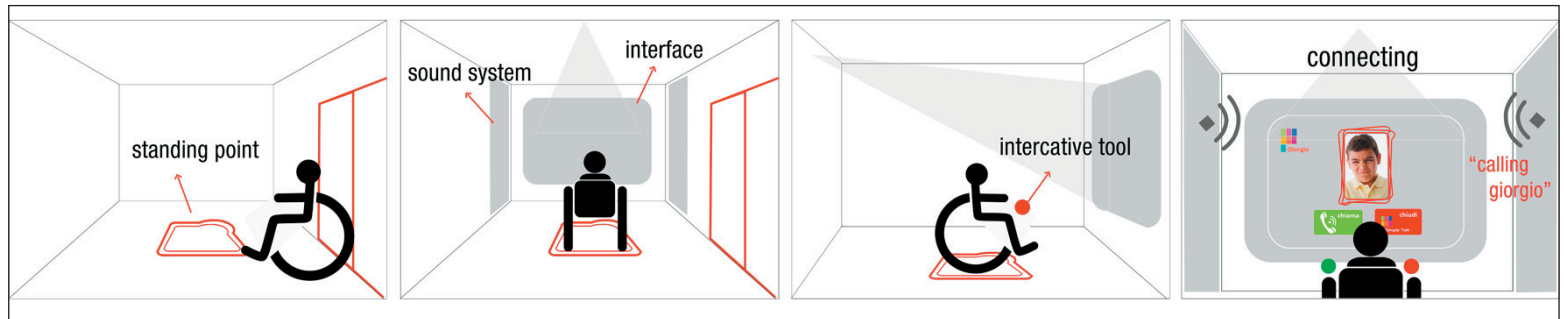


12 All the team working during the user test in Sim-patia

During this period we also focused on the research to find already existing interactive devices. Sim-patia already had some tools that were being used by the differently abled people in their computer laboratory. We observed them and looked for other ones in order to understand how they would better fit.

Considering the interaction devices, we often noticed that they were strictly personalized for each patient: this is due to the fact that each one uses a different way to communicate depending on the limitations of their disease.

We understood that we had to separate the control devices from the communication system and create a common interface for these devices in order to avoid the need to create a new one for every patient in Sim-patia.



GENERATING A SOLUTION

In order to fulfill all the technical and social requirements, we designed the whole system trying to make it simple enough for the differently abled to use and powerful enough to perform high quality video communications. We called our system “Simple Talk”, a self-explanatory name.

We decided to improve the current “communication room” available in Sim-patia, which is equipped with a small embedded personal computer and a projector. When the user approaches the door, he is recognized by a RFID reader, so the system activates all peripherals preparing them for the communication and loads his contact list. We entirely designed the software and the user interface of “Simple Talk”.

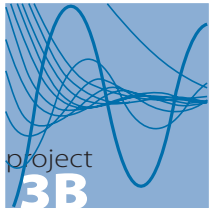
Moreover, particular attention was given to the system’s user interface. We worked on trying to make it as simple as possible without compromising its usability. Human interactions, necessary for the use of the system, were reduced as well. “Simple Talk” can be used by simply pushing two buttons or any other kind of interaction device able to trigger two different events also including voice activation. The number of devices able to perform such a simple task is huge and this fact guarantees that it can be used by invalid people with different pathologies and problems. So “Simple Talk” offers two different interfaces: one showing contacts sliding, sorted from the most to the least used, in front of the user and another one in which patients’ friendlist is organized like in a matrix. Moreover all personal settings are

managed by a database in order to set up each user’s configuration automatically.

“Simple Talk” was developed starting from Skype which included some Application Program Interfaces (APIs), therefore our software was able to control it easily. In this way “Simple Talk” can use all the advanced features of Skype as the efficient management of the bandwidth, the possibility of making calls through the common voice networks like PSTN/GSM and the ability to choose the best media format for communication.

“Simple Talk” has a simplified and customizable interface that can be automatically adapted and connected to special interaction devices and RFID readers. It is able to manage audio and video data flows and re-adapt according to the user’s preferences. We also focused on software modularity in order to be ready for future developments such as the Flash-written interface and multi-party communication.

According to the UCD technique, the user was always at the centre of our development process, so we performed a final step of “on the field” validation which was a great success because everybody in Sim-patia was enthusiastic about the system. The four patients who collaborated with us in the development of the system were able to make calls without significant problems and differences in terms of ease of use, speed and performances were evident if a comparison with the old rudimental system had to be made.



Speedy Gonzaga

A wireless device to explore novel paths in old cities

TASKS & SKILLS

Michele Bonardi, assessment of the software technology and technical feasibility of the service.

Alice Bertòla, layout of the service, system flow and human interaction design.

Lorenzo Cirio, state of the art and literature, revenue model and context awareness.

Francesco Longo, cost analysis and technical evaluation of the network issues.

ABSTRACT

The driving idea of our project was to understand how Information and Communication Technologies (ICT), in particular wireless communications, could contribute in turning traditional massive and superficial tourism into a more aware, personalized and independent experience. The two facets inevitably blended in a service that includes a means of transport and a portable device. The main issues we dealt with concerned the device, the services provided, the business and revenue model.

A state-of-the-art analysis convinced us to conceive a closed platform based on standard hardware (HW) components, shortening time-to-market, along with a software inspired by existing solutions. We decided to design an ad-hoc interface abiding by the principles of usability, with the advantage of including a wide range of potential users.

Simplicity also drove us to make the choice of the provided services: we restricted the range of services to obey usability and with the strategic intention to make this solution clear and innovative. The personalization of the touristic experience is a key point here: the system provides context aware suggestions, backward learning from the user's preferences and community options.

The above mentioned choices apply to a general framework transcending the actual location and means of transport. A breakthrough of the project consisted then in the choice of the town of Mantova which proved adequate. The presence of several bike paths and the issue of eco-compatibility persuaded us to choose the bike as the displacement tool. Soon after we contacted the local authorities.

The most suitable business model lies in renting and customizing both the device and the bike, melting them into a unique concept from a marketing standpoint. Nevertheless, the device can be detached from the bike, so that versatility is preserved. Revenues come from the users, the advertisers and externalities are generated.

This bundle of design principles and solutions is the clue for the amount of innovation brought about by Speedy-Gonzaga.

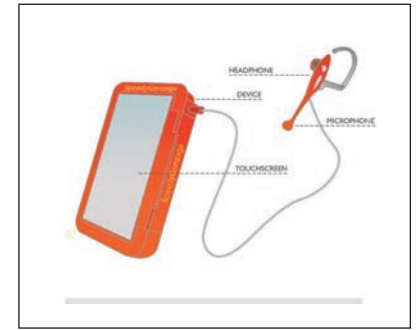


1 Definition of the areas of interest that interact in SpeedyGonzaga project: broadband, tourism, bike renting

2 The essential ingredients of Speedygonzaga: tourists, the city of Mantova, the bike and the wireless device



3 Some of the services provided by SpeedyGonzaga thanks to the wireless device: navigation, cultural information, call center, radio FM, video streaming



4 Synthetic description of the device as perceived by the user: it is a smartphone endowed with a touch screen, a headphone and a microphone

UNDERSTANDING THE PROBLEM

The initial analysis was triggered by the customers, who suggested that we should focus on innovative broadband applications in a public shared environment. In agreement with Corecom, Pirelli and Telecom, we decided to target tourism: we perceived the need to bridge the gap between bulky paperback guides -requiring a planning effort- and a spontaneous and unaware walk -resulting in superficial visiting. This gap often absorbs main stream tourists that end up walking down the fancy commercial streets that are the same worldwide, ignoring the gems of the city.

We foresaw a great potential in ICT ability to turn massive tourism into a personalized experience tailored on the individual needs, for instance providing portable devices for personal computing.

Nowadays a general concern is the human impact on the environment, thus we decided to tackle the problem of eco-compatibility.

The integration of newborn ICT with time-honoured transportation solutions became the key factor of our project, respecting the popular and inclusive character of the latter.

During the outset phase, usability emerged as a primary requirement in order to widen the targeted audience beyond technologically savvy users.

EXPLORING THE OPPORTUNITIES

The quest for innovative solutions to support tourism requires an exploration of the existing alternatives and a comparison between possible future scenarios that could end up competing with our final results.

Tourists can already rely on paperback guides, podcasts, rentable audio guides and guided tours, each having its own strengths and weaknesses.

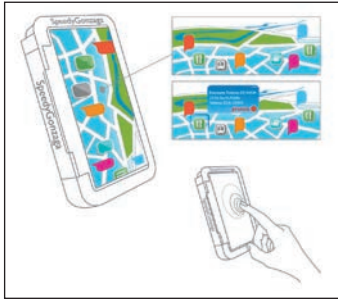
Keeping in mind the possibilities offered by wireless technologies, we envisioned a scenario in which people are automatically provided with anything they might need to independently explore the town, according to their preferences and current locations.

The basic idea was to provide both a means of transport and a certain device, thus keeping a traditional concept familiar to tourists and adding new technologies.

The issue of displacement and the actual location of the project gave rise to many ideas, spanning from segways in Chicago, through cabs in London, to rickshaws in an Asian capital.

Leveraging on the connections of the academic tutor, we met the municipal authorities of Mantova and we made up our minds on a bike and device rental service in that innovative and culturally rich town in Northern Italy.

In order to shape the proper business model, we examined alrea-



5 *Prototype the user interface and description of the interaction paradigm: designed to be user-friendly, simple and accessible also by technologically unaware users*



6 *The device enclosure is attached to the bike by means of a security hook. Nevertheless, the user can leave the bike safely and walk around with the device. The bike and the device are blended into a unique concept*

dy existing bike rental services, including the casestudy of Berlin, London, Ravenna, Parma and Pomurje.

From a technological point of view, the most important issue was to choose a small device connected to the UMTS/EDGE infrastructure with a touch screen simple interface, highly portable and able to provide access to a wide range of heterogeneous services.

We mainly focused our attention on the present smart-phones market, that proved to be the most suitable field for our purposes; we considered both closed hardware platforms, totally open source projects and hybrid commercial solutions. Other hardware (HW) solutions were discarded for cost reasons.

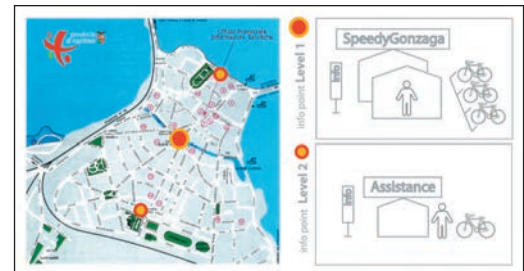
Following the best practices in software engineering, we searched for an existing solution to reuse. Minimum impact design and high usability were the main drivers of our search.

The last technical feature to examine was the network connectivity. Suitable technologies resulted in being a municipal Wi-Fi network to be created or the UMTS/EDGE services already marketed by telcos. Peak and average load conditions were carefully estimated.

Another tricky topic of the service, regarding the relation with the user, is the device itself, in terms of offered services and intelligibility of the product. We coped with the latter through an in-depth examination of the human interaction design.

Instead, regarding the services proposed, we made a selection among the wide range of services the technologies in the device could have suggested: navigator and GPS, info about historical

7 *The users can rely on two different typologies of info point offering different services. They represent the most visible part of SpeedyGonzaga in the city. The picture also shows the real locations of the info point that resulted to be the most strategical*



places, restaurants, hotels, clubs, cultural events, parties; community; telephone, booking service; useful numbers list; help line; music; FM radio; photo camera.

Each of these services would be feasible without a sizeable alteration of the device's HW structure.

Placing the burden of content management only on a central administrator would have been overly onerous, while wishing to leverage on the community effect: users can enrich the information in the database adding comments about new interesting places; therefore the more the service is used the more the knowledge base grows.

We finally estimated that, beyond the administrator, content generators could be the municipality, the user himself, advertisers, museums and tourist attractive centres.

The value offered by the service lays in providing customized information to tourists, by allowing them to explore a city autonomously. Two tools are needed: a means of transport and a device. We considered several options about how to share these



8 Simulation of the proposed service: tourists are exchanging information while riding their bikes in Piazza Sordello, Mantova



9 Tourists experiencing SpeedyGonzaga in front of Palazzo Te (Mantova)



10 The device is highly context aware: whenever the user gets close to a point of interest, the screen displays suggestions and information about it, for instance explanatory videos made available by broadband technologies and GPS system

11 Estimate of the percentage of users out of the total amount of visitors. A growth of the user base is foreseen, justified by the notoriety of the service and the increasing knowledge base provided. More and more externalities are likely to be generated

costs between the organization and users: spanning from rental to purchase. The most suitable business model lies in renting and customizing both the device and the bike, melting them into a unique concept from a marketing standpoint.

Revenues can be sought in three ways.

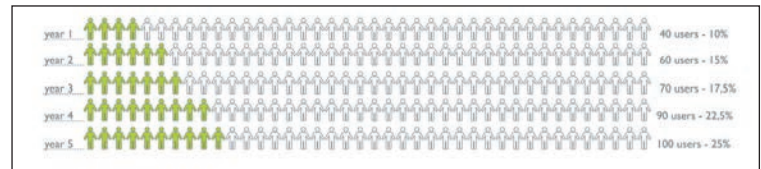
As an information service, charging the user. A premium price can be asked for the convenience of finding the set of services that most tourists use in one bundle.

- As an advertising service, charging the businesses: a trade off must be found between extracting revenue and compromising the user experience with unsolicited information.
- Externalities: the service is likely to increase the number of tourists or the sum spent on average by them.

GENERATING A SOLUTION

The options we have formulated so far leave many scenarios open, but at the same time they identify three core aspects: the service will provide location based tourist information, via a personal electronic device and will be associated with a bike. A solution that suggests images of well-being, leisure and eco-compatibility.

Our system complements traditional static touristic contents with user generated suggestions. Moreover it takes into account the tastes and habits of the user, providing customized hints and reacting to changes in the external world.



The suggested solution is innovative using an electronic device as a hub in bundling together a convenient set of tourist services: cultural and commercial information, directions, users' community, bookings and a radio.

Differently from existing solutions developed by mobile phone operators, the service is perceived as a black box containing both an already configured device and a bicycle. Renting the device lets us guarantee a homogeneous quality of service across the user-base, being as inclusive as possible.

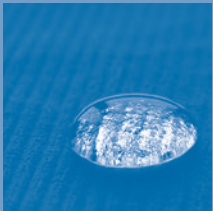
After designing this service model, which preserve a certain generality, we developed a blue print implementation in the city of Mantova.

In the full report the interested reader can find the feasibility study of a bike renting service in Mantova associated with our context aware tourist guide. This real-world analysis offers precious insights on the technical, logistic and financial aspects of the service.

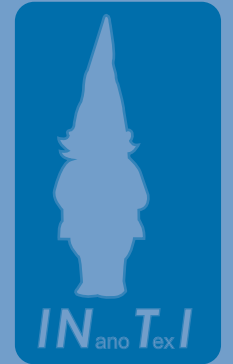


PROJECT

4



INTI



IMPACT OF NANOTECHNOLOGIES ON TEXTILE INDUSTRY



INTI Impact of Nanotechnologies on Textile Industry

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Kun Fu

Management, Economics and Industrial Engineering

Michele Caramella

Mechanical Engineering

Anna Lottersberger [Project Communication

Coordinator]

Fashion Design

Dayana Pesando

Mathematical modelling in Engineering

project 4

*Assessing organizational
implications and marketing
opportunities of nanotechnologies
in the textile industry*

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Michele Santoro

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PROJECT DESCRIPTION

The goal of the project was to explore the opportunities offered, by nanotechnologies, to the textile industry, and of the innovations in process plants and industrial organization which are needed to take full advantage of these opportunities. Consistently with the main focus of ASP projects, and with the initial lack of a specific industrial demand, a significant fraction of the work was devoted to ‘problem setting’: if a fruitful encounter was sought, an awareness of the peculiar characters of nanotechnologies on one side, and of textile industry on the other side, was needed. The interdisciplinary team composition, including industrial expertise as well as management, materials and design, was appropriate to this task.

Information was gathered by various means with a broad scope, and showed a highly diversified scenario. ‘Nanotechnology’ turned out to be the fashionable collective name for a wide variety of technical endeavors, which range from imaginative proposals to technologies whose feasibility is being demonstrated, and to improvements of existing technologies in search of better selling names. ‘Textile’ is another collective name for a wide variety of products, ranging from ordinary clothing for which production cost is the crucial issue, to high quality fashion clothing which sees an interplay of technical performance and aesthetical appearance, and to technical fabrics for which technical performance has the crucial role. Producers range from mass producers of intermediate products, to highly specialized producers who found a niche for a specific end-product. The ability to promote and sustain innovation also sees great differences: a few firms simultaneously have the size that makes them able to undertake a development effort, and the market stability which allows it to assess its outcome over a time scale of years. At the other extreme, a great number of small producers lack the size and the technical infrastructure needed to invest in technological developments. At the same time the life cycle of several products is so short that it hampers the innovation of productive processes, because it needs a very short time-to-market and it does not justify the investment for new equipment. Compatibility with existing pro-



duction plants and processes thus becomes a crucial issue. Once an awareness of the general picture was achieved, the two teams focused on two specific examples of the introduction of nanotechnologies. One team, in close interaction with the Pontoglio firm, explored the introduction in the production process of velvet of nanotechnological products, able to confer specific properties to the velvet, and still satisfying the constraint of compatibility with present production lines. The other team, without a specific industrial interaction, developed an innovative design of a product, a glove for winter sports, in which nanotechnologies were exploited to achieve better performance than those currently available. The new design captured the interest of Hydra Information Technology, an Australian Venture Capital Company, in contact with Fondazione Politecnico. Both cases gave us the opportunity to exploit and test ‘on the field’ the various expertises gained in the first part of the project.



NHiPerG Nanotechnology for High-Performing Gloves

INTI | IMPACT OF NANOTECHNOLOGIES ON TEXTILE INDUSTRY.

TASKS & SKILLS

Michele Caramella studied the state of art of the textile production process to understand how to introduce new technology in the already existing chain and products; he was also responsible for collecting text and illustrations.

Anna Lottersberger focused her contribution in exploring market needs and designing the new product: logo, shape and fabrics.

Kun Fu performed a market analysis exploring the opportunities in the sector and estimated management implications in the project.

Dayana Pesando examined patent trends looking for short term applications and already feasible technologies.

Simone Sala gathered information on nanomaterials with interesting properties for textile applications and looked for uses in the final product; he coordinated all the team work and kept contacts with tutors.

ABSTRACT

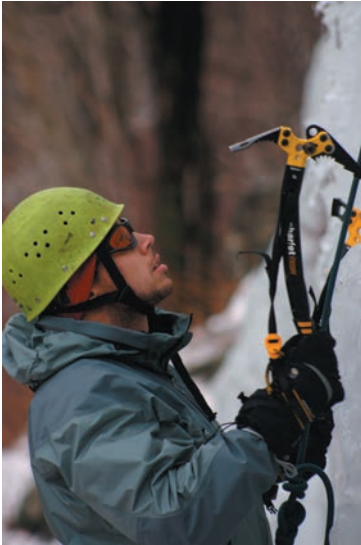
The framework of our project is the need for innovation in the textile industry. Some industries in Lombardy planned to meet the challenge for a new impulse of ‘made in Italy’ textile production, through the study and the strategic evaluation of nanotechnologies. These techniques are supposed to have great potential, which could be exploited to give the materials some absolutely innovative and unique properties (such as antibacterial and antimycotic activity, self-cleaning capacity, reduction of electrostatic charge, etc...).

In the first part of our activity, we worked together with the NE-TeX project, an initiative by Fondazione Politecnico di Milano, and we had the opportunity to interview Lombardy businesses interested in this type of technology. Despite their interest in some applications of nanotechnology, there was no possibility to establish any cooperation, because of PMI’s insufficient investments in R&D.

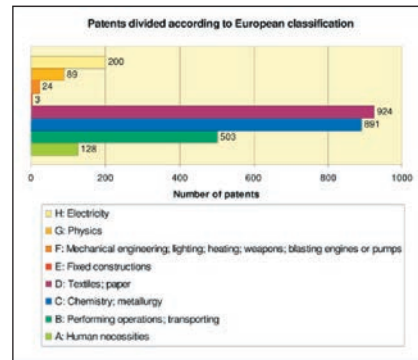
First, we explored some alternatives, such as possible applications in the textile industry of an innovative technique to deposit nanostructured materials on substrates. Then, we finally decided to focus our attention on developing a new product matching nanotechnological fibers and fabrics already available on the market. This choice was supported by a contact of Fondazione Politecnico: a representative from an Australian venture capitalist company interested in developing high-performing textile apparel.

According to the first conclusions of our work and market analysis, we identified the field of application: extreme sports and outdoor clothing, a sector always considered fertile soil for innovative materials and final products. In particular, we chose mountaineering gloves, an avant-guard sector where nanotechnology can improve some properties (such as lightness, hygiene, comfort, etc...) with limited costs and finicky customers ready to pay extra for better products.

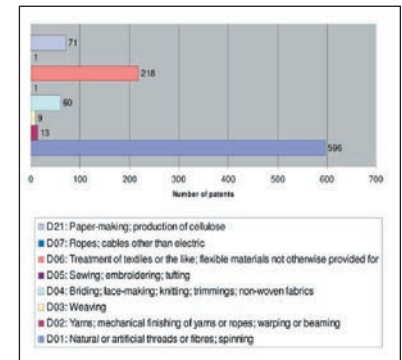
There are many possibilities in this niche market, and our idea is to continue in developing this product even after the end of the ASP project itself, trying to evaluate the possibility to enter the market.



1 Expedition on the North side of Cervino



2 Patents divided according to European classification



3 Subclassification of patents of type D (textile; paper)

UNDERSTANDING THE PROBLEM

In the apparel and home-furnishing world new technological textiles have made a huge impact with their unique look, handle and performance. In the last two decades momentous advances in textile technology have provided all areas of final market with futuristic fabrics that are totally functional as well as good-looking.

The latest synthetics and finishing treatments answer market needs with their eye-catching appeal, desirable touch and high performance. Some firms are incorporating these new advances into their clothing and garments, often combining them with traditional materials to create an interesting balance.

As we can see in Figure 2, the major number of patents in nanotechnology in the last years belong to the category of 'Textile, paper' and 'Chemistry, metallurgy'. Analysis of the subcategory D (Figure 3) demonstrate that fibers and threads represent the main field of application.

Nowadays companies are more interested in including nanotechnology in the finishing process, so that only the final product is involved, in order to avoid any modifications in the production plant. But, according to the distribution of patents, the future

trend is to work directly on the fiber in order to allow a better penetration of the new properties in the woven fabric.

To better understand the market needs we have organized some interviews with local firms. We had the opportunity to visit some of them and talk to some managers. These firms are located in Lombardy (in particular, in the province of Como), and are also industrial partners of NETeX (Nano Engineered TeXtile), a project promoted by Fondazione Politecnico di Milano. The common interest was to find a way to improve the plus-value of their products, by the deployment of nanotechnologies.

The impression of these interviews was that these firms were not ready to introduce these technologies in their production chains. However, according to them, consumers are supposed to be ready to pay extra for the key consideration of easy care, especially when it concerns leisure activities.

Fabric with nanofinishing can allow companies to significantly distinguish their apparel lines and tap into the expansion opportunities.

According to market and patents analysis, our conclusion is that the area where a significant increment of innovation from Nanotechnology can be certainly accepted is high-performance sportswear.

EXPLORING THE OPPORTUNITIES

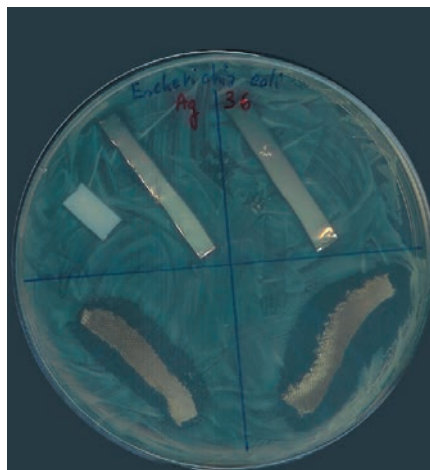
Once defined the area of interest, we focused our attention in looking for already existing applications of nanotechnologies in the field of sports and outdoor textiles.



4 Mountaineering gloves: top competitor



5 Milano, 31st October 2007, Team A at Fondazione Politecnico, with the externat tutor Matteo Bogana



6 Bacteriostatic action of silver nanoparticles on Polyester stripes (on the bottom) compared to untreated stripes (on the top)

In the very last years, nanotechnologies have provided this sector with high-performance clothing that are light weight, impact protected, cold resistant, UV protected and anti-bacterial whereas maintaining flexibility and durability. These properties are used to improve easy-caring, physiological comfort and safety, and are obtained mostly by exploiting metal oxide nanoparticles, nanofibers with silver nanoparticles and fabrics coated with metallic and ceramic thin films.

The majority of nanocoatings are produced using standard evaporation techniques.

So, our first idea was to evaluate the opportunity of using a different film deposition technique, the so called Pulsed Laser Deposition or PLD, to provide finishing treatments to fabrics for outdoor applications. This technique has been widely studied in the last years, but it still needs industrial applications. Its main advantage concerns the possibility to deposit a huge variety of materials with many different properties. Unfortunately, it cannot be used to cover large target areas. Soon, we realized that this restraint would have increased the costs of apparel fabrics too much. PLD justifies its application only in the military and biomedical sector, with costumers always ready to pay big premium prices for superior performance.

We decided to change perspective and, instead of looking for

applying new technologies in the textile industry, we tried to understand if it would be possible to develop a new product with improved performances starting from already existing technologies. In fact, regarding sportswear, nanotechnologies are mostly applied in track suits and over-alls, while little has been done with key products such as gloves. High performance gloves are widely used for extreme sports (ice and falls climbing, rafting, sky-surfing, etc...) and in motor racing, and represents a niche in the mass-market.

Niche markets are usually more opened to innovative products than mass markets. The quest for extreme properties always justifies the high costs related to the introduction of nanotechnologies.

Finally, we managed to define our goal: understanding how to develop innovative gloves for mountaineering.

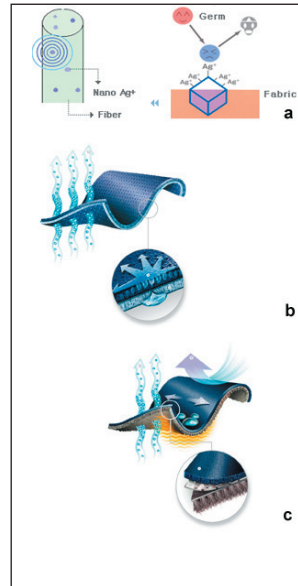
GENERATING A SOLUTION

Starting from the choice of innovative gloves for mountaineering, the first step was to define all the key properties these gloves would have to satisfy:

- Water-proofing
- Heat insulation
- Breath-ability

7 Fibers and fabrics for NHiPerG Gloves

- a: Silver nanoparticles
- b: Polyester anti-bacterial microfiber
- c: Waterproof and breath-able layer



- No odor
- Thin thickness and light weight
- Abrasion resistance (gripping capacity and high tensile strength).

Some or all of these properties are already pretty advanced in top market firms.

So, as second step, we drew a benchmarking analysis in the mountaineering gloves' sector, identifying main competitors and the final price spread of the leaders' products: 130-200 €.

We took for granted that the technology applied to winter apparel must help end users to adapt to multiple and ever-changing climates and situations: comfort, freedom, versatility and functionality are key properties. The latest multi-layer products answer market needs with their smart appeal, comfortable touch and high performance.

Assuming waterproof, excellent heat insulation, breath-ability and high tensile strength already exist, what are the market's needs and desire not yet developed by current market leaders? The answer is obvious: antibacterial properties, thin thickness and light weight, gripping capacity. Sportsmen are prepared to pay extra for the key consideration of hygiene and comfort, so it is

**8 Illustration of NHiPerG: Nanotechnology for High Performing Gloves**

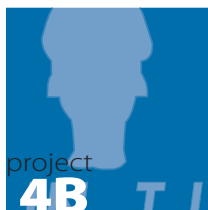
possible to trouble-freely invest on these aspects. These characteristics could be defined as the plus-value, the necessary competitive edge of our product.

The third step was therefore to get from properties to defined outstanding but achievable specifics:

- No odor: accomplished by fabrics with antibacterial properties; the smartest solution is produced by an American firm, and consists in Polyester microfibrils with the addition of silver nanoparticles.
- Thin thickness (less than 1 cm) and light weight (less than 280 g): accomplished by using one single layer, a non-woven with a nano-cave yarn, replacing the heat insulation plus waterproof and breathable ones already adopted in many existing products.
- Abrasion resistance: gripping capacity improved thanks to rubber patches plugged in parallel with standard Kevlar protective layer.

The final scheme of multi-layer gloves is so narrowed:

1. Polyester microfibril with silver nanoparticles: comfort, touch and antibacterial properties.
2. Polyamide layer: wick liquid away.
3. Non woven with nano-cave yarn: heat insulation, breath-ability, water-proofing.
4. Kevlar: abrasion resistance.
5. Rubber grip inserts: adhesion.



TASKS & SKILLS

Francesca Iacono outlined the short-term perspectives of R&D, thanks to the analysis of European patents data; she often took care of joining the individual works in a general framework.

Giovanni Meola has contributed to the survey of some nanotechnological applications for textile and carried out an analysis of the most common traditional finishing processes for fabrics.

Irene Roghi worked on the general analysis of nanotechnology in textiles, also focusing on end users' point of view; after an internship in Pontoglio S.p.A., she became the direct project referent with the firm.

Michele Santoro helped the team in finding information and solutions about the application of nanotech in textile, in particular within Pontoglio.

Giacomo Vigorelli was in charge of the macroeconomic analysis of the clothing and textile industry. He also tried to set up the general structure of the report.

Zhiqiang Zhao has contributed to the study on the nanomaterial developers and acted as the Conference Coordinator.

ABSTRACT

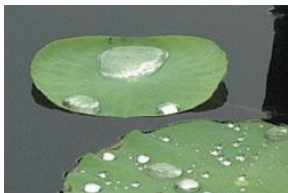
A possible way-out to the current complicated situation of the European textile market could come from the R&D departments of some companies and many research institutions or universities. Nanotechnology can offer new and unexpected solutions to this crisis and give the possibility to gain a sustainable competitive advantage.

Pontoglio S.p.A. is a multinational firm, originally from Lombardy, leader in producing velvets, with a long-tradition and vivid interest for innovation. Nanotechnologies are the right tool that could allow the creation of high performing velvets. We proposed a finishing process using ready-made solutions of TiO_2 nanoparticles to obtain an easy-cleaning effect: as a matter of fact, the treated fabric should become stain and water repellent, such as the lotus plant's leaves (the so-called 'lotus effect').

These kinds of nanoparticles solutions are already present in the market, and their producers sell them to be applied with normal finishing methods (spray or full wash) on textiles. The interesting point is that none of them has ever been tested on velvet-like fabrics. Thus, many points have to be clarified: how these solutions act on velvet, which effect is really obtained, along with a costs and benefits analysis.

The idea is to propose this new material for interior furniture purposes, such as sofas and armchairs. The easy-cleaning velvet could become the 'unique selling' proposition of Pontoglio velvets, setting the product apart from the competitors.

The advantages of this finishing, if compared with the traditional fluorocarbons treatment, are given by comparable costs with a better final 'touch' on the fabric. Since Pontoglio aims to the high-end segment of the market, it is a main concern for the end-users to feel the same 'touch' of the fabric even if new features are applied to the velvet. Moreover, also by an environmental point of view, the use of TiO_2 particles has a smaller impact with respect to fluorine-carbonic resins. Finally, from a technological and economic perspective, the production plant does not have to be changed: nanoparticles are applied on the velvet with a normal finishing process.



1 The “Lotus effect” on a leaf guarantees a self-cleaning action: water droplets roll off the leaf’s surface, taking mud, tiny insects, and contaminants with them

UNDERSTANDING THE PROBLEM

The last five years have been really tough for European textile companies. They have lost market share and profitability and the competition arising from the new Asian players is becoming a dominant issue. On the other hand, the market itself is changing: nowadays, end users know their strengths, and are able to use them to request specific products. Low prices are no longer the best way to achieve and maintain new customers: there is the emerging necessity to offer something more and different from the others.

Italy has always been interested in the textile industry and, in fact, it has always played a very important role. Some important production companies intend to meet the challenge for a new impulse of the ‘made in Italy’ textile production, through the study and the strategic evaluation of nanotechnologies. These techniques have enormous potentialities, which include both product and process innovations.

Our project started mainly as an assessment analysis, aiming to evaluate the role played by nanotechnologies in today’s textile market. A huge variety of technologies goes under the common name of ‘nanotechnology’: working at the nanoscale means that it is possible to modify the main properties of the materials and to use molecules as elementary components.

The nanotechnology in the textile industry comes across as the perfect way to allow a firm to add value to its products. In particular, it leads to identify a characteristic and specific point of strength of the production company, its ‘unique selling’ proposition and defines the company’s competitive advantage.

But there are some features of this particular market and of this kind of technology which slow down the innovation process. On

2 Orange juice on a basic corduroy fabric by Pontoglio: immediately after the application, the drop starts to lose its original rounded form



3 After about one minute from the application on a standard not-finished Pontoglio product, water has been almost completely absorbed by the fabric

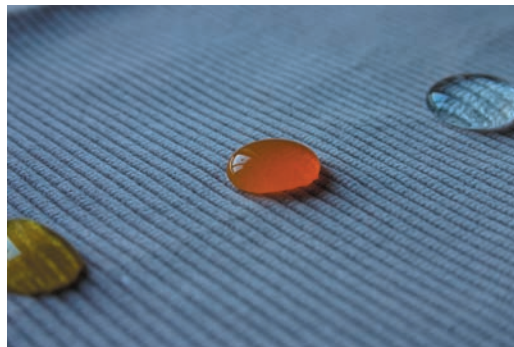


the one hand the clothing and textile industry is mainly dominated by small and medium-sized enterprises: so small players find it hard to adopt new technologies due to tight margins and the cost of switching. Moreover, this is at the same time a labour-intensive, low wage industry and a dynamic, innovative sector, depending on which market segments one focuses upon. On the other hand, many of the technologies grouped under the common ‘nanotech’ label are still in the laboratory phase.

EXPLORING THE OPPORTUNITIES

The great challenge of our project consisted both in the variety of the ‘nano’-labeled technologies and in the vastness of the textile market itself. Hence our first main target was the achievement of a good level of knowledge of the state of the art of these two big realities, aiming at obtaining any useful information on products realized using nanotechnologies that are already in the market.

4 A drop of water on a waterproof corduroy by Pontoglio: the treatment with fluorine-carbon resins makes the fabric totally water repellent, so the drop remains totally round and fixed (“lotus effect”)



5 Fluorine-carbon treated corduroy: from left to right, drops of olive oil, orange juice and water immediately after the application on the fabric; it is already possible to see that the oil drop has just started to break and penetrate the textile’s surface

We also wanted to know which performances and effects are assured; the key point was not to focus just on the textile market but try to import already experimented solutions from other fields. This investigation brought to the identification of possible scenarios and feasible implementations.

The following step, finding out a possible and feasible textile application of one specific nanotechnology, brought up two issues: to select a technology, already available and in an advanced research phase, and a suitable application, which could arouse the interest of the customers. As a technology we chose to deal with nanoparticles, but we had to understand in which phase of the production process it was more appropriate to insert them. Nanotechnology can be introduced in several steps (dyeing, printing, finishing) within the textile chain of production process. The choice of the phase in which to intervene leads to different final effects on the fabric and asks for different levels of modification of the production plant. Since nanoparticles can be applied to the fabric with standard finishing techniques, the finishing phase is the most suitable to be modified in our case study.

GENERATING A SOLUTION

There are several differences between using the standard *micro* chemicals and the *nano* chemicals in finishing. With a controlled percentage of the latter and with a uniform distribution of the molecules themselves in the solution, the finishing phase is opti-

mized, less quantity of raw material is wasted, and the resulting coating is more uniform.

The added cost, with respect to the standard chemicals, is due to the purchase of the nanoparticles, and, in case of large amounts of nanomaterial in stock, due to the maintenance of the stored solutions (a careful storage is very important). There is no added cost due to the introduction of the technology neither in the process nor in the machines. Additional costs also concern the acquisition of the know-how: even though the finishing methods are exactly those that are standard, the technicians have to set up different parameters to obtain the best results from the technology innovation.

After considering different firms, we ended up with a collaboration with *Pontoglio S.p.A.*, a Lombardy based multinational firm leader in producing velvets and moleskins both for apparel (fashion oriented) and furniture (technical oriented). Nanotechnologies can be the right tool to create high performance velvets, without lacking in ‘touch’ and exterior appearance, very important features for this particular fabric. Basically, the firm needs and looks for a simple technology, easy to be implemented with the current infrastructure, without purchasing new machineries. In particular, we thought about easy cleaning applications, for the furniture collection. Easy care textiles simplify customers’ use of the fabric, in terms of money spent to enhance the garments’ life and to maintain them at their best. Less time and lower costs for



6 A drop of water on a standard Pontoglio's corduroy treated with the easy-care nano-finishing: picture taken immediately after the application



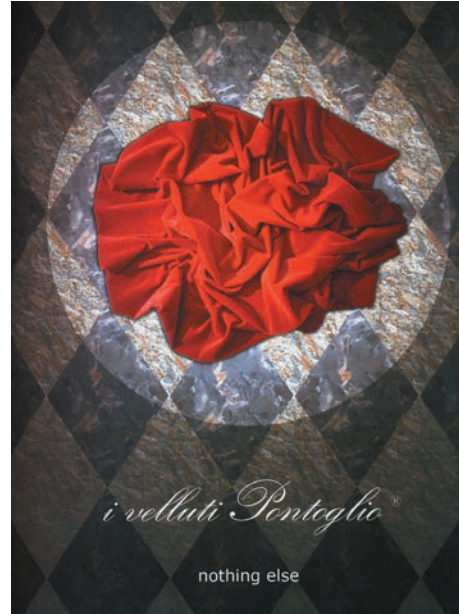
7 Drops of honey and olive oil on the nano-treated fabric: both maintain a round, closed form



8 Application on the nano-treated corduroy: from left to right, drops of honey, olive oil, orange juice and water

care can justify a higher selling price in a long term perspective, since they are considered a key point by end users.

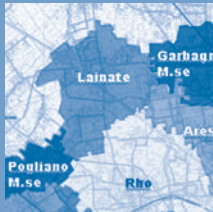
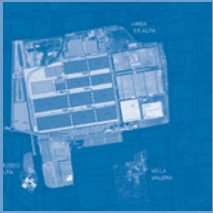
Our proposal deals with the introduction of a new easy-cleaning finishing, made up of TiO_2 nanoparticle solutions simply applied to the fabric with standard machines and processes. These solutions have not been tested yet on a three-dimensional fabric such



9 Pontoglio S.p.A., a multinational firm leader in producing high-quality velvets, advertises its products on Vogue Tessuti, a magazine specialized in textiles trends

as velvet. However, the first empirical results show that the water repellency effect is comparable with the one already implemented by the firm (with fluorine-carbonic resins). The resistance to stains seems not to be remarkable, but better with respect to untreated velvet fabrics. Moreover, the fabric characteristic-its soft and charming touch- is fully maintained, even a little enhanced; the fluorine-carbonic resin, on the other hand, gives a worse, less delicate touch to velvets.

As previously said, nanotech finishing has a higher cost compared to similar (but not nano) techniques, but the touch issue is a very important point for a firm like Pontoglio. Thus a deep and precise analysis to seriously evaluate this possibility is necessary: entering the interior textile market with an easy-cleaning product that maintains the real velvet touch can be a concrete competitive advantage on other firms' commercial proposals. For a future implementation of this solution, it will be important to market to end users the enhancement of garment's performances and make them aware of the new properties (often not visible or immediate to perceive).



PROJECT 5



Cmilano



CONVENTION CENTRE FOR MILAN



Convention Centre for Milan and the north-western macro-region

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project **5**

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and the North Macroregion*

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Federica Tron

Architectural projects and management of
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PROJECT DESCRIPTION

THE CHALLENGE

The idea of building a Congress center for Milan and the macro-region of the North-West must be perceived as a great opportunity for the polycentric character of Lombardy. Such an opportunity may be lost by an intervention conceived in a sectoral approach, that's composed of an "infrastructure" of global-relevance in a local situation, simply by superimposing it by itself. Taking this presumption as a starting-point, the project is aimed at verifying the effectiveness of a methodological, multi-disciplinary manner in order to redefine the problem of techno-economic feasibility by considering the typological-functional reasons and needs of the area.

For this reason, the activity was developed by linking specific territorial-logistic questions and by defining the qualitative and quantitative management of the architectural organisms that may either concern questions regarding nature, environment and landscape caused by different decisions on location or may concern, as usual, conflictual problems of the many subjects involved.

THE TEAMS

Three teams worked together in the construction of an interpretative synthesis of a settlement system of the concerned area, its evolutionary tendencies, specifying various actors potentially interested in its construction, management and use of a Congress Center and interviewing some of them in order to clarify a framework on various supplies and demands. Simultaneously, they conducted a detailed analysis on the existing congress structures in the concerned territory and a comparative analysis of the most significant experiences in the projecting and construction of the congress structures according to different professional points of views.

Based on the specifications of different possible scenarios for locating a spatial, functional organization of the congress center, each team came up with a specific hypothesis, verifying and presenting the feasibility, strengths and weaknesses of it.

Team A, developed the hypothesis of realizing the Congress Cen-



ter in a large, dismissed industrial area (Ex-Alfa Romeo of Arese), accentuating the remarkable landscape and environmental potentials of the Lura stream, until now considered as a second element in the process of requalification.

Team B evaluated the opportunities linked to putting a grand architectural complex (Castellazzo of Bollate) into re-functioning, as part of a strategy of taking a big-step for the valuation of the existing resources.

Team C has verified the possibility of creating a system of "network of congress centers" realizing a principal core located in the area of Expo 2015, with a series of punctual interventions of rehabilitation of rich estate of historical buildings and open spaces connected to valley-system of Olona River.

THE RESULTS

The most significant results obtained consisted in the construction of an insightful sample of relative examples of projecting congress centers, together with project-related hypothesis for locating and defining the characteristics of congress centers in the North-West of Milan, which may constitute important instruments to accompany the complex decision-making process.



Synergy of resources for a congress Centre

CONVENTION CENTRE FOR MILAN AND THE NORTH - WESTERN MACRO-REGION

TASKS & SKILLS

Chiara Alfieri analyzed the territory from an environmental point of view, underlining the most relevant infrastructural, natural and architectural aspects.

Luiz Augustin Fochi Golin studied the peculiar nature of a Congress Centre analysing the major Congress Centres in the world, to understand what kind of functions and activities were necessary and how many people visit each Congress Centre in a year.

Ilaria Menolascina analyzed the strategic dynamics of this territory, in relation to the possible stakeholders who could be involved in this project, through some interviews with important people, experts in political and territorial dynamics.

Leonardo Zuccaro Marchi studied the history of the area of the ex-Alfa through its different phases and analysed the projects which had already been presented for this area.

ABSTRACT

The group has been focusing its efforts on the elaboration of a scenario which would consent the allocation of a new polarity in a highly complex context: a Congress Centre for the Ente Fiera in the Milan North-West region. Such allocation was to be done in a rational matter, thoroughly researching throughout each possible alternative the one which, by the analysis, could merge the highest number of resources and opportunities as possible into synergy.

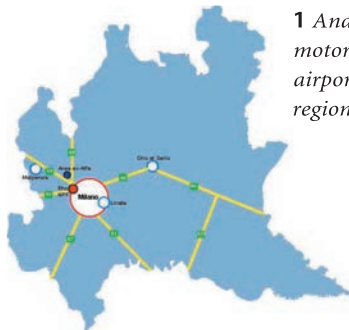
Goals The group filtered the vast information, gathered at the beginning of the work, by a network of goals:

- Match the international range of a Congress Centre with the local context, generating the opportunity for a multi-perspective vision.
- Depend on the available infrastructure network and evaluate the feasibility to enhance it, avoiding the risk of potential traffic issues.
- Gain fast connection accesses with New Polo Fiera and with Milan's downtown and its airports.
- Exploit the opportunities already available on the territory by what it has to offer in historic, cultural, artistic and natural resources, attempting to re-enforce their value and put them in a circuit.
- Use the EXPO 2015 candidacy as pretext for the creation of a service network related to the event but that could be reconverted to meet the citizens needs.
- Put a set of functions, not only related to the congress activity but also to the territory itself, in order to create a complex set which could result on auto-funding capabilities generating positive economic impacts on the territory.

Solution After the study of the initial situation, the group was able to select one potential scenario centred on the reuse of a portion of the ex-Alfa area and of the contiguous Villa Valera, located in Arese.

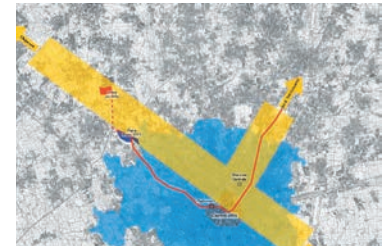
These are the reasons:

- Strategic position: border between four Municipalities and short distance from Polo Fiera.



1 Analysis of the motorways and the airports in Lombardia region

2 Actual view of the chosen area: the ex-Alfa in connection with Villa Valera in Arese



3 Analysis of the motorways and the airports in Lombardia region

- Vicinity to important infrastructural networks, with the possibility of reaching the area by the connection with line 1 of Milan's subway.
- Vicinity to various resources such as the system of the villas, Groane park and so on.
- The importance attributed to the Rhodense by local companies because of its historical importance thanks to the development of Alfa Romeo.
- Existence of some previous projects currently under examination, which could be implemented and integrated into our project.

UNDERSTANDING THE PROBLEM

The Requests The principal stakeholders are Ente Fiera and Milan's Chamber of Commerce, whose initial request was to locate and project a Congress Centre that would have to be a place of international exchange, situated at the centre of a good network of infrastructure connections.

Since the beginning, the key to the question was if such function is needed and, if so, what the best possible location for it would be.

The EXPO 2015 factor The issue was complicated by Milan's candidacy for the Expo 2015: now all the attention is geared to the realization of services for this big event. Certainly it is an occasion that will serve to improve the existing infrastructure and to create a service network spread throughout this territory in order to generate positive impact even after the Expo 2015 period.

The actor's system

The chosen zone presents an elevated complexity in existing interests and strategies, as well as offering a great number of resources and opportunities.

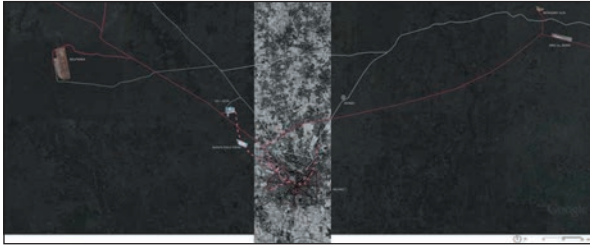
To best understand the dynamics of this area, it was necessary to delineate the actors involved, or those that would be involved, and this was carried out by interviews with experts in strategic policies.

The two different levels of actors are:

- Big Actors Level - such as Ente Fiera, Chamber of Commerce, the Lombardia Region, the Municipality and the Province of Milan.
- Local Level - such as local administration and firms: Municipalities of Arese, Lainate and Rho and the CRAA (Consorzio per la Reindustrializzazione dell'Area di Arese),

The goal would be to make these actors work synergistically since, in the actual state of things, they tend not to speak to each other, resulting in net opposition. This lack of dialogue and interaction creates an atmosphere where every actor seeks only his own goal, missing the importance of a wider view of the process as a whole.

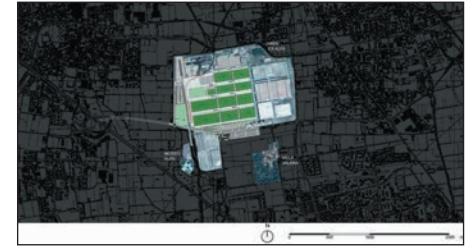
The Functions About the activities the Congress Centre should host, the highly shared opinion seems to point in favour of a functional mix to consent greater flexibility, exploring the local available resources and inserting itself on the territorial dynamics, instead of imposing itself to the area. The term functional mix implies functions which are related to its fulcrum function, but



4 Transversal axis between Malpensa airport and Orio al Serio airport, going through North-Milan region



5 Analisis of professor Macchi Cassia's project



6 Analisis of new Alfa Business Park project

also public utility functions capable of attracting visitors all year long, despite the events taking place in the congress centre.

EXPLORING THE OPPORTUNITIES

The several development opportunities for the project should keep the following necessities in mind:

- Milan's access to the circuit of international congress tourism, becoming a new European polo.
- Connection between the Congress Centre to the city and to strong entities such as NPF and Expo 2015, besides the airports.
- Presence of sponsors.
- Advanced project that could make it one of Europe's most innovative Centre.
- Offer of complementary services which could run parallel to congress activities, incrementing the local economy.
- Creation of services which are currently missing for the Municipality of Arese and the neighborhood in a way to strengthen the suburbs of Milan.

Among the available resources in the local context we were able to locate local manufacturers, who could be inserted in the commercial activities developed at the Congress Centre. This would insert the congress-commercial activities among the local development factors for the Rhodense, guaranteeing local artisans and manufacturers an international showcase for their products. Other resources can be researched in some of the urban projects that were proposed for this area: the redevelopment of the area

by the master plan presented by professor Macchi Cassia and the re-industrialization of the new Alfa Business Park. The first proposal seemed to be the most interesting since it predicts a hosting of a functional mix such as residences and services, aiming at a total reformulation of the area into a new urban polo. The ex-Alfa is one of the most overshadowing dismissed areas of the hinterland besides being situated on the axis which connects Milan to Malpensa, it's also located on the transversal axis which connects the airport of Malpensa and Orio al Serio. Macchi Cassia also considers the possibility of a new transversal development of the City of Milan.

It's important to underline the direct connection with the system of the historical villas (which could bring an additional value to the intervention) and with Groane park.

According to the master plan, it is predicted that a commercial centre to the south of the area will be built, which could be near to the Congress Centre or parts of it. Additionally, there would be an Alfa historic museum which could join the exposition environment of the Congress centre.

Nevertheless, the channel Lura should be high lighted and, once improved, it could become a green path between Villorese and Olona, growing into a path of importance among the polo and the territory of Rhodense. Other ways of communication proposed by the plan are the Line 1 of the subway, which would be extended from the New Polo Fiera directly connecting the Milan area, along with the extension of the railway to improve access for people and cargo.

GENERATING THE SOLUTION

Following the analyses and the studies it is clear that Milan could benefit from a high quality international Congress Centre.

However, a winning project shouldn't aim at a mono-functionality but should predict an interaction between several functions creating a functional mix which allows:

- Better administration.
- Raise on the economical balance.
- Occasion to raise the stakes of the game attracting a higher number of consensus.
- Sustainable diversification of the service offered to the local population.
- Motivation for local development, also creating a showcase for local products.

The term functional mix might seem banal, but it certainly isn't when it's time to define the set of functions it defines and how they interact among each other. Besides the "over-local" functions normally linked to a Congress Center:

- Conference rooms
- Exposition rooms
- Hotel
- Entertainment and rest areas
- Aggregation areas

the group inserted a series of other functions more related with the local reality, such as:

- A commercial gallery
- Space for university residences with attached services (useful for both students and the habitants of the nearby municipalities).

Regarding the placement of the functions, the team chose to avoid the alternative of a single mega structure, which is too impacting, preferring the disposition which is diffused in different pavilions but concentrated into a restricted area. The only external element of the project is Villa Valera, where the group intends to host high-level functions with the intention of preserving its historical-architectural aspects. The project foresees that the villa and the ex-Alfa area interface with one another by connecting elements.



7 State of the art of ex-Alfa area

8 Scheme of the new scenario proposed by the group

Naturally a project of such entity can't be abstracted from the infrastructural aspect, especially since this area lacks connections. Therefore, the group proposes:

- Works on the Line 1 of the subway, which already connects Milan's downtown with the New Polo Fiera, extending it to the area of the project, passing through Rho.
- The re-establishment of the existing rail tracks to connect the area with Milan and with Malpensa airport.
- Improvement of the local public transport.
- Creation of bicycle paths towards the nearby municipalities, making use of the channels to emphasize the environmental aspect and to support visiting circuits of the historical villas around.

Finally, it's important to underline the role which such a project would have, offering its own structures to serve the major events that take place every year at the Fiera and in Milan.

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Congress Centre a cultural chance for the territory

CONVENTION CENTRE FOR MILAN AND THE NORTH - WESTERN MACRO-REGION

TASKS & SKILLS

Francesco Goia analyzed the Congress Centre within the studied area. He also elaborated possible scenarios about the localization of the project and functional schemes of the Congress Centre.

Michal Laube analyzed the feasibility of the project from economical and managerial points of view and he studied the local actors within the decisional process.

Clelia Pozzi analyzed the environmental context and the local actors that were involved in the project. She also elaborated possible scenarios about the localization of the project and functional schemes of the Congress Centre.

Federica Tron analyzed the different kinds of Congress Centres all over the world. She also elaborated possible scenarios about the localization of the project and the functional schemes for the Congress Centre.

Ali Ustun analyzed the territory from an environmental point of view, in particular the most relevant infrastructural and natural network.

ABSTRACT

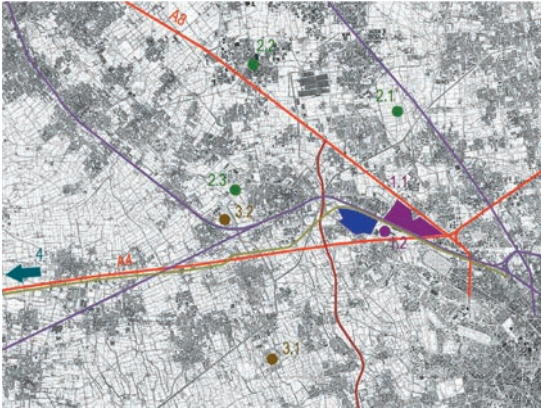
The project, commissioned by the Milan Chamber of Commerce and Fondazione Fiera, aims at realizing a congress centre in the north-western macro region of Milan. The first inquiry of the project, resulting from a phase of territorial and political analysis, concerns the actual need for a convention building in that area, and the answer to that question implies a partial adjustment of the given mission. As a matter of fact, the main challenge is the feasibility of the centre itself, that should not be considered as a monofunctional architectural object but should rather be a complex structure, characterised by integrated functions aiming at the promotion of territorial development.

In order to achieve that purpose it is necessary to widen the planning approach and to focus on a wider context, including not only a study on the lay-out of functions but an analysis of medium and long-distance connections and relationships with the surrounding environment and interactions with existing architectures. As a result the plan is composed by a complex network of elements, so that any component of the system cannot but benefit from the others, configuring a sustainable intervention from the environmental, economic, ethical and social view points.

After exploring different solutions, the optimal location appears to be Castellazzo of Bollate, a place characterized by remarkable historic pre-existences and easily reachable from both the Fairground of Rho-Pero and from the railway line Milano-Saronno. Since Castellazzo is part of a close net of cycle and pedestrian paths that cross Groane Park, moreover, it could become a significant gateway to the park.

The main idea of the project consists in the restoration and in the reuse of the most degraded manufactures and is based on an subterranean expansion of Villa Arconati, where the bigger congress rooms are localized. The task is to extend the villa without breaking the existent equilibrium between architecture and natural surrounding context.

As a result, the new complex becomes a driving force for the entire district and answers the need for a cultural centre “other” than Milan.



- 1 Purple: Congress Centre combined with Nuova Fiera and Expo 2015**
 1.1 Re-project the Expo 2015 Area for the Congress Centre after the event
 1.2 A new Congress Centre in a contiguous area
 Green: Reuse of ancient villas of the Rhodense area
 2.1 Castellazzo di Bollate
 2.2 Create a system among Villa Litta, Villa Valera, Villa del Pozzo and ex-alfa area
 2.3 Create a system among Castellazzo di Rho, Villa Burba and Molini dell'Olona
 Brown: reconversion of dismissed industrial areas
 3.1 ItalTel area in Settimo Milanese
 3.2 Bull area in Pregnana Milanese
 Blue: Congress Centre in the intermodal node of Novara

UNDERSTANDING THE PROBLEM

Setting up a congress centre for Milan and the north-western macro-region is a particularly complex task, not only for the difficulties concerning the architectural and urbanistic aspects, but above all for the consequences that this operation will have on the territory.

One of the major difficulties in the definition of the project is that every intervention will not affect only the area directly involved in the transformation but the whole region of the north - west, that will bear both benefits and negative effects that such an operation involves.

For the Chamber of Commerce and Fondazione Fiera, our external institutions, the purpose of the project is to develop the territory. In order to achieve this task, the location of the con-



- 2** The drawing points out the macro-relationships created by the infrastructural network among Rhodense area, Castellazzo di Bollate within Groane Park, the city of Milan and the new Fairground. In red, the project area; in orange, architectural heritage; in purple, bricks kilns and industrial archeology

gress centre should appear as the key element for the success of the operation, but even before choosing a certain location it is basic to verify its necessity, since it must not be assumed as a fact. As a matter of fact, the discussion about the real necessity of a new congress centre of relevant dimensions should provide some useful instruction for the development of the project.

After defining the necessity of this function, together with the localization of the building it is important to face the strategic issue, that is to define whether the centre should be composed by an isolated big object or by a system of smaller elements diffused on the territory. The strategic choice has different consequences as far as the number of actors and stakeholders involved in the decision making process is concerned: even if, at a first glance, more actors could be considered an obstacle to the project, it proves to be a basic element to increase its feasibility conditions.

As a result, the project is fully multidisciplinary and involves economical, urbanistic and architectural aspects in order to properly answer the questions previously outlined.

EXPLORING THE OPPORTUNITIES

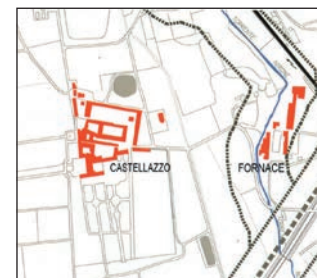
The first challenge of the project is to establish the real need for a congress centre and to understand how such an element could act as a driving force for the territory instead of increasing its congestion.



3 Existing and future art centres along the FNM railway line connecting Milano and Saronno. In orange, existing centres; in red, planned centres



4 Closer look to the project area with particular regard to the hypothesis of cycle and pedestrian connections along the banks of river and canals. In red, the project area; in orange, architectural heritage; in purple, bricks kilns and industrial archeology; in blue, cycle and pedestrian corridors



5 The map shows Castellazzo of Bollate and the brick kiln coloured in red and the cycle corridor along Nirone river

The presence of this building is justified by the interest it aroused in local authorities, associations and enterprises. However, it is important to remember that any proposed structure should be useful to the whole community and not only a mere convention facility for the New Fairground of Rho-Però. At any rate, the starting point of the location analysis is the new Fair since it is the main attractor element of the entire area and it is clearly linked to a convention building because of the interaction of its functions. This choice is strengthened even more by the fact that Milan is a candidate for the Expo 2015 competition, and therefore there is a strong demand for congress rooms.

Still this kind of approach entails different problems: first of all, it would support only the new Fair, without an adequate involvement of local actors and municipalities, and moreover it would increase congestion of an already overcrowded area. Since those kinds of features do not satisfy the basic requirement of the project, it is proper to look at the problem in a wider perspective. Therefore our analysis focuses on the entire Rhodense area, a critical region crossed by one of the historic directrices of the Lombard territory, characterised by a close infrastructural network and in direct proximity to the Fairground of Rho.

As far as the exploiting program is concerned, the project of a congress centre must be multifunctional: as shown by different examples analyzed both in Italy and in the world. This kind of building, as an autonomous entity, shows a deficit in its financial statement. Only in a few cases can it square expenditure and income, where a lucky mix among spaces for tertiary, duty free and

other activities is able to create a sustainable economy that covers the management costs. Moreover, one of the main purposes of the project is to create a structure working year round and not only during exhibition periods, therefore, a functional mix is the only approach that thoroughly satisfies the requirements.

In order to choose a proper location for the complex, territorial analysis on environmental, infrastructural, architectural and managerial issues are essential and help outline some possible scenarios. Since one more challenge of the project is linked to the enhancement of the environmental and architectural local patrimony with the intention of restraining the amount of new volumetry, the plan focuses on interventions concerning dismissed industrial areas, ancient villas and parks. Moreover, studies on the territory point out a strong tendency to form local associations and a deep level of participation in public policies, elements that could both ease the feasibility of the project if properly considered.

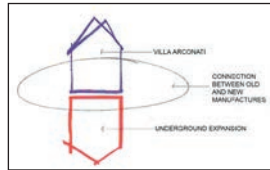
GENERATING A SOLUTION

The final choice for the location of the complex is Castellazzo of Bollate. Its scenario answers all the challenges previously outlined, since the Congress Centre perfectly merges into the existing settlements' net and cannot be considered as an autonomous and self-referential element completely taken out of context. This



6 As this image shows, Castellazzo is a gateway of Groane Park, that strats from its back. In the back ground, on the right, we can see the brick kiln of Bollate surrounded by the trees

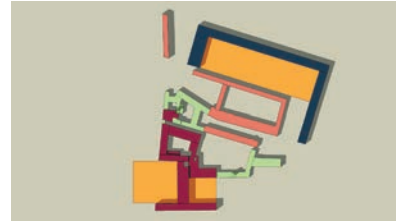
7 The main idea of the project is not to transform Villa Arconati in itself nor to annex a new building to the old one. Instead, the project conceives the extention as a subterranean building set under the Villa, where are localized the biggest congress rooms



choice allows the satisfaction of different tasks: restoration of the architectural patrimony, enhancement of the natural environment and development of the infrastructural network.

The main purpose is the reuse of the complex composed of Villa Arconati, its suburb and the close brick kiln of Bollate, respecting all legal restrictions in order to avoid any modification to the features of the settlement. Therefore, the project focuses on an underground expansion of existing structures that preserves and differentiates old intervention from new additions: major halls are localized in new hypogean spaces, while other facilities are settled in the existing buildings.

The functional program aims at an integrated and continuous functioning of the structure in order to avoid economical problems caused by a restrained usage, as often verified in the many similar structures. In addition to facilities usually existing in a conference centre, such as halls, auditoria, meeting rooms and restaurants, the new complex hosts a hotel, a guest quarter, exhibition spaces, a high level educational and research centre on restoration, connected with the identity of the Villa, and a high level educational centre on music, connected with the well-established concert fame of Villa Arconati. The proposed functions are linked to a wider reflection on the role of culture in the re-evaluation of the hinterland of Milan, so that the complex will be part of a path that, winding down the Milan-Saronno railway line, gathers several locations tuned to different forms of art. As a re-



8 Purple: restricted buildings. Conservative restoration.
Green: restricted buildings. Restoration and functional adaptation.
Pink: no restricted buildings. Functional adaptation.
Blue: no restricted buildings. It is possible to increase the height of the buildings.
Yellow: new underground buildings

9 Red: Congress Centre and facilities

Yellow: Educational and research centre of restoration

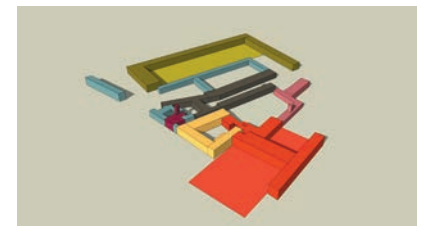
Pink: Exhibition facilities

Purple: Place of worship

Grey: Hotel and guest quarter

Light blue: Residential area

Green: High level educational centre on music



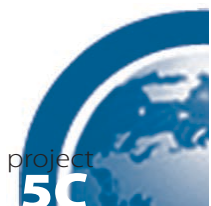
sult, the project becomes a driving force for the territory, thus answering the need for a cultural centre “other” than Milan. It must involve local associations and municipalities, becoming part of a wide-ranging program of territorial development and granting better accessibility to Groane Park. Cycle and pedestrian paths on the banks of rivers and canals connect the site to the context and provide Groane Park with the role of a green lung within an overcrowded area, turning it into the stage for an innovative cultural and social centre.

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A congress centre for the north-western macro region in Milano a chance for development for the entire rhodense territory

TASKS & SKILLS

Julien Aimonino analyzed the investigated scenarios from a technical point of view, giving a technical contribution in problem solving approaches, combining pragmatism and precision.

Francesca Guidetti took care of the local policies and of the decision making process. She did a part of the analysis on the offer of spaces for congresses within the studied area.

Michela Penna analyzed the offer of spaces for congresses all over the world, selecting the main representative ones. She elaborated possible scenarios regarding the localization of the project.

Francesca Pozzoli analyzed the environmental context and the local actors within the decisional process.

Vitaliano Tosoni analyzed the environmental context; the relationships with the main actors involved in the project and gathered the preliminary information.

ABSTRACT

The project was commissioned by the Milan Chamber of Commerce in accordance with the “Fondazione Fiera” foundation and it concerned, initially, a congress centre for the northwestern macroregion of Milan. After the required feasibility analysis, the demand shifted to a model of integrated services for the territory, that would also be able to support both the Fair and the Expo 2015. Before coming up with our final solution, many different alternatives were explored, considering the possible mix of many important factors such as the typology of the congress centre to be settled up, the resources of the mentioned area and their criticisms. The typological aspect was crucial, as was also seen by the interviews with the local actors, along with being extremely problematic. In particular, three main different kinds of congress centres were identified: a concentrated, a spread and a hybrid solution. Actually, the last one was chosen for its flexibility and its capability to be integrated, so that it could really adapt itself to the services demand on the territorial dimension. It consists of a central core, where the conference hall with the larger capacity should be, and many satellite – buildings for the complementary facilities. The hybrid solution sums up the values of the two previous typologies, and limits their faults.

From this preliminary study six different scenarios came up regarding the localization and the typology of the congress centre, whose chances and criticisms were then analyzed.

A further processing of those scenarios led to what has been considered the best solution for the realization of a congress centre, within an integrated model of services strongly linked to the territory.

The main idea was to integrate the project of the congress centre with the Expo, in order to conceive a structure of services able to exploit the “main event” as a chance for the urban retraining. The creation of a congress system network, starting from a main core settled in the Expo 2015 area would be the next step.

Within the project, a basic role is played by the metropolitan agriculture park, conceived in a modern way and with contents related to the contemporary frame. It would also take into consider-

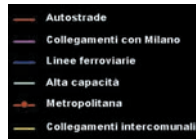


1 The eleven cities of the Rhodense area

2 Map of the existing road system (legend: red for the motorways, magenta for the links to Milan, blue for the railways, grey for the high-capability trains, red with dots for the underground and yellow for the links among rhodense cities)



3 Legend of the road system map: red for the motorways, magenta for the links to Milan, blue for the railways, grey for the high-capability trains, red with dots for the underground and yellow for the links among rhodense cities



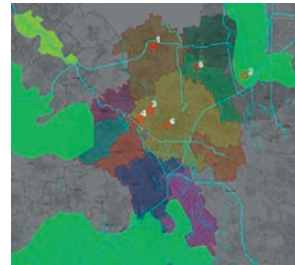
ration some historical villas, located all over the territory of Rho and Pogliano Milanese, increasing their value, and the system of the mills on the Olona river, allowing their restoration.

The proposed project results to be sustainable from an environmental, social, economical and cultural point of view, and it allows the rehabilitation at the end of the Expo 2015 event.

UNDERSTANDING THE PROBLEM

The project of a new Congress Centre for Milano in the northwestern macroregion of Milano was commissioned by the Chamber of Commerce of Milano (“Camera di Commercio di Milano”), in cooperation with the “Fondazione Fiera” foundation. The initial request included a study of the area and an analysis of the common architectural typologies of congress centres, in order to evidence possible localizations, possible typologies for each hypothesis and finally formulate complex scenarios.

In accordance with this initial request, we conducted an analysis of the northwestern area : the environment, the infrastructures and the social context, we identified the local and external stakeholders that could be involved in the project, and we analysed the existing structures that could compete or complement the future congress centre.



4 Map of the existing green system, hydrography and historical villas (legend: dark green are the green node; light green is Olona Park; light blue is the hydrography; red dots are the villas, the bigger are the main important , the smaller the secondary and the empty dot stands for a mill)



5 Legend of the map about green system, hydrography and historical villas. Dark green are the green node; light green is Olona Park; light blue is the hydrography; red dots are the villas, the bigger are the main important , the smaller the secondary and the empty dot stands for a mill

In parallel, we chose a number of case studies of existing congress centres all over the world in order to analyse their operations from a business management point of view and their interactions with the surrounding territory. On the basis of this information we formulated possible scenarios that would fit the northwestern Milano macroregion context.

However, during the course of these studies, the objectives of our academic project were modified. In fact, since the beginning, the feasibility analysis of such a project brought negative results about the implementation of a congress centre in the northwestern macroregion. As a consequence, we noted a lack of interest in our project from our own sponsors, while the “Milano Expo 2015” project was more and more promoted as a better scenario to develop the macroregion.

After these disappointing findings, it was then decided to reformulate the problem encountered by our sponsors: we were not asked to only imagine a congress centre but a complex and global scenario of development for the macroregion, a model of integrated services, amongst which the congress centre was just one of them, that would involve the existing resources identified through the first analysis of the area.

6 *The area of Expo 2015*7 *The Scolmatore canal*

EXPLORING THE OPPORTUNITIES

Before coming to our final solution, we explored several alternatives, which took into account the combination of numerous factors such as the typology of congress centres, the resources of the area and its criticalities.

The typology appeared to be crucial, as was demonstrated by the several interviews of stakeholders we conducted. Three main typologies were theorised: the concentrated solution, the spread solution and the hybrid solution.

The first solution is the one traditionally noticeable that provides the aggregation of all the functionalities within a unique building (or in a complex of halls, strongly connected and close to each other). The advantage is essentially the possibility to find all the functionalities in a restraint space. This solution required an extensive area that would be dedicated to this project, with high environmental impacts and little chance to integrate the reuse of existing buildings.

The second solution, the “widespread” congress centre, consists of a series of buildings, not necessarily contiguous, disseminated over a wide area and connected to each other thanks to transportation infrastructures. This solution required efficient transportation infrastructures with minor environmental impact. It would integrate better with the existing resources, especially with the historical and cultural resources (the reuse of historical monuments for example).

The third solution, the “hybrid” solution, provides a core building, which hosts the conference rooms with highest capacities,

8 *A mill on the Olona river*

and a series of satellite buildings for complementary activities. The hybrid model, tries to combine the advantages of the two previous solutions and to limit their negative aspects. According to the interviews with local stakeholders, it seemed that this solution was the most desirable one, because more flexible to the requests of services needed for the implementation of the congress centre.

Six complex scenarios emerged from this preliminary study. We then analysed both the opportunities each of them offer and their criticisms.

Further development of these scenarios resulted in what was considered the best solution in order to design a Congress Centre that would contribute to the development of the northwestern Milano macroregion.

GENERATING A SOLUTION

As a result of the analysis previously described, we chose the hybrid solution which consisted in the creation of a network of annexes connected to a core structure located within the “Expo 2015” area. In case the city of Milano was chosen to host the 2015 international exhibition, this area would in any case host additional exhibition structures for the “Fiera”. The basic idea was to integrate the new congress centre with the “Milano Expo 2015” project, in order to propose a network of services capable of exploiting the “great event” as an opportunity for urban re-qualification.

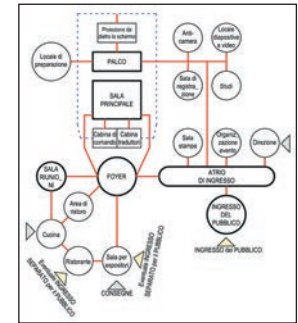


9 Villa
Besozzi and
Olona river,
Pregnana
Milanese



10 Villa
Scheibler, Rho

11 Scheme of
the possible
relationships among
the components of a
congress centre



In fact, the area needs new infrastructures that can be poles for development of the urban dimension, new elements of catalyst to enhance and promote social relationships, communities and networks, so as to bring dynamism and offer new opportunities of socialization. Therefore, the conception of spaces and environments that make up the new centre tried to combine two different time scales: the daily relation between the new building and the urban activity that should turn out a perfect symbiosis and the periodical “big events” hosted by the structure.

The specificity of the area, caused by the multidimensional temporality which is included in the design of the infrastructure, allowed us to develop a new and original way to operate. This new approach integrates three different realities: a static reality, which is part of daily life that interacts with the development of the area; a **flexible** reality, which should re-adapt itself for each exhibition event; a **permanent** reality, which contains elements of continuity and elements of innovation.

In order to meet the objectives, we tried to promote the creation of an urban framework, so as to underline the characteristic variety of the hybrid solution, able to infiltrate the surrounding territory and to create strong inter-connections. This concept was concretized by the design of a park, a new typology of modern metropolitan agriculture in line with the contemporary situation. A park with various facilities and activities, open all year (temporary and permanent conference facilities both indoor and outdoor, laboratories, areas for floriculture, greenhouses, places for restoration and businesses, accommodations, green mazes,

zen gardens and recreational spaces of all kinds); a structure with cultural and exhibition spaces for educational events and exhibitions. These spaces would be disseminated along a path with traffic limitations, along the main rivers and would find their place within the residual agricultural landscape of the area.

The network created by the park would also involve some widespread historical villas within the territory of Rho and Pogliano Milanese, promoting a reuse and enhancing the network of the mills of Olona. The project was designed as a sustainable project characterized by a functional mix able to integrate the local economy and the local social context, revitalizing the area through the restoration of historical buildings and abandoned areas. The sustainability component of the project was also supported by the minimization of the impact on transportation infrastructures and by the flexibility ensured by the widespread network of annexes both in terms of variety of spaces capacity and in terms of functional continuity in interaction with “Milano Expo 2015”.

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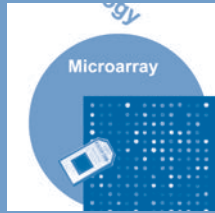
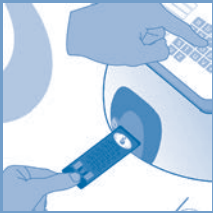
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PROJECT

6



NDT



NANOBIOTECHNOLOGIES FOR DIAGNOSTICS AND INNOVATIVE THERAPIES: OPPORTUNITIES AND SCENARIOS



NDT Nanobiotechnologies for diagnostics and innovative therapies: opportunities and scenarios

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project 6

Nanobiotechnologies for Diagnostics and innovative Therapies: Lab on Chip opportunities and scenarios

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Environmentally friendly product Design

PROJECT DESCRIPTION

In a study by the NIH (National Institutes of Health, in the USA) reported in Science in 2006 to identify ‘Grand Challenges for Global Health’, two of the 14 priorities involved diagnosis and measurement of patients’ health statuses: first “develop technologies that allow assessment of individuals for multiple conditions or pathogens at point-of-care”, and second “develop technologies that permit quantitative assessment of population health status”. In this context, micro and nanotechnologies find even more challenging demands from biology and life sciences, showing high potentiality also for applications in molecular diagnostics and personalized pharmacology. These new and emerging technologies are clinically relevant, enable the diagnosis at molecular levels, and some of these can be included into current molecular diagnostics such as Lab on Chip (LOC). LOC research holds substantial potential for fulfilling these priorities by automating complex diagnostic procedures that are normally performed in a centralized laboratory into a hand-held microfluidic chip; this capability could empower health-care workers and patients with important health-related information even in every day life. The fields of application, practically unlimited, ranges over a lot of topics from cancer research, DNA analysis, to allergy, diabetes and HIV tests. Designing and fabricating such systems is extremely challenging, but engineers, physicists, biologists and designers are beginning to construct highly integrated and compact labs on chips with exciting functionality, as outlined in this project.

NDT project mission focused on a real interdisciplinary approach for the exploitation and evaluation of opportunities and scenarios for extending the limits of current molecular diagnostics. It enables Lab on Chip and Point-of-Care (POC) diagnosis as well as the development of personalized medicine through a dramatic improvement in a very broad range of features and opportunities. The use of actual small volumes to reduce the time taken to synthesize and analyze a product; the unique behavior of liquids on the micro and nano scale which allows greater control of molecular concentrations and interaction. Reagent costs



and the amount of chemical waste that can be greatly reduced are only some examples of the topics which constituted the problem understanding for the two different teams. Their work is geared towards genomic and proteomic applications respectively, performing two distinct approaches, but also exploring some common solutions.

In this context, and following indications from ST Microelectronics’ experts and from the academic tutors, the teams identified some strong key barriers for a more rapid and concrete diffusion of LOC technologies and proposed some common solutions. Particularly relevant is to be considered a worthy cooperation between NDT teams and FIMMG (Federazione Italiana Medici di Famiglia) which led to the design and realization of a specific web survey and a project of a handbook for the LOC knowledge dissemination and awareness enhancement of General Practitioners. ST Microelectronics and FIMMG greatly appreciated the proposals and considered them a concrete follow up of the NDT project towards the development of future profitable partnerships and collaborations.



GE.N.O.M.A. GEnetic New Opportunities for Medical Applications

TASK & SKILLS

Federico Bonacina dealt with technical aspects of DNA chips. He drew up the general guidelines for the project, and managed the overall organization of the work.

Stefano Fissolo investigated the world of the most advanced research. He traced out a roadmap for the scientific development. Important work in gathering material.

Michele Pugliese dealt with the medical and biological aspects, relating technology to healthcare. He identified future medical applications, and evolutionary market trends.

Nerea Zenigaonaindia worked on the creative approach of the technological problem to bridge the gap between technology and users by identifying communication solutions.

ABSTRACT

Research into micro and nanotechnologies applied to biology and medicine is highlighting new possibilities for changes in everyday medical practice, thanks to the widespread use of genetic diagnostic technologies (GDT). Imagine going to your General Practitioner (GP) one day, and within half an hour being able to get an idea of the presence of a disease in your body. All this by simply placing a drop of blood onto a chip the size of a microscope slide. It seems worthy of science fiction, but these technologies, the so called Lab-on-Chip, are now in the first stages of implementation. The work of the GE.N.O.M.A. team was based on research into solutions for breaking down the key barriers to the large scale adoption of GDT. We focused our interest on the figure of the GP as the principle future user of this innovation. The strong point of our project was that we looked at different aspects of a structural problem in introducing this innovation to the mass market; we proposed specific solutions to various key barriers that we identified, using a strong multidisciplinary approach.

We followed two main approaches: one in the technical field, and one in the field of communication. Indeed, on the one hand the technologies currently on the market are inadequate for widespread use in society, due to their complexity of instrumentation and protocols; on the other, future users are generally unfamiliar with what GDT is about, and its potential uses.

Based on these considerations, we offer solutions that could bring the technology closer to the market; namely, the design of a Microfluidic device for DNA testing through an integrated on chip photodetectors matrix, for diagnostic uses. The specific objective of this is to reduce the complexity and costs.

We enriched this part of the work by drawing up a technological roadmap on which to base the development of new diagnostic devices, with the specific objective of reducing overall testing times.

In the field of communication we identified the following as being interesting solutions for an information campaign: writing



1 A Lab-on-Chip is a small-size device that integrates several phases of DNA analysis protocol using microfluidic technology and so reducing analysis time, overall costs, dimensions of the equipment

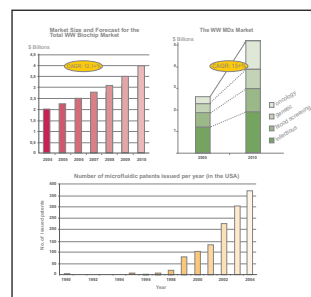
a manual that introduces doctors to the concepts of GDT and its potential uses; devising an info-point placed in hospitals; and a questionnaire to be distributed to GPs through their federation's website, with the dual purpose of informing doctors on how genetic technologies may contribute to their profession, and of helping manufacturers to understand the needs and expectations of doctors.

UNDERSTANDING THE PROBLEM

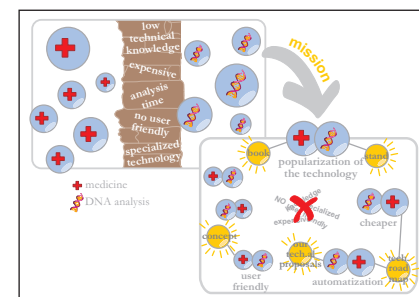
The objective of the project was defined as researching and evaluating likely future scenarios with the introduction of DNA testing technologies for mass use; the intention was to assess the opportunities and advantages that these technologies could offer, and to suggest solutions which can be useful in bringing Genetic Diagnostic Technologies (GDT) further towards a widespread use.

Understanding the problem and searching for solutions required an in-depth survey in the world of research. Our first steps were in the direction of creating a rock-solid, indispensable technical background.

While we believe that the deeply innovative spirit of our project is clear, we believe that one of the keywords of the ASP philosophy,



2 these graphs show the dynamism of the market sector to which Lab-on-chip are entering



3 Key barriers for the adoption of the genetic analysis in day-to-day medical practice

multidisciplinarity, is intrinsic to the subject that we have examined. Indeed, research in the field of genetic testing has brought together scientific areas that until only a few years ago were considered unrelated: electronics, IT, chemistry, biology and genetics.

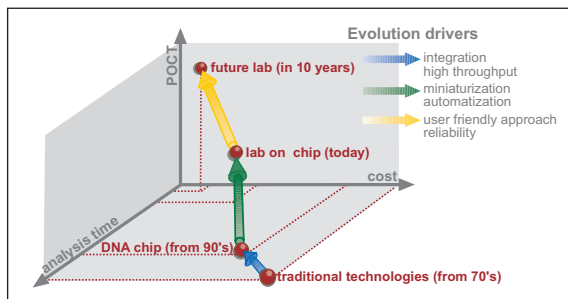
In parallel to this, we analyzed the market for diagnostic and genetic testing products and the relationship between the many actors involved.

Our analysis led us to understand that the main issue in the world of genetic diagnostics is based on the fact that today there are two worlds that are distinctly disconnected from each other: the manufacturing world and future customers world. There are two main reasons for this disconnection: the inadequacy of the current technologies for mass use and the public's lack of preparation for the prospect of such advanced instruments being used in daily life.

The key barriers that were identified can be summarised by the following concepts:

- Lack of preparation of future customers regarding the basic concepts and potential of DNA analysis in day-to-day medical practice.
- Costs and size of current instruments for genetic diagnostics too great to become a point-of-care testing (POCT).
- Low level of automation, instrumentation and analysis complexity.

4 Evolution trend in genetic analysis technology



- Lack of a user-friendly approach in designing testing instruments.

For these reasons, genetic analyses is still limited to specialist research or testing centres, instead of being widely distributed into our society e.g. into the National Health Services.

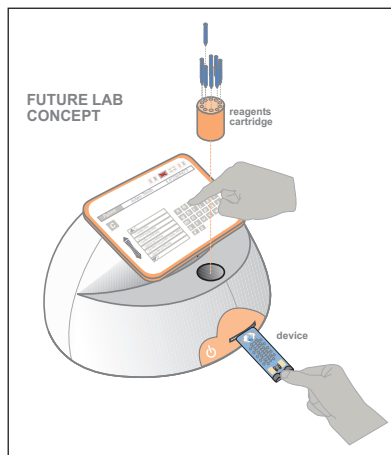
Our desire to assess across-the-board suggestions for this problem, and not necessarily at the level of pure technological innovation of the device, was appreciated by our tutors and by our partners at STMicroelectronics; they encouraged us to suggest solutions that from various perspectives, communication in particular, could help bring future users closer to an avant-garde technology, and vice-versa.

EXPLORING THE OPPORTUNITIES

Among the scenarios we analysed for future use of GDT, we focused on the segment of General Practitioners (GPs) as the ultimate users of genetic testing instruments at the level of POCT. We consider this segment as being the most interesting because it is going to be promising for the market and it is a big challenge from the technological point of view.

Unlike almost all of the other projects, we did not focus on a single solution; instead we maintained a multidisciplinary approach, suggesting various solutions that could be a bridge between the two worlds in this market. We did this by looking at various aspects, from the most technical issues to marketing and communication.

Based on the key barriers described above, we thought about how



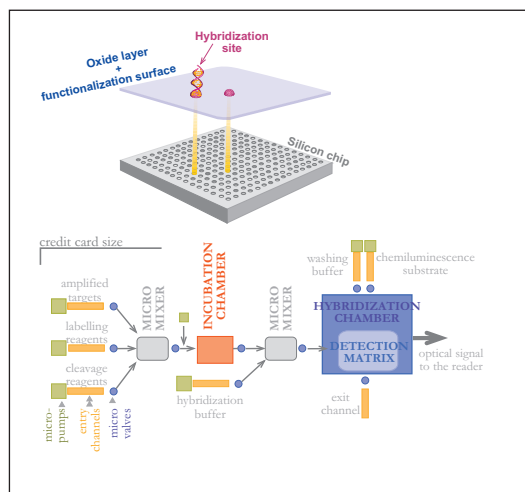
5 Future lab concept: a possible new genetic diagnostics instrument for use at Point of care testing level

technical innovation could bring the two worlds on the market closer together, considering the following issues in particular: cost of the complete system, reduction in complexity of instrumentation, analysis time, automation and flexibility of use. We therefore asked ourselves what the most interesting guidelines could be, for the purposes of generally simplifying and integrating testing protocols within a single device, according to the characteristics listed above.

No less important, in our opinion, was the current problem of communication between manufacturers and future users. It is essential that society at large is adequately prepared before this new technology comes onto the market, in order to immediately maximise its beneficial impact. Indeed, we realised that so far no attempts have been made to offer widespread information to physicians and to the population as a whole, beyond some scientific reviews or trade fairs for researchers or specialist technicians in the sector. What is currently lacking is a thorough information campaign on the basic concepts of this technology and on how it can be used.

GENERATING SOLUTIONS

The results of our research in the technical area was the design for an alternative to the optical scanners traditionally used in



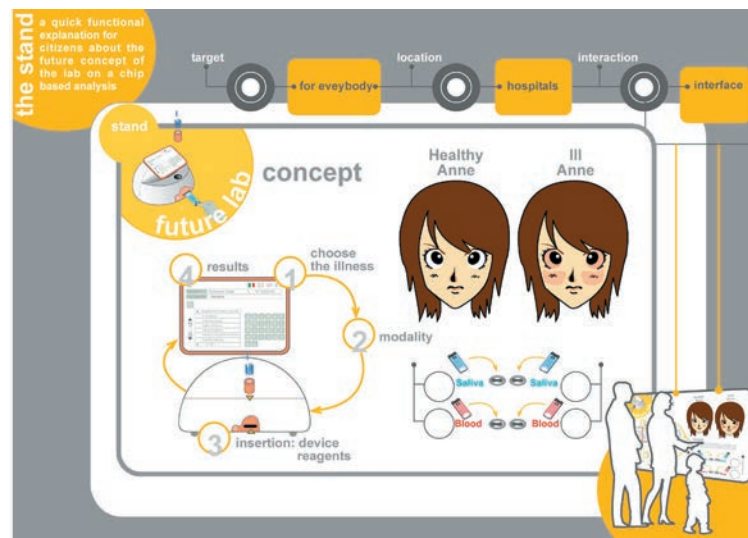
6 Our technical solution: a microfluidic device for DNA analysis through an integrated photodetectors matrix

the detection phase of genetic testing. This uses a matrix of integrated photodetectors that are part of the device itself, and a microfluidic circuit board in which some of the preliminary phases of testing are carried out. Our “Microfluidic device for DNA analysis through an integrated on chip photodetectors matrix” is designed for diagnostic uses. Its strong points are the elimination of the optical system that is part of commercial devices, and the microfluidic board which guarantees the automation of the analysis.

We traced out a roadmap for the technological development of the product, based on which current devices can come closer to the requirements listed above in particular in terms of reducing costs and complexity.

Lastly, working with the team B of the project we came up with a concept for a possible new genetic diagnostics instrument for use at a POCT level. For this, we particularly considered the features of compactness, simplicity of use and user-friendly interface.

As for the idea of bridging the communication gap between manufacturers and future users, we conceived a project that entails writing a manual in a thorough yet accessible style, to introduce GPs to concepts such as genetics, DNA testing techniques, the products currently on the market and future developments in re-



7 The info-point. Strategically situated in the hospitals, the info-point has the aim of popularizing the future integrated lab and to prepare the patient for the next future applications of the technology

search. This solution is the result of working together with members of the other team in our project.

The second solution in terms of communication was the concept of an info-point that could be installed in hospital waiting rooms. The info-point would present the basic concepts of genetic diagnostics, and the advantages that this innovation could offer to society. Our aim was to use interactivity in order to allow the average user to effectively be introduced to complex subjects.

As a last form of direct communication with physicians, we drew up, through a brainstorming session with team B, a questionnaire that would be distributed to members of the Italian National Federation of GPs (FIMMG) through its official website (www.fimmg.org, Centro studi). This solution has a dual role in informing people: on the one hand, it can assist manufacturers in understanding the needs and expectations of physicians; on the other, it appears to be a real solution for informing doctors about genetic analysis techniques and on how these could make a contribution to their profession.



MaPS

Medical advances through Proteomic Solutions

TASKS AND SKILLS

Chiara Bellini dealt with gathering information about the State of the Art and was involved in the organizational part.

Fabio Cancarè focused on the study of existing solutions, dealt with website administration and technical aspects related to the survey.

Andrea Gastaldi was in charge of delineating the technical aspects of the developed solution.

Maria Luisa Grossi explored the market opportunities and was in charge of the stakeholders and needs analysis.

Andrea Tarelli worked on the market analysis, carried out pathology research and designed a business model of the system.

Alex Urrutia Rivero took care of graphics, logo and concept design, focusing on the interaction between hi-tech and users.

ABSTRACT

Lab on Chip (LoC) devices represent a new challenging frontier in nanobiotechnologies. They are expected to perform genomic and proteomic analysis, replacing slow and expensive techniques traditionally used in medical diagnostics. While genomic LoC devices already exist, there is no counterpart in the proteomic field. The aim of this project team is to study the feasibility of protein LoC devices from a technological point of view and their expected profitability. The target of the device was chosen to be the Family Doctor because of technological issues. A flow diagram of the ideal device was designed, taking into account the users requirements, and the best techniques for each stage of the process were identified, demonstrating the feasibility of the device. The team also designed a concept of the whole analysis system, from sampling to the displaying of results, paying particular attention to the interaction between hi-tech and users. In order to prove the profitability of LoC devices, a market analysis was carried out. It showed a good trend in the molecular diagnostics market, especially in the emerging proteomic field, thanks, for example, to the possibility of performing fast and cheap detection of tumoral markers. Then the team developed a survey, in collaboration with FIMMG (Federazione Italiana Medici di Famiglia), in order to test the attitude of Family Doctors towards the introduction of LoC devices, and in general of nanotechnologies, in their ordinary practice. As a consequence the team proposed some solutions for providing a technical background to physicians, allowing a correct comprehension and use of a LoC. Among these solutions the most promising are: publishing a book describing LoC devices in a simple way, creating an informative brochure to be distributed at conferences and meetings and designing a website describing the innovations and advantages of LoC devices.



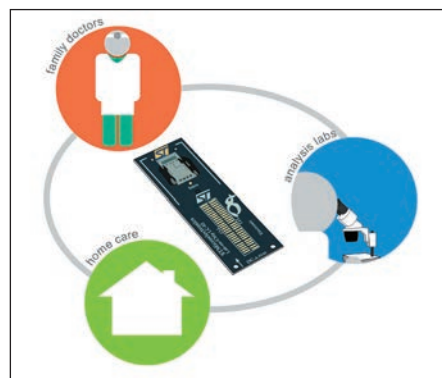
1 Expected technological evolution for diagnostics

UNDERSTANDING THE PROBLEM

Nanotechnology is expected to revolutionize the field of diagnostics in the near future (Figure 1), thanks to the development of microfluidic devices called Lab on Chip (LoC). These systems rely on fluid transportation within microchannels, where the entire analysis process can be carried out. A LoC will perform extraction of biological samples, sample treatment and detection very close to the point of sampling, replacing traditional analytical instruments. Although various prototypes have been recently developed, no proteomic LoC is market-ready. Since ST Microelectronics would undertake R&D investments to realize a commercial device only in case of actual profitability, the team was assigned the task of evaluating the outlooks of protein LoC devices in the diagnostics field. The task has been worked out considering two different issues:

- figuring out the main technological features that a LoC should exhibit in order to satisfy users needs;
- investigating how future users are expected to behave in order to achieve an efficient use of LoC technology.

The team focused on three main targets in the diagnostics context (Figure 2): Analysis Labs, Family Doctors and Point of Care applications, showing different needs in terms of times and costs, automation of the process, level of integration, performance and reliability of results.



2 Protein Lab on Chip and its potential targets within the diagnostic context

EXPLORING THE OPPORTUNITIES

Technical issues

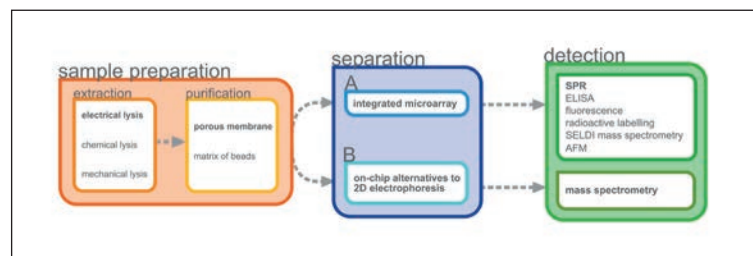
Screening of proteins in biological samples is achieved through the following stages (Figure 3):

- extraction and purification of total protein content from a biological sample;
- separation of individual proteins;
- identification of separated proteins;
- storage, manipulation and comparison of data.

Proteins are traditionally extracted by electrical, chemical or mechanical cell lysis, then separated by 2D Gel Electrophoresis (2D-E) or High-Performance Liquid Chromatography (HPLC), and finally identified by Mass Spectrometry.

Recently the traditional process of separation has been partially replaced by microarrays. These systems are based on spots of material, immobilized upon solid supports in a 2D addressable grid, that retain targets from liquid media, hence supporting an “n by n” characterization of the interaction between different proteins. This characterization can be performed by well established techniques (fluorescence, radioactive labelling, ELISA, SELDI mass spectrometry, AFM or SPR).

The first challenge faced was the feasibility study of a LoC device, integrating the entire process through the implementation of microfluidic systems for fluid transportation.

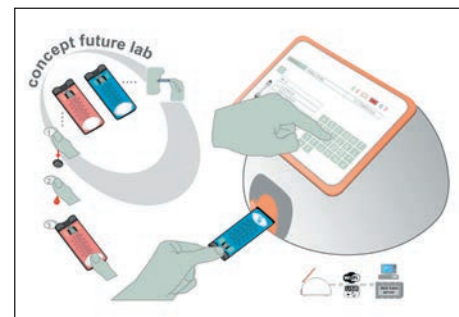


3 Flow diagram of the ideal protein Lab on Chip. Path A and B refer to the two alternatives explored. Several possible techniques are presented for each stage of the process

Two alternatives were identified, differing one from another for separation and detection techniques. The first is expected to perform separation with a fully integrated high-density microarray. The second requires the implementation on the chip of a separation technique similar to 2D-E, performing detection with a mass spectrometer. In both approaches microchannels allow the transportation of the solution, avoiding human intervention. Microfluidics, together with the realization of integrated extraction, are the most critical technical issues.

Market issues Among the possible target alternatives identified in the field of diagnostics, Analysis Labs, providing high-performance and complex analysis, were not considered a suitable target, since the introduction of fast low-cost devices would jeopardize their market leader status. From a commercial point of view the most suitable targets were Family Doctors and Point of Care applications. The team, with the approval of ST, decided to focus on Family Doctors because of technological issues. Therefore, the second challenge was to find out how to provide these professionals with competences allowing an appropriate use of LoC devices: publishing solutions, institutional approach (National Health System) and conferences were taken into account. In order to better understand Family Doctors needs, the teams created a survey that was published on FIMMG website. A total of 430 answers was gathered, giving the possibility to better outline the users requirements, concerning not only Family Doctors, but also Patients and the National Health System.

4 Concept of a future protein Lab on Chip device showing how should it work



GENERATING A SOLUTION

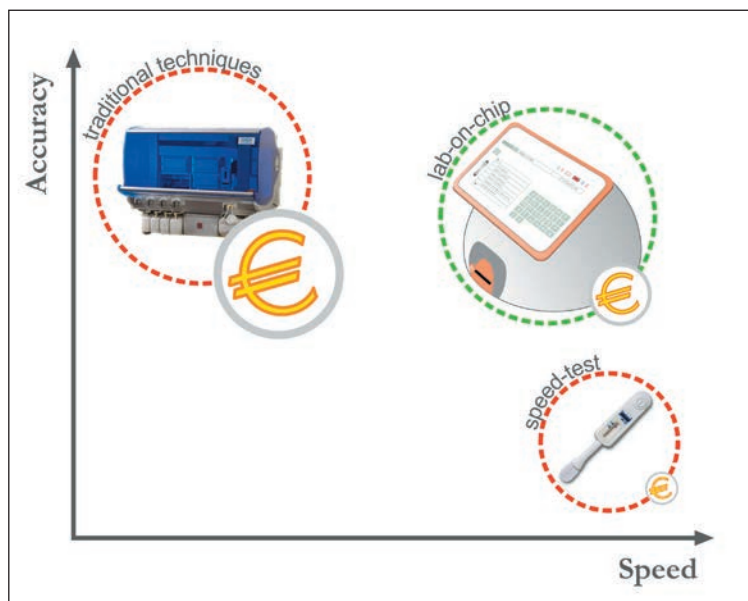
Technical solution Between the two alternatives previously described, the analysis led us to choose the microarray-based solution, since it is more easily implementable with current technologies and it assures many diagnostic applications.

Several methods for each stage of the analysis process were taken into account, in order to evaluate their advantages and disadvantages. As Figure 3 shows, the most promising implementations for each step are the following:

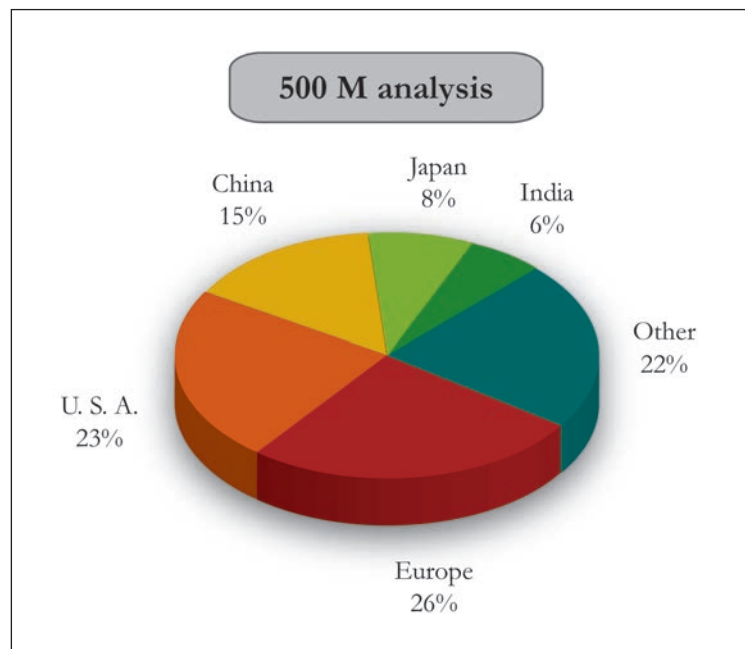
- Extraction: electrical lysis, easily implementable with a couple of electrodes next to the sample, and effective, thanks to the presence of ionic species in biological fluids;
- Purification: silicon filter, allowing the retention of bigger cellular debris;
- Separation: microarray integrated on a silicon chip;
- Detection: SPR (Surface Plasmon Resonance), a label-free technique requiring a polymeric matrix substrate;
- Microfluidic systems: electrosmotic flow, realized applying a voltage at the ends of microfluidic channels.

The two teams designed a concept for the entire system of analysis (Figure 4); besides, the future protein LoC was compared to traditional techniques and speed-tests (simple, cheap and rapid tests providing visual qualitative results, as pregnancy tests) in terms of accuracy, speed and costs (Figure 5).

Market analysis The team carried out a market analysis on LoC devices and applications. The LoC market is expected to grow with a CAGR (Compound Annual Growth Rate) of 21% in the



5 Comparison between Lab on Chip devices, traditional techniques and speed-tests in terms of accuracy, speed and costs



6 Shares for the expected total number of analysis, considering diagnosis of cancer, HIV test, microalbumine test for diabetes, allergy test, T.O.R.C.H. complex (Toxoplasma gondii, Other infections, Rubella, Cytomegalovirus, Herpes simplex virus) test, thyroiditis test

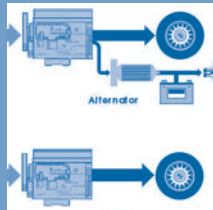
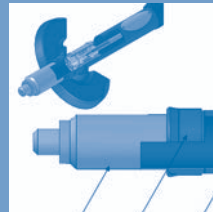
following years, increasing from about 300 \$ Mn in 2006 to 600 \$ Mn in 2010.

The team made a quantitative evaluation of the future market of the protein LoC for some specific applications. Here they are listed in decreasing order of expected market size: diagnosis of cancer, HIV testing, microalbumin test for diabetes, allergy tests, T.O.R.C.H. complex (Toxoplasma gondii, Other infections, Rubella, Cytomegalovirus, Herpes simplex virus) test and thyroiditis test. The expected number of analysis per year for those diseases is about 500 million, while the most profitable markets are Europe and U.S.A., followed by China, Japan and India (Figure 6).

Market solution In order to provide Family Doctors with competences allowing an appropriate use of LoC devices, the two teams proposed to write a manual, intended for doctors, concerning

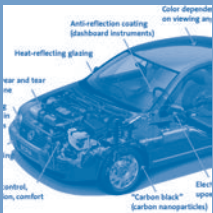
both proteomic and genomic LoC devices. The book would be about 150 pages long.

The teams contacted Polipress editor to obtain an accurate estimate of costs/revenues and evaluated 1000 copies of the manual to be suitable for a first publication. Distribution and promotion would be carried out both in traditional and internet bookstores. Other expedients for the promotion of LoC devices were proposed: the design of a synthetic brochure, intended for specialized meetings, and the realization of a website (www.lab-on-chip.org), addressed to the public, in order to spread knowledge among patients as well.



PROJECT

8



NanoTra



INTEGRATING NANOTECHNOLOGIES WITH THE DESIGN OF MATERIALS AND COMPONENTS
OF THE FUTURE TRANSPORT SYSTEMS



NanoTra
integrating nanotechnologies
with the design of materials
and components of the future
transport systems: towards the
formation of a nano-engineer

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Martino Zuccali

Mechanical Engineering

project 8

*Innovative applications of
nanotechnologies to transport
systems field are proposed
to meet environment and people's
expectations*

TEAM B

Andrea Simonetto [Team controller]

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Andréa Zaneti Caligares

Mechatronics Engineering

Pietro Borghesani

Mechanical Engineering

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Mechanical Engineering

Alessandro Surrente

Physical Engineering

PROJECT DESCRIPTION

THE CHALLENGE

Nanotechnology is expected to bring essential contributions in many fields. The challenge of this project was to achieve a better understanding on if and how nanotechnologies could be integrated in the automotive industry, helping to match growing performances and environmental requirements.

A strong interdisciplinary character is associated with nanotechnology, since matter exhibits, at the nano-scale level, different and often amazing properties and the borders between established scientific and technical disciplines fade.

A concurrent engineering approach was used in order to think of new ideas. The adopted point of view was that of the customer, so the question was: “What would I like to see on my car?”

The answers to this question were the ideas elaborated by the teams and checked to verify their feasibility; in particular: the application of micro fuel cells for auxiliary power generation; the use of nano-structured materials in car components; the use of anti-frictional nano-coatings for glass and light alloy mechanical components; new illumination systems employing OLEDs.

THE TEAMS

Most part of the students were mechanical engineering students who brought their competences in the mechanical parts and the constructive problems. The physics engineering students concentrated on fundamental physics aspects, while the mechatronic engineering students contributed to the integration of new devices within the car instrumentations.

Team A, “Nano Inside”, was asked to study new nano-material based power generation units and to examine nano-structured materials able to improve the efficiency of catalytic converters and the mechanical properties of traditional components.

Team B, “e-Car”, focused on exploiting nanotechnology-based components and systems in order to reach the final condition of a fully controlled car.



THE RESULTS

The starting points were the identification of law constraints and the comparison of the performances of the current technology with the predictable ones of the nano-engineered systems. As it has to be for each multidisciplinary project, results are ideas: ideas of applications of micro and nano technology in the automotive sector. These ideas are concepts in the direction of a nano-car, showing some strategies and suggesting some solutions that the nano-technology industry can work on.



Nano Inside Nanotechnologies for automotive components

_ NANOTRA _ INTEGRATING NANOTECHNOLOGIES WITH THE DESIGN OF MATERIALS AND COMPONENTS OF THE FUTURE TRANSPORT SYSTEMS

TASK & SKILLS

During the project development each member of the Team dealt with some specific subjects. Often the Team was divided into sub-teams made up of two or three people, who had the task of investigating a specific theme. More in detail:

Francesco Cattoni and **Francesco Marangio** analysed the state of the art of the Fuel Cell technology and the possible applications, with the related advantages and problems. Francesco Cattoni then developed an organic text describing the results of the work, while Francesco Marangio had to organize the material produced by the whole team.

Marco Mazzucco dealt with Nano Structured Materials, investigating the state of the art and the main benefits their use could bring to the automotive industry.

Giovanni Vanacore studied Thin Film Technology and the possibilities offered, by the use of coatings, to improve the surface properties of the materials used in automobiles.

Martino Zuccali and **Daniele Perottino** carried out an investigation of the possible applications of innovative nano and micro sized materials, in particular composite materials to reduce car weight and titanium dioxide materials for power generation. They also performed a study on the state of the art in catalytic converters.

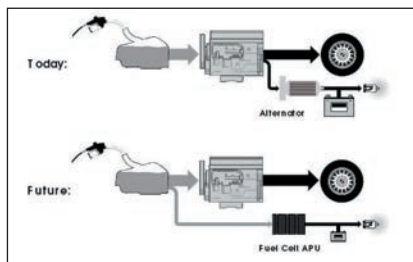
ABSTRACT

The aim of this work is to study possible future applications of nanotechnologies in the automotive field. In particular the Fiat Research Centre (CRF), the external institution partner of the project, required as to develop ideas about the implementation of new concepts in the automotive market, which could be useful by potential customers, improving performances while being at the same time environmental friendly and cost effective.

Our research had to take into consideration safety, comfort and environmental requirements. We concentrated our efforts on the design of a car able to actively help the driver in reducing the risk of accidents and to offer a more pleasant driving experience. At the same time, the power required by these new systems should be supplied without reducing the engine performance or increasing the fuel consumption, but on the contrary improving both of them.

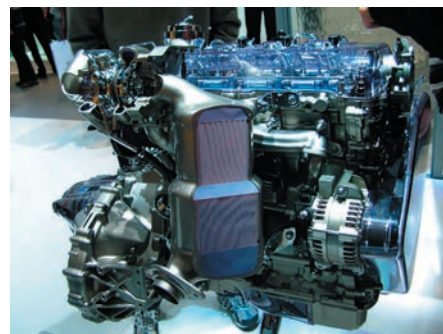
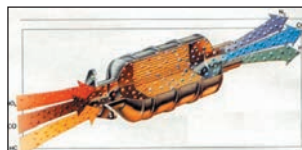
The explored technologies are new, and in most cases they are still undergoing research activities. At the moment it is therefore very difficult to forecast the possible market evolution in the next decades, because industrial standards still haven't been set. Moreover, these technologies are still very expensive due to their pioneer nature, but they will be within the consumers' reach as soon as a large-scale production can be started.

Team A studied the possibility offered by the new field of nanotechnologies and micro fuel cells to improve the performance of car components. Micro fuel cells could supply the growing electric power requested by new devices. Nanocomposite materials could be used to build lighter cars, thus reducing fuel consumption without affecting the structural performances of the car body (important for safety reasons). Titanium dioxides are likely to be used to build solar cells (working together with fuel cells in supplying auxiliary power) and UV-blockers. Thin films realized through nanotechnologies could be used to give the desired surface properties to any material.



1 Today power flux on a car, compared with the future one

2 Operating mode of a three-way catalysts



3 In front of the engine is visible a catalytic converter (Geneve Motorshow 2007)

4 The droplet only touches the super-hydrophobic surface at a few points and due to its surface tension, forms a sphere



UNDERSTANDING THE PROBLEM

The automotive industry is divided between trying to reduce costs on the one hand and, on the other, dealing with the high price of performance-enhancing technology and environmental compliance. The ever-growing demand for mobility around the world causes a number of areas of transportation, such as safety, to require advanced technological innovation: it is here that nanotechnology will make the greatest impact.

The identification of customers' needs was mainly based on a wide examination of specialized articles and papers. The collected information was then compared with market analysis performed by Fiat, corporate partner of the project, in order to define the most relevant features required by the market. These can be summed up into three main themes:

- **Environment:** a deeper sensitivity towards environment protection leads to a demand for greener technologies; regarding cars, that means a lower fuel consumption rate, a reduced use of energy in the whole production process and the maximization of material recycling.
- **Safety:** the tragically high number of road accidents could be considerably reduced by the introduction of new, cutting-edge safety technologies aboard cars (and by a wiser driving style, of course).
- **Comfort and performances:** since most car owners are supposed to spend at least two hours per day in their cars, great

attention has to be paid in order to turn a simple trip into a life experience (a "Grande Viaggio", quoting a Fiat advertisement).

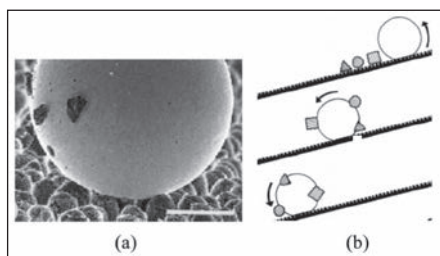
EXPLORING THE OPPORTUNITIES

The answer to future cars and mobility systems requirements can only come from an innovative way of using the strengths of new technologies and materials.

After an extensive study of the topics involved, all the members of the team cooperated in generating a range of possible solutions, which were later discussed with the experts of CRF to sort out the most interesting ones, which were those most likely to be on the market in the next few years.

The increasing amount of electrical equipment aboard cars represent a great opportunity to improve safety, performance and comfort in vehicles, but also implies a significantly higher demand for auxiliary power, which has to be supplied without increasing fuel consumption or worsening engine performance.

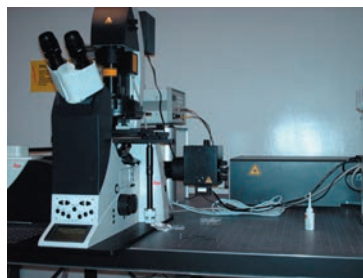
Since the traditional battery systems are not likely to stand the new needs, micro fuel cells could represent a valid alternative. Unfortunately the feasibility of pure hydrogen-fuelled fuel cells has still to face important technological problems, while the use of conventional fuels (bio-originated too) in Solid Oxide Fuel Cells (SOFCs) or Proton Exchange Membrane Fuel Cells (PEMFCs) is



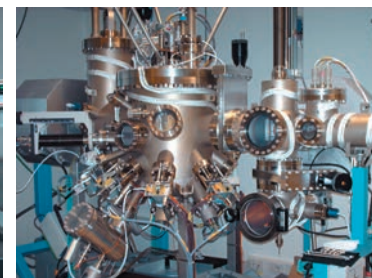
5 Self-cleaning surface: (a) contaminating particles adhere to the droplet and are removed when the droplet rolls off the surface; (b) the diagram shows the cleaning process of a rough surface. (W. Barthlott, C. Neinhuis *Planta* 1997, 202, 1-8)



6 A droplet takes up dust covering a lotus leaf



7 31/10/2006, Lecce. Visit to the National Nanotechnology Laboratory. Optical microscope



8 31/10/2006, Lecce. Visit to the National Nanotechnology Laboratory. UHV (Ultra High Vacuum) Chamber for MBE (Molecular Beam Epitaxy) deposition

already within current technology's reach. In particular, SOFCs could run directly on petrol, while PEMFCs need an internal treating (reforming) system for the fuel. PEMFCs have already been implemented by BMW on a luxury car to power the cooling systems, while SOFCs fuel cells are being successfully tested for the use in lorries. The latter are likely to be commercially available in the next few years, due to the high amount of auxiliary power required by the cabin comfort equipment in lorries; on the contrary the use of fuel cells for the mere supply of auxiliary devices on cars is still not economically profitable and, as confirmed by the advice of the experts of CRF, is going to proceed side-by-side with the use of fuel cells as main power generators for traction.

Composite materials have experienced rapid development over the last 30 years. Some aspects of composites' performance are light weight, corrosion resistance, unique mechanical characteristics and ease of fabrication. In the 1990s car builders became aware of the great possibilities that composite materials could give to the new purposes of manufacturing cars. The USA was the first country where large quantities of these materials were used to build lighter cars.

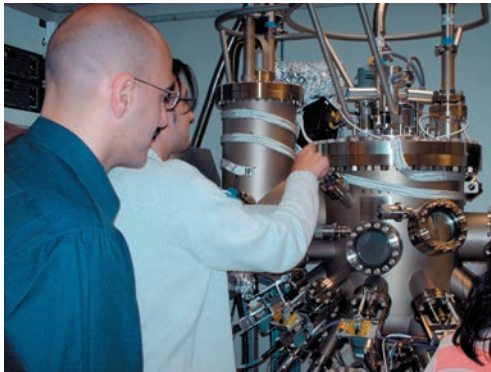
In spite of their scarce mechanical strength, titanium dioxides show interesting properties and are likely to be used to produce cheap solar cells (able to work together with micro fuel cells in supplying auxiliary power), pigments (to give whiteness and

opacity to products such as paints and coatings), photocatalysts, UV blockers (titanium dioxide nanoparticles are already used in solar creams to block UV rays) and oxygen sensors.

The main advantage of thin films (or any other coating) is that material properties can be transferred to the substrate surface, thus enabling the use of different substrates. In general, optical, mechanical and chemical properties represent the most remarkable properties for a thin film. At present, nanotechnology provides the tools for controlling some key parameters for the performance of thin films, such as chemical composition, crystalline structure, thickness and superficial topography.

GENERATING A SOLUTION

Layers of nanoparticles could produce beneficial effects on the interior and exterior surfaces of vehicle parts. For example, rain on the windshield or rear-view and side mirrors can often impair the driver's view: nanosurfaces could help to solve these problems. Layers of water-loving (hydrophilic) chemical compounds make the condensation melt into an even, transparent film rather than letting it form droplets that can impede a clear view. Nanotechnology also makes it easier to clean the vehicle's exterior surface. Chemical compounds containing a high percentage of fluorine create the chassis surface that are dirt-repellent and easy to clean. Anti-reflection coatings that prevent glare in the dashboard di-

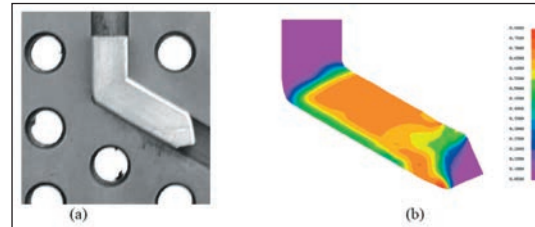


9 31/10/2006, Lecce. Visit to National Nanotechnology Laboratory. UHV (Ultra High Vacuum) Chamber for MBE (Molecular Beam Epitaxy) deposition, with Gianmaria Vanacore and Marco Mazzucco

10 31/10/2006, Lecce. Visit to the National Nanotechnology Laboratory. Clean Room: in this protected environment the number of particles in each cm^3 of air is kept below a fixed threshold. It is used for lithographic processes.



11 The roof of this car is equipped with solar cells



12 Physical and computer model of the ECAE/P process: (a) ECAE/P die and partially extruded work piece; (b) a simulation of the ECAE/P process, showing strain distribution

13 09/03/2007, Visit to the Geneva International Motor-Show. From the left: Daniele Perottino and Marco Mazzucco



splay instruments comprise another advantage. In the future, they could contribute to making windshields completely glare-free. If we take a look at ongoing research projects, it may soon be possible to have “changeable surface areas” that determine the outer appearance of a vehicle.

There are already vehicles in the luxury class today that have nanoplatelets in their paint to create different color effects when seen from different angles. In the future, it might even be possible to change the colour of your car to suit your mood by simply activating a nanopigment switch.

It is much more important, however, to employ today’s findings in nanotechnology in new products that increase vehicle environmental friendliness and safety.

The wear and tear on engine components, for example, could be reduced, lightweight engineering could lower fuel consumption

and the efficiency of fuel cells and catalytic converters could be increased.

Through nanotechnology, the automotive industry can get its new growth potential and development momentum. The design and manufacturing of cars, trucks and buses can be heavily affected by nanotechnology and related technologies, because they provide the automotive industry with huge space for innovations and chances for new markets. In fact, almost all automobile components can be improved by nanotechnology, and the automotive industry will benefit from this trend by getting e.g. advanced powertrain, using new energy, reducing car weight, enhancing material functions, increasing comfort degree & flexibility, raising cost efficiency.



E-Car Nanotechnologies to rethink the car

NANOTRA _ INTEGRATING NANOTECHNOLOGIES WITH THE DESIGN OF MATERIALS AND COMPONENTS OF THE FUTURE TRANSPORT SYSTEMS

TASK & SKILLS

The team studied the framework of nanotechnology in the automotive sector, possibilities and trends.

Pietro Borghesani and **Davide Cabella** studied the magnetorheological damper, focusing on the feasibility study and on the final design. Their analysis includes dynamical simulations and a very detailed roadmap.

Andrea Simonetto studied several smart actuators to find the best suitable applications. He made feasibility studies and gave ideas for new microtechnology concepts.

Alessandro Surrente analysed the OLED display technology. He provided physical basis and studied the main problems in this field from a market point of view.

Andrea Zaneti Caligares dealt with sensors, in particular tire pressure sensors and pollution nano sensors. She suggested the first step towards an environment-friendly car.

ABSTRACT

Nowadays cars are still not simple enough for the driver and they are not so environmental friendly. In fact the outside conditions could decrease safety, i.e. rain, humps, and so on, and drivers must adapt their driving style to the strongly variable environmental conditions in order to drive safely. Moreover decreasing pollution is also one of the most important issues in the automotive sector.

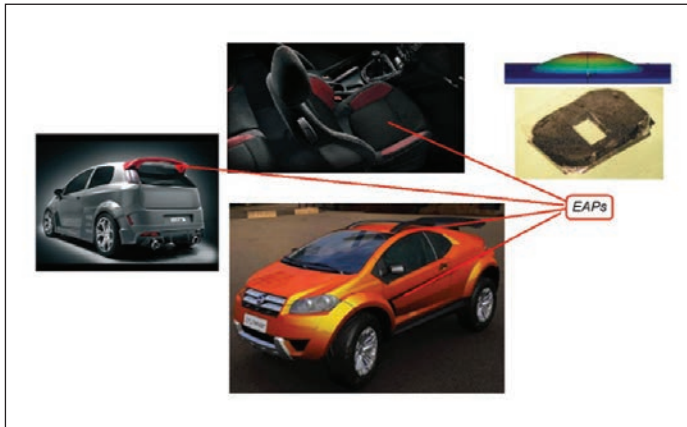
This project deals with the possibilities given by nanotechnology both to offer the customers simpler cars and to reduce polluting emissions. This is achieved by using nano-actuators, sensors and displays to have a fully controlled and electronic car. This can be simply obtained, since all the work is accomplished by an internal Electronic Control Unit, and the customer has only to enjoy the driving, without worrying about outside conditions. Moreover weight might be reduced, as well as fuel consumption, size, complexity and cost and performances could be improved.

The main solutions proposed in this framework with the advantages above are magneto-rheological dampers, micro-piezo patches for noise reduction, MSMA actuators for brake by wire and self repairing coaches, EAPs for shaping morphing, nanosensors for air pollution detection and OLED displays.

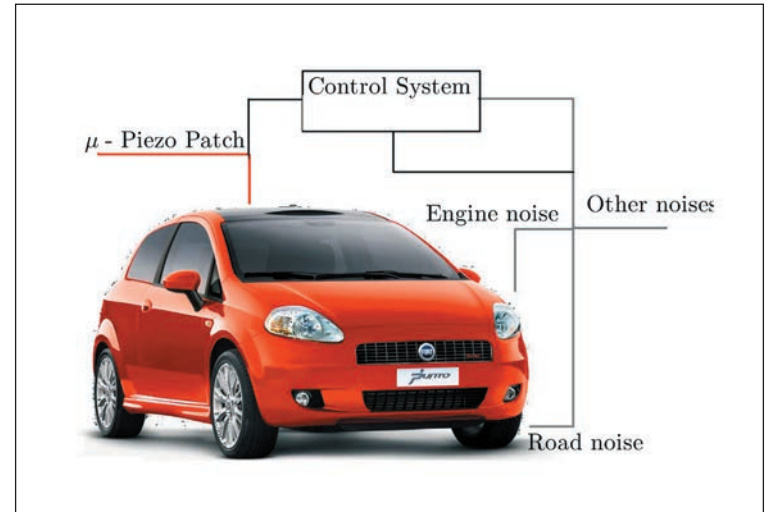
Some of these ideas are not new, e.g. MR dampers, nanosensors, OLED displays, but the idea of using all these for a common purpose is new. Moreover, even if they are quite well known, there are still some problems to deal with, which have been analyzed.

Other ideas are new applications of known or new materials. These are analyzed both for physical and cost feasibility. The results of these studies are that MSMA actuators are not feasible within the automotive industry nowadays, but both piezo and EAPs could be used.

The whole project was thought out for a mid-term industrialization, so all the concepts presented were also studied within this constraint. The first group of applications, i.e. MR dampers and so on, could be commonly used in few years on every car; whereas the second one is expected to enter in the market some time after 2015.



1 EAPs possible applications



2 The idea of piezo patches

UNDERSTANDING THE PROBLEM

One of the most important and wide spread innovations in automotive industry is the hybrid car, where an internal combustion engine is coupled with an electric motor.

The aim of hybrid cars is not the substitution of the traditional fuel engine with electric power, but the improvement of efficiency in the combustion engine for reducing both fuel consumption and pollutant emissions.

This new idea of an eco-efficient car involves nanotechnology in two ways. One is related to what new materials could offer for a more efficient car: reducing its weight, improving catalytic performance of the exhaust and so on. Another concept goes in the same direction as hybrid cars, but it does not depend on it, and it is the adoption of electronically controlled nano-devices, as magneto-rheological dampers, clutch and brakes, nano-sensors and nano-actuators, which could allow the Electronic Control Unit control the dynamics of the vehicle faster and more effectively. This would improve energy consumption, safety and comfort.

Thus, team B, “e-Car”, researches focused on exploiting nanotechnology based components and systems in order to reach the final condition of a fully controlled car, where different hi-tech

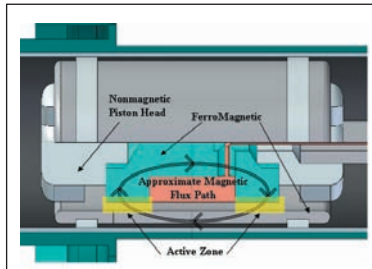
nano-devices work together to bend the vehicle dynamics to the control of the electronics. The aim was to study, verify and discuss the applicability and economical feasibility of those nanotechnology based devices, pointing out the entity of the improvements and comparing them with the costs.

The solutions have been designed for short-medium industrialization time, and for this reason the team paid attention to the industrialization costs and the time to market. The main goals were: improve vehicle safety, performance, comfort and environmental impact.

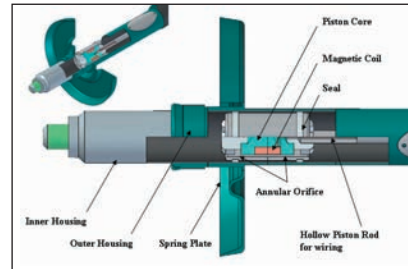
EXPLORING THE OPPORTUNITIES

The fields that were investigated are actuators, sensors and organic electronics, i.e. OLEDs. OLED displays could be important in a fully controlled car both for the interface with the passengers and for entertainment.

Actuators. Smart materials for microactuation, SMA (Shape Memory Alloys), piezo and electro-active polymers, are now viable for early applications in the automotive field. They provide advantages in terms of weight, cost and size reduction.



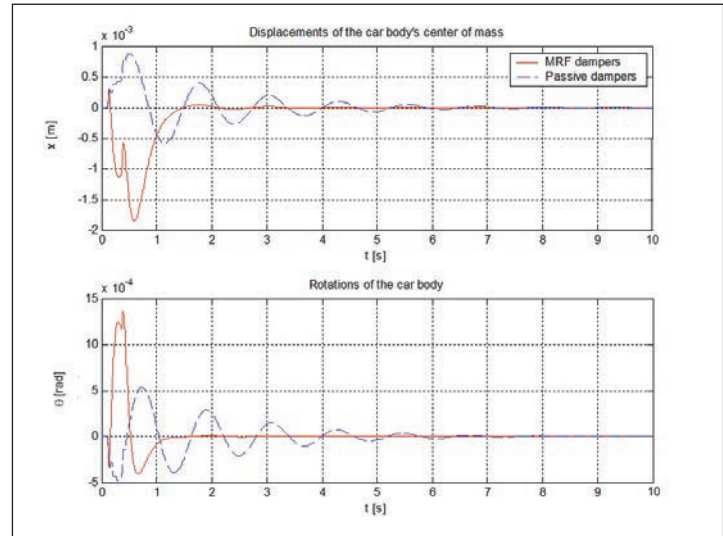
3 Magnetic flux path inside the damper



4 Damper overall design



5 OLED grown on a flexible substrate



6 Comparison of performance for a random profile of the street

Through the integration of actuators in moving structures, the actuation mechanisms could be drastically simplified. The application of SMA trunk latches was developed on an industrial level by Fiat, demonstrating reliability and cost savings.

Lord developed MR fluid for damping for automotive application. In the past five years it has mounted these kinds of actuators on several different car brands. The speed and simplicity of MR technology enables the use of low-stiffness springs without compromising between ride and stability. Regarding the electronic car concept, the brake by wire system has to be mentioned. Siemens recently (2005) developed a 12 V brake by wire system which could easily be integrated in the most common cars.

Sensors. Nowadays MEMS sensors have a market size of 6000 M\$ in the automotive industry and they are expected to arrive at 10000 M\$ within a few years.

In this context the TPMS (tire pressure monitoring system) sensor is one of the most promising market investments. This is because new laws on safety could impose it as a requirement on cars in Europe, as it has been in USA since 2007. Besides road safety, TPMS can increase the tire life cycle and reduce fuel consumption.

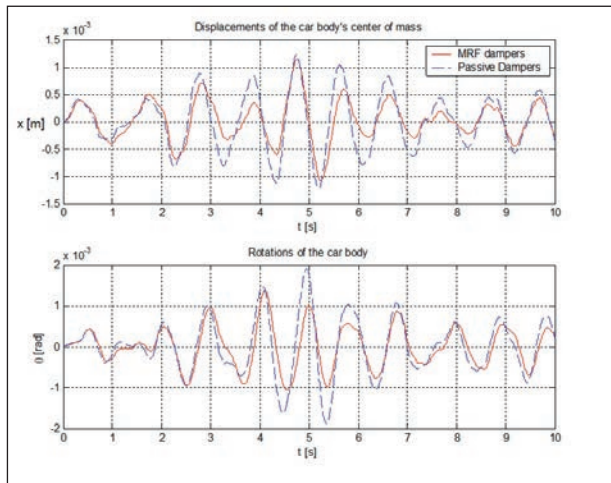
On the other hand nanosensors are a complete challenge in the

automotive industry. The main brands are currently studying nanosensors for safety. The most promising ideas are nanosensors for air pollution detection made by using nanoribbons of SnO₂. This could be the first step towards an environmental friendly car.

Organic electronics. Since the 1990s the technological development of OLEDs has evolved dramatically with their commercialization (1998). In the market, OLEDs are starting to compete with the liquid crystal display (LCD). OLEDs have several advantages compared to LCD technology: viewing angles of almost 180°, reduced thickness and weight, intrinsically emissive, ultra fast switching rates, high color contrast and high brightness. These properties could be useful in the automotive sector.

OLED display technology is at a relatively immature development stage. In 2006, however, a series of products appeared in the market. Pioneer and Alpine developed an animated multi-color OLED display for their car audio system.

Becker Traffic uses OLED displays for their car navigation systems.



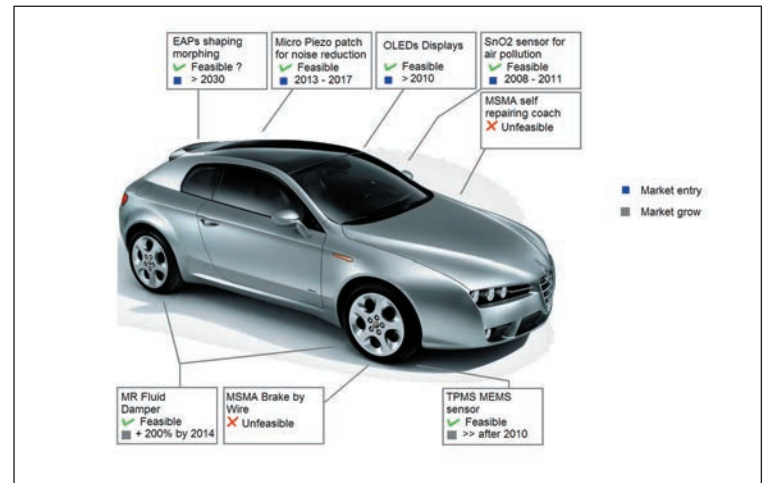
7 Comparison of performance for a hump profile of the street

GENERATING A SOLUTION

Actuators. MR fluid dampers is the application proposed; it is not innovative in concept but in the design of the actuator itself. With the proposed idea the performance as compared to available passive dampers is better both in dynamics and in comfort. The MR fluid damper market is expected to grow by 200% within 7 years. Micro - piezo patch could be useful in noise reduction. This application is completely new in the automotive industry but well known in aerospace, even if still under investigation. The critical factors are scalability and cost-performance ratio. By 2017 the latter is expected to decrease in a way that commercialization could become feasible. The key advantage could be weight, complexity, power and cost reduction in comparison to the available microphones solution.

SMA could have several applications as well as Magnetic SMA. Two of them have been explored, namely brake-by-wire MSMA actuator, and MSMA self-repairing coach. Both are completely innovative and unfeasible in the current automotive industry.

EAPs are in their first stage of research so it was only proposed as a technological development plan. However, their possible applications are several, e.g. shape morphing, and the clear advantages could be weight, complexity, and power reduction.

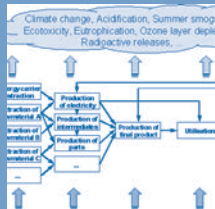


8 Main proposed solutions

Sensors. Nanosensors for air pollution detection is the main application proposed.

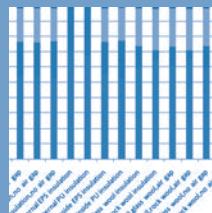
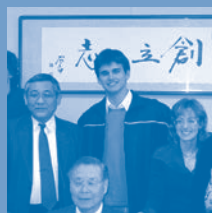
For example they could be used to check the air quality in the car, as well as using them as a feedback for the air conditioning system, in order to improve comfort. SnO₂ nano ribbons are used for this purpose. This idea is quite known in the nanotechnology field and the market entry is expected within 1-3 years, so 2008-2011.

Organic electronics. There are several reasons why OLED is an interesting new display type. Namely, the thin format that also leads to lower weight, the wide viewing angle that allows multi-user capabilities, cheap manufacturing for future developed manufacturing processes and a good power efficiency. The OLED technology is also believed to possess good chromaticity properties that will enable correct and good visual presentation of data. A substantial disadvantage with the new technology is that the displays have not yet proved to be lifetime sufficient for the market demands. When and if the problem with its lifetime will be solved the OLEDs will surely take large portions of the display market (after 2010).



PROJECT

9



EPD



EPD FOR BUILDING SECTOR



EPD for Building sector

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EXTERNAL INSTITUTION

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EXTERNAL TUTORS

Gian Luca Baldo

Life Cycle Engineering

Leonardo Maffia

Life Cycle Engineering

project 9

*The EPD system
to improve
environmental
conscience*

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Nuclear Engineering

Chiara Brocchi [Project Communication
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Safety and Prevention Engineering
in the process industry

Antonino Ripepi

Environmental Engineering

Elena Dalla Vecchia

Environmental Engineering

Allan Martins Rodrigo Gaban

Mechatronics Engineering

Emanuela Peduzzi

Nuclear Engineering

PROJECT DESCRIPTION

CHALLENGE

In the near future, several industrial sectors will have to face the challenge of reducing air, water and soil pollutions, decreasing environmental damage: the construction industry could play a key role in sustainable development.

Nowadays, designers have to select materials and technical solutions with low energy consumption and resource depletion. Internationally recognised LCA - Life Cycle Assessment (UNI EN ISO 14040 and 14044) is currently the most reliable methodology for energy and environmental impacts evaluation in production processes and products.

In this work, the LCA method was used to evaluate the energetic and environmental burdens taking into consideration the most important life cycle phases for the building envelope.

TEAM

In this work three groups focused the analysis on the environmental impact of building envelopes, in particular walls, roofs and windows considering the new normatives of the Directive 2002/91/CE and D.Lgs 311/06. Examining different types of components helped the students to improve their knowledge of LCA in order to master a problem setting approach. LCA does not require any previous competence, but constitutes an interesting tool which is the basis in developing the sustainability of industrial processes.

RESULTS

The different technological solutions for building envelopes were compared, adopting the same thermal trasmittance as a “functional unit”. The thermo-insulating materials were selected to be compatible to the type of technology under study. The results associated to material and energy consumption, air, water and soil emissions were calculated in a form to present the following main energetic and environmental effects:

- 1.GER (Gross Energy Requirement), to measure energy consumptions (MJ);
- 2.GWP (Global Warming Potential), to measure the greenhouse effect.



The results associated to walls, roofs and windows were normalised taking into account the respective percentage in the building envelope for four building typologies: single family house, terrace house, row and tower building.

These first results are able to help designers to compare solutions for a correct selection of both materials and technological components. Some more analysis could be performed to complete the results with new technologies and materials.

The project demonstrates the key role of LCA as methodology to support management and marketing strategies in the building sector and, since the environmental consciousness in the building sector is raising, the need to use LCA and materials selection techniques here also offers the opportunity to introduce a satisfactory approach to eco-materials.

Ultimately, the Environmental Product Declaration (EPD) scheme was introduced as a valid support and vehicle for the environmental communication (ISO 14025 application), evidencing the importance of the Product Category Rules (PCR) document development.



LCA in the Building sector

_EPD_FOR BUILDING SECTOR

TASK & SKILLS

Chiara Brocchi and **Antonino Ripepi** were responsible for the roofs models, insulating strategies and related LCA analysis.

Elena Dalla Vecchia and **Allan Martins Rodrigo Gaban** analysed the walls of our prototypical house and carried out the dedicated analysis.

Emanuela Peduzzi and **Stefano Passerini** worked on the analysis of windows taking into consideration both glass and frames.

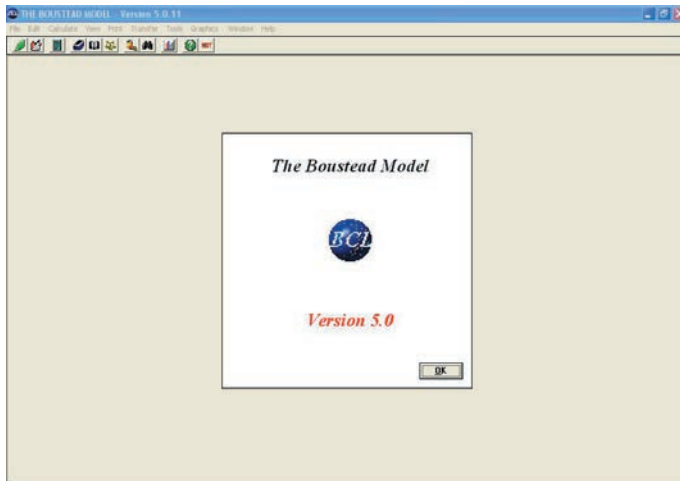
ABSTRACT

The evaluation of environmental performances of products is becoming strategic in the building sector. This situation requires objective and reliable information systems describing the environmental performances in a comparable way. This is the purpose of EPD - Environmental Product Declaration - that, starting from Life Cycle Assessment studies, aims at quantifying environmental data within a set of parameters based on ISO 14040 series. This approach can lead to the development of product labels which certify and assure the results obtained from the LCA analysis. The consequences of this process might be crucial also in the development of public policies regarding environmental processes. The decision to concentrate our efforts in the building sector reflects the increasing importance that the energetic efficiency and the environmental impacts in this context are gaining in these past years also in Italy. This is reflected in the national legislation regarding this sector and in recent examples of preliminary LCA analysis (winter Olympic Games - Turin in 2006).

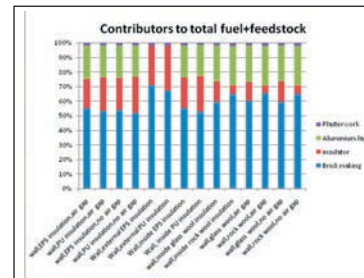
In our project we analysed the environmental performances of different materials and solutions applied to the building products concerning different parts of a building.

The main tool we adopted for our analysis was the Boustead Model, a computer modelling tool for lifecycle inventory calculations developed by the English company Boustead Consulting Ltd. Using the Boustead Model we developed many different scenarios and compared qualitatively and quantitatively the different solutions obtained.

During this project we realised that the LCA approach is not equally accepted everywhere: during the participation in the 7th Ecobalance in Japan we assisted several debates about this methodology. This experience allowed us to expand our perspective about the problem and made us reflect on the importance of a consolidated methodology useful in improving environmental conscience.



1 Screen from the Software “The Boustead Model”



2 % Contribution of each layer in the wall packages to the Gross Energy Requirement

PRODUCTION DATA			
OUTPUT PRODUCT (to which following data are referred to)	QUANTITY	UNIT	
INPUT RAW MATERIAL DATA			
INPUT RAW MATERIAL	QUANTITY	UNIT	
ENERGY CONSUMPTION DATA			
ENERGY SOURCE	USE	QUANTITY	UNITS
Natural gas	Production		
	Services		
Electricity (public supply)	Production		
	Services		
Crude oil	Production		
	Services		
AIR EMISSION DATA			
SUBSTANCE	QUANTITY	UNITS	
WATER CONSUMPTION DATA			
WASTE WATER	QUANTITY	UNITS	
SOLID WASTE DATA			
SOLID WASTE -TYPE	DESTINATION	QUANTITY	UNITS
TRANSPORT DATA			
INPUT			
INPUT MATERIAL	TRANSP. SYSTEM	TRUCK TYPE (TONNES)	DISTANCE (km)
OUTPUT			
PRODUCT	TRANSP. SYSTEM	TRUCK TYPE (TONNES)	DISTANCE (km)

3 Schema of the process to collect data about materials from firms

UNDERSTANDING THE PROBLEM

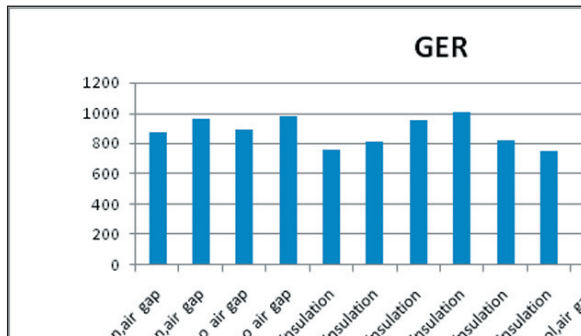
Energy efficiency in buildings is the primary purpose of our project. Nowadays there is a growing demand for new research in the Eco-Building sector. It is associated with the need to attain the targets fixed by the new normative in International, European (EC Directive 02/91), National (DLGS n.192 19/08/2005 and amendments thereof) and local/regional contexts. The first objective is the reduction of energy consumption, also through suitable insulation materials, to bring economical advantages for families and firms and to diminish Global Warming Products emissions, in order to protect the environment and respect the limits fixed by the Kyoto Protocol.

Environmental policies, like the new version of ISO 9001, take up the indirect environmental effects of products, given by the exploitation of energy sources and raw materials, during the complete life cycle until the end of life.

To answer customers' needs as well as laws in act, the analysis is focused on the optimization of the choice of insulation materials. This study of energetic efficiency has to be developed for “the life cycle of a building”. The project of new buildings has to

optimize not only the so called “operating energy”, used in buildings during their operational phases, but also the “embodied energy”, sum of all the energy needed to create the structure. The impact analysis is developed with the LCA methodology in order to obtain simple parameters (EcoIndicators), which give a great deal of useful quantitative information about the damage to the ecosystem.

The approach, followed in the project, agrees with the principles established by “Eco-design”: a link between the results calculated by LCA analysis and the know-how for technical design is useful for the realization of the best eco-compatible and economic-sustainable project. So the analysis, from the laws in act and usual practices to build on typologies and materials of use, was supported by the application of the LCA methodology, an extremely appreciated decisional tool on a global level. The results gave practical and real data, structured in graphs and quantitative indicators, that can be used by the builders to get the best global performance of the building.



4 Histogram of Gross Energy Requirement (GER) for each wall package

EXPLORING THE OPPORTUNITIES

Our project was tackled from two points of view, the first, more technical, was the quantification of the environmental impact of a building, the second, was the effort to understand the implementation possibilities and problems of the LCA methodology within decisional processes on a regulative level.

Regarding the first issue, in order to follow the LCA methodology, we defined the limits of the analyzed system in terms of phases of the life cycle and in terms of considered parts of the building; we studied the possibilities for eco-compatible external envelopes of habitable buildings during their lifetime from cradle to gate; where the eco-compatibility derives from the restrictive value of thermal transmittance, in accordance with law requirements. Subsequently we created several packages of building elements (external walls, windows and roofs) with different kinds of insulating materials and calculated their environmental impact. During this phase a few critical aspects came out: data collection for impact calculation regarding all insulating alternatives was arduous, due to the scarce collaboration of material producers; the choice of the indicators to consider more relevant for the definition of the less impacting solution was tricky, since qualitative, subjective, criteria are needed for using the quantitative results.

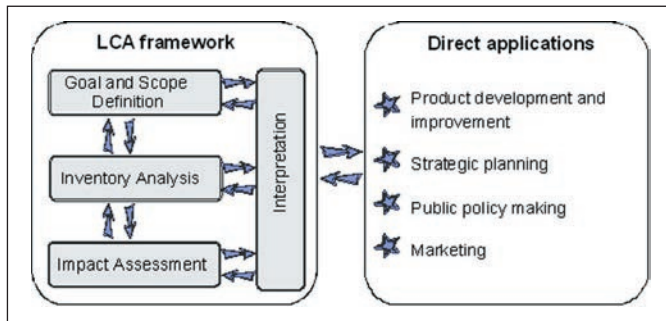
Database	Code	Operation name	Quantity	Unit
Mat_proc_core	1025	Electric use - IT	0.0000	MWh
Mat_proc_core	10597	Electricity use - IT	0.0000	MWh
Mat_proc_core	3607	Water production	0.07960	litre
Mat_proc_core	3708	Building sand quarry/deliver	0.28780	kg
Mat_proc_core	3726	Cement (Mean val 1 day)	0.12250	kg
Mat_proc_core	4000	Aggregate quarrying	0.5710	kg

5 An example of Input Table written in "The Boustead Model"

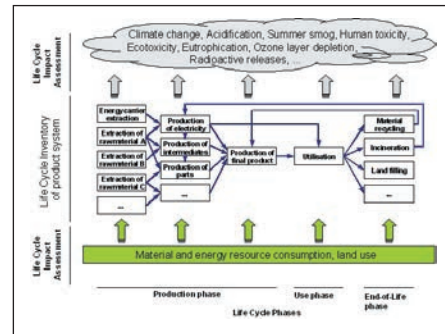
As for the second issue, the application of the LCA methodology at a regulative level as a decision making tool is a complex but fundamental topic because of the necessity to integrate the environment with the social and economic aspects. The European Community is moving in this direction, in particular by developing a programme, called CALCAS, which will act as a decision support model at all public policy levels in the context of Life Cycle Management. The idea is to provide a science-based and environmentally conscious support for the conception, development, implementation and monitoring of EU policies.

GENERATING A SOLUTION

A remarkable aspect of our work consists in the fact that we did not focus on just one solution but we analysed a wide range of possible applicable solutions. We considered the possibility to vary the different substructures that constitute the external envelope of buildings generating many alternatives: we were able to match 14 kinds of external walls and 9 kinds of windows together with 19 roof typologies, providing more than one thousand feasible configurations. An overview of the achieved solutions is available on the following website:



6 Description of Life Cycle Phases



7 LCA framework and its direct applications



8 Mark of
EcoBalance
Conference

http://web.omnidrive.com/APIServer/public/zjDDvviT70uTTgggBZUcGkKX/ASP_Project9.zip

The innovative approach of our way of proceeding lays in trying to identify among all the feasible solutions those able to meet the best energetic and environmental requirements, even taking into account building materials and configurations traditionally not very widespread (e.g. the use of rock or glass wool as insulating material provided many worthy solutions compared with the traditional ones concerning polystyrene or polyurethane).

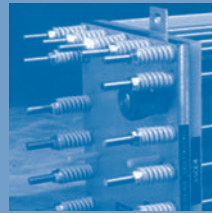
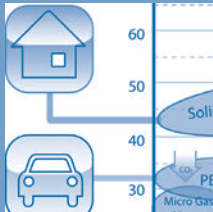
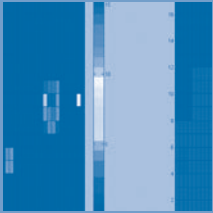
In order to compare the different achieved solutions, the LCA methodology proved to be very effective. By using it we were able to select 2 indicators, GER and GWP, suitable to assess the impacts related to each solution. As stated, LCA methodology provided us with the objective procedure to be followed during the course of the whole work but the practical instrument used to effectively quantify impacts was the Boustead Model software. It allowed us to implement the ideated configurations through the creation of **input tables** representative of the production processes of our interest. By using this software we were able to put into practice the main stages that characterize LCA:

- **Goal and scope definition**, through the definition of the functional unit (m² of surface area) and of the boundaries (from cradle to gate) for the system to be analysed

- **Inventory analysis**, through the creation of the input tables
- **Impact assessment**, through the calculations of the impacts. By using the outputs of the software's calculations we finally were able to deal with the closing stage of **Interpretation**, trying to understand the results achieved but without giving conclusive judgements, in perfect agreement with LCA philosophy.

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PROJECT

10

AEIOU



ITALIAN HIGH SPEED RAILWAYS



AEIOU Environment & Energy Hydrogen: Opportunities and Utilization

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Matteo Lai

Architecture

Christian Poma

Energy and nuclear engineering

Pierfrancesco Spagnol

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project **10**

*Analyzing the “hydrogen
society” opportunities in R&D,
infrastructures and applications*

TEAM C

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Antonio Andreoli

Urban Planning and Policy Design

Alessandro Baldari

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Fabio Chiapello

Mechanical Engineering

PROJECT DESCRIPTION

The project wants to create and understand a global scenario for the so-called “H2 society”: the aim is to analyse the feasibility of spreading a new energy carries, both in terms of R&D on technologies and in terms of investment and infrastructures. The project context involves a complex set of implications, from environmental to energetic ones, also connected with economical and social aspects.

The goal is to create a knowledge path, able of both classifying the existing applications and previewing how to prepare the regional territories, to anticipate and understand trends.

The teams deals with the analysis of the state of the art of H2 diffusion, with the definition of open problems, the elaboration of new perspectives of evolution and of possible technology-transfer processes. The starting point is the study of initiatives and experiences all over the world, followed by the scenario analysis that the EU is now proposing; the consequent step is looking for solutions that could be applied in Piedmont and Lombardy considered Excellence Regions for the H2.

The project is developed following three different approaches: the first deals with quantitative tools for decision making support;

the second is connected with the stationary application;

the third is focused on the automotive sector.

Team A aims at developing tools of analysis to describe local realities and design roadmap prescriptions. In fact, scenario analysis may help stakeholders in verifying how hydrogen demand and costs may vary with the underlying assumptions and in testing the contribution of public intervention.

Multidisciplinary competences were required to model institutional and energy aspects and implement them in mathematical models.

Team B elaborates scenarios for stationary applications, studying the perspectives of evolution and the possible technology transfer. Visits to California and Japan allow the team to generate a solution for Piedmont and Lombardy. This work requires a mul-



tidisciplinary team, composed by: an energy engineer, automation and mathematical engineers, an architect and a designer.

Team C focuses the attention on the automotive sector. The problem is the contrast between offer and demand: the question is “Which one has to come first, the offer of new cars, adopting H2 engines and technologies, or the demand supported by a network able to distribute the H2 itself?” (CHICKEN-VS-EGG problem). What is going to emerge is a sort of guideline for Piedmont and Lombardy.

The most important results are connected with the mid-term strategy that Piedmont and Lombardy should adopt to move towards the new H2 society. The timing of all the adoptable solutions is shifted with respect to other countries (as Japan and California), but the entire process is feasible and profitable. Our regional industries appear to be in line with the most advanced countries, so there seem to be good opportunities to develop the new “H2 society”.



Quantitative tools in decision making process

TASK & SKILLS

Sara Uboldi Referent for institutional analysis: policy screening and modelling. Support on economical aspects.

Giorgio Feletto Referent for know-how of hydrogen technologies and research. Modeller of the Reference Energy System for Piedmont and Lombardy.

Umberto Emanuele Villa Referent for the mathematical modelling and numerical implementation.

ABSTRACT

A roadmap usually outlines a series of steps to get to a large-scale adoption of a new technology. and are usually used as advocacy tools to bring together key stakeholders.

It follows how description of reality through a model could help both in visualizing impacts of possible public and private actors' decisions and in identifying constraints that can ultimately be removed by parties' contributions. Thus, the aim of this subproject is to provide tools which will help the client of the project to develop quantitative scenarios and gather consensus on proposals from other local actors, even from the Regional Governments of Piedmont and Lombardy.

Since the introduction of a technology may have disrupting effects by creating new companies, institutions, markets and so on, other countries' targets cannot be simply transposed to Lombardy and Piedmont. In addition, a market analysis may identify the reasons why the technology may fail in our regional contexts, though it may not deeply analyse how to artificially remove those barriers.

We decided to develop forecasts models since they consider policy and external scenarios in demand analysis profile, in order to simulate how the regional energy system will vary its outputs according to external conditions, like regulations and incentives. In our analysis we preferred to focus mainly on the automotive side because of easier data availability to concentrate our attention on the model design and development.

In particular, we conceived two different and complementary tools for decision making:

- a linear optimization model (LOM), to identify which technologies are more likely to be introduced and their shadow prices for adoption;
- a multi-agent model (MAM), to simulate how hydrogen demand may spread geographically in Piedmont and Lombardy.

The models exchange data: the LOM has a disaggregated view on the problem and provides, as output, average data and costs which inform the multi-agent model. The MAM provides data on demand which support cost and price elaborations.



Tools for Policies

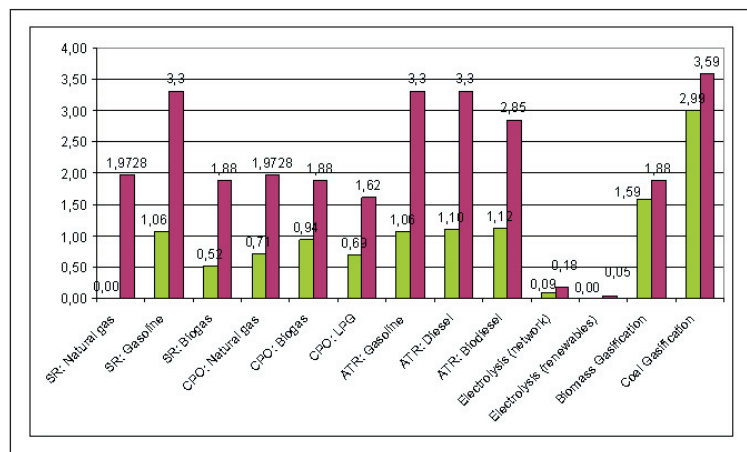
UNDERSTANDING THE PROBLEM

Our first step has been to understand the concept of “roadmap”. A literary review by McDowall and Eames (2006) identifies four main elements to characterize it:

- 1 a description of the available technologies to identify the mismatch between current performance and demand, and technologies opportunities (technological barriers);
- 2 the identification of likely markets and niche markets to assume a pattern of diffusion for hydrogen technologies and highlight main market challenges (market barriers);
- 3 the definition of actions to bridge the gaps between the technological supply and demand (policy solution);
- 4 the identification of main stakeholders’ requirements and their possible contribution (“what’s in there for me?” logic).

The fourth point highlights that a roadmap must be built by progressively propose and discuss different alternatives among key stakeholders. According to the subproject task (working on the “demand side”), the team has decided to focus on the analysis and development of modelling tools to simulate scenarios and provide numerical basis for discussion on the measures required to overcome the identified barriers. The ultimate goal is to help the client of the project (the Camera di Commercio, STEP) to develop quantitative data to gather consensus on proposals from other local actors.

To our opinion, the description of a model can help both in visualizing the impacts of possible public and private actors’ decisions and to clearly define the set of assumptions underlying the model so that constraints can be identified and ultimately removed by parties’ contributions.

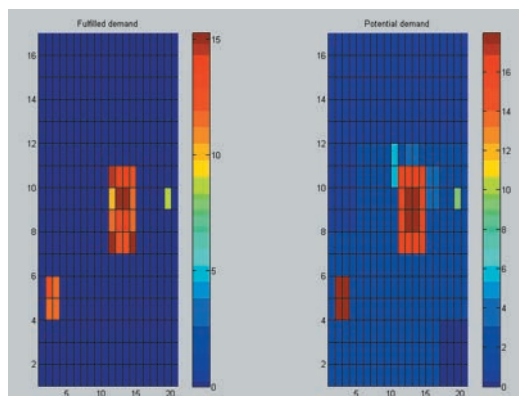


1 LOM predictions: Dual values on CO₂ emissions of different technologies and fuels in 2010

EXPLORING THE OPPORTUNITIES

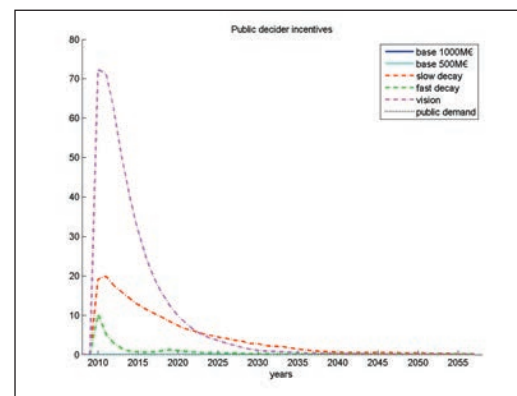
As a roadmap follows a “normative” approach in facing the problem of hydrogen technologies introduction, first a “descriptive” analysis should be carried out to inform such prescriptions. Three main approaches have emerged:

- 1 an *international experience comparisons* to identify possible line of actions, but as the introduction of innovative technologies depends on the very specific context, transposing targets from other regions to Piedmont and Lombardy should require some testing;
- 2 a *market analysis* to understand the inclination to adopt hydrogen technologies according to population demography and habits (average trip distance, environmental consciousness, safety perceptions, ..). Though it can certainly identify the main gaps between supply and demand, it cannot deeply analyse how to artificially remove those barriers;
- 3 a *scenario analysis* with simulation and/or optimization models to support likely futures prediction from current trends through formal quantitative extrapolation modelling. Since this method can combine the results of the approaches above we decided to develop it.



2 Projection up to 2060 in base-line scenario: local hydrogen installed capacity (left) and potential hydrogen demand (right) - Colour bar units: PJ

3 Public decision maker incentives (M€) in order to increase consumer's willingness to pay for the considered scenarios



The idea to develop a scenario analysis came with the “TIMES Model” by the International Energy Agency. The TIMES is dynamical model which combines:

- traditional engineering models of energetic system optimization (bottom-up approach), that describe in detail the technological aspects;
- neoclassical dynamical models of general economic equilibrium where a “representative” consumer and an “aggregated” producer interact by exchanging an “aggregated” good.

The main advantages of the TIMES model are:

- it can represent every energetic system, with a variable number of technologies and energy services’ demands;
- it determines the combination of energy technologies that satisfies minimum cost demand;
- it allows an integrated analysis of energy, economy, and environment issues.

Currently, this model has been applied by the Politecnico di Torino to the Piedmont energy system to model the effects of some policy interventions on emission levels. We introduced in the model hydrogen technologies, which missed in the previous analysis, but calibration could not be realised because of model’s requirements unsupported in the current version of the software. That’s why we decided to develop a simpler “do-it-yourself” model to replicate some logics behind the Times.

Concerning the methodology, we moved in three different and

complementary directions:

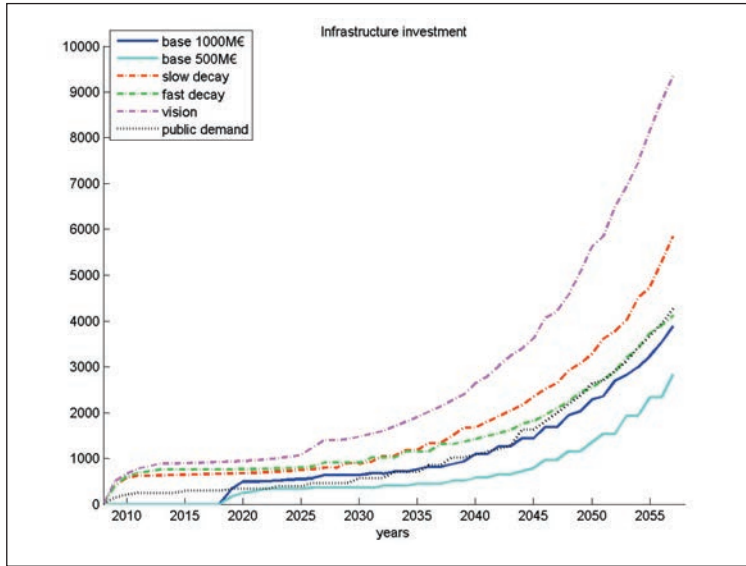
- some bibliographical research in order to get confident with the issue, understand opportunities and threats, manage implications and key factors;
- direct experience of hydrogen technologies (Tokyo Expo, Los Angeles Clean Air Agency) in order to become more familiar with the state-of-the-art and future developments;
- modelling of some mathematical tools in order to perform quantitative analysis.

Finally, although our first aim has been to look at the whole hydrogen technologies market, we preferred to focus mainly on the automotive side because of easier data availability in order to concentrate our attention on the model design and development.

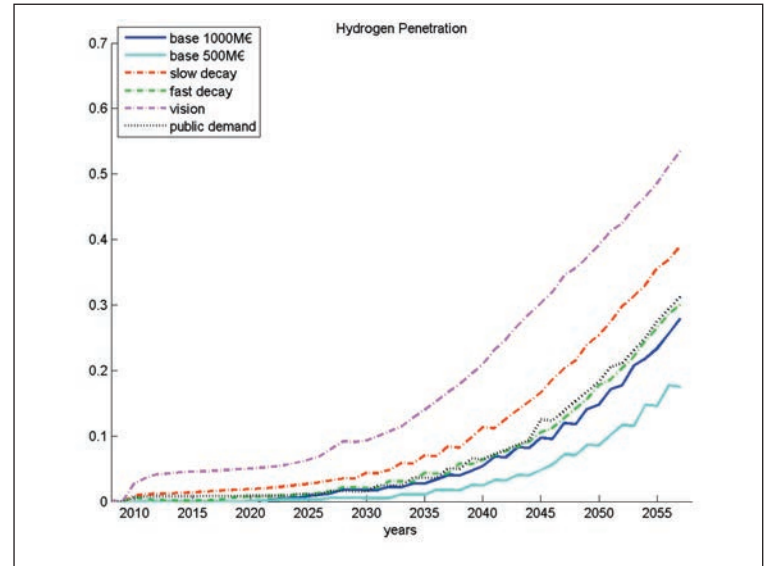
GENERATING A SOLUTION

Given the difficulties and the limits in adopting the Times, we decided to develop a simpler “do-it-yourself” model to replicate some logics behind it. Two main parts have been developed:

- a linear optimization model (LOM), focused on the technological barrier. Given a certain level of demand, it selects which hydrogen technologies will be implemented according to costs and emission restriction goals. It helps in identifying the technologies more likely to be introduced and their shadow prices for adoption;



4 Producer's investments in hydrogen infrastructure (M€) for the considered scenarios



5 Hydrogen market share penetration projection for the considered scenarios. Ratio between PJ of consumed hydrogen and total energy needs

- a multi-agent model (MAM), which simulates how hydrogen demand may spread geographically in Piedmont and Lombardy, coping with market uncertainty and unexpected agents behaviour by Montecarlo techniques.

The two models are coupled by data exchanging: LOM performs a disaggregated and static analysis, taking as input an exogenous demand calculated by MAM and provides, as output, average fixed and variable costs of hydrogen technologies to MAM.

Given these main traits, the models above support scenario simulations.

The MAM shows how demand-supply will spread geographically in the next 50 years by investigating hydrogen technologies penetration and producers' investments level and resulting returns.

These figures have been computed for different scenarios presenting, as an example, different assumptions as regards policies:

- in terms of price reductions resulting from incentives to the users (in this case three scenarios have been performed to test the right timing for the incentives);

- in terms of minimum demand level deriving from regulation on technological park (e.g.: "green certificates for car") or from direct public expense.

The results show how the introduction of hydrogen could be profitable. Nonetheless, in analysing these results we must be aware that models cannot totally represent reality, especially the "psychological" aspects behind the hydrogen "chicken-egg dilemma" or other complementary actions like the establishment of commons standards. They can offer support to make the main stakeholders take those right decisions.

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www.transportation.anl.gov (Argonne National Laboratory Fuel Cells Canada, "Canadian Fuel Cell Commercialisation Roadmap", Industry Canada (March 2003).



Stationary applications

TASK & SKILLS

Elena Negro Evaluated the scenario proposed by EU based on the technological environment analysis and focused on normative aspects of the emerging technology.

Ortzi Akizu Gardoki urements and possible applications of FC in the stationary field and engaged in graphic aspects.

Matteo Lai Focused its attention on world initiatives and experiences in stationary market of H2. He also participated in producing the overall design layout.

Christian Poma Worked on the state of the art of H2 production and storage. He performed an analysis of residential applications of H2-related technologies.

Pierfrancesco Spagnol He explored past and current existing applications and elaborated possible scenarios for introducing H2 technologies in commercial applications.

ABSTRACT

This sub-project deals with developing three guidelines whose application would foster the introduction of H2-based technologies in the stationary field, to produce electricity and thermal energy.

A consistent part of the project is spent in understanding the inner features of the H2 world: from a technical involvement in the modes of H2 storage and production, to the potential of FCs; from the market outlook to safety concerns; these issues form a necessary basis on which any planning analysis should be drawn upon.

Studying past and current initiatives carried on at several regional levels is helped by a direct involvement through learning trips, especially in the most advanced realities in Japan and California. These tasks are necessary to complete a state of the art analysis, where the reasons behind successes and failure are highlighted.

Behind the proposed solution lies a plethora of conflicting issues, such as the a-technological core of the problem, a lack of consistent regulation in the Italian case, a poor education and insufficient awareness among the final users. Therefore proposing generated distribution as a winning solution, where H2 is a complementary vector rather than a substitute, enforces the willing to pursue multi-disciplinarity instead of tunnelling into technology.



Stationary

UNDERSTANDING THE PROBLEM

The main starting issue is understanding and evaluating the contour lines surrounding the possible creation of a H₂ market for energy generation in the stationary field, where the target would be Piedmont and Lombardy (P&L).

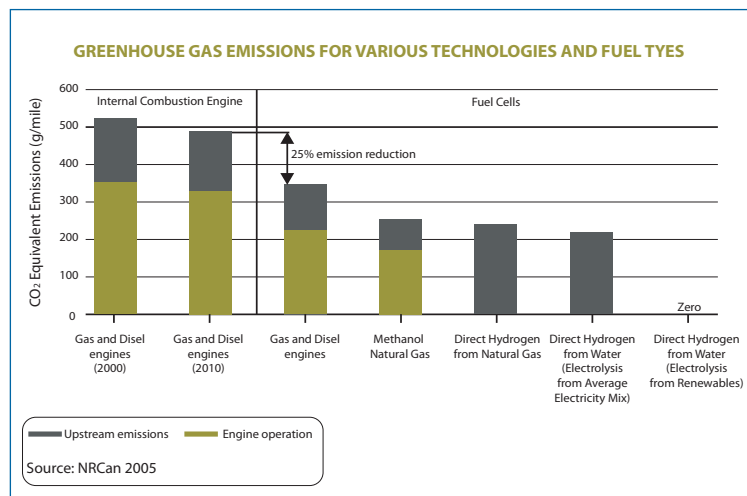
It is critical to understand all the forces behind H₂ world, either in terms of technological issues and, especially, economic and political ones, to structure a compromise with the needs of P&L that could open the market. A first analysis was divided into technological outlook and a territorial analysis of P&L.

Therefore a study is carried on:

- H₂ features in terms of energy and safety
- H₂ production and storage modes taking care of conversion gains for current and most promising technologies
- main features and applications of FC

It is possible then to outline potential application chains going from primary energy sources to end sectors of use.

The second phase of our work is dedicated to studying the territory exploring several segments: on one hand the different regions are classified under an energetic perspective, on the other hand collaboration with Piedmont's Chamber of Commerce is directed to studying the industrial environment that could foster an Italian H₂ market. Moreover the team considers possible interactions to create synergies between the two Regions that could accelerate market entry for H₂.



1 Different kinds of technologies for stationary and effects on green house emissions

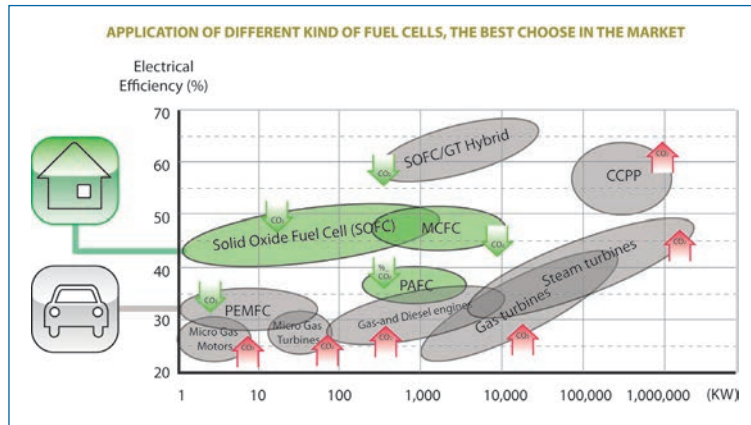
EXPLORING THE OPPORTUNITIES

The team focuses on deepening the understanding among past and current H₂ applications, through a direct involvement and a bibliographic research. The team's strategy analysis started from a broader perspective, involving global international initiatives, ending in smaller-scale approaches and finally our regional approaches. The aim is to understand the reasons behind the different initiatives' successes and failures.

The team focus is directed at the two global champions for the H₂ field, Japan and California, whose understanding has been funnelled through intensive study trips. The most significant learning moments have been the visit to Japan's Expo FC, the world's biggest in its field, and a comprehensive analysis of California's initiatives.

The awareness of experiences deeply different from Italy or even other Italian regions' realities is a fundamental starting point to build up a proposal for P&L.

An important consideration is draw upon the normative side, where California is pursuing standards for evaluating the eco-



2 Focus on H2 stationary applications

friendliness in new and existing buildings (LEED certification). The second field of analysis is dedicated to the scenario proposed by the EU. The team reviews EU “road-maps” and “vision-maps”, the documents on which all Member States have to refer their national initiatives.

The following step is the state of the art of the H2 field in Italy. A clear regulative system is thought to be a primary prerequisite to push diffusion for H2. The results show a lack of consistency of Italian regulations while there are some efforts to overdue these delays.

The team then looks at some of the major national initiatives, considering their distinguishing features, the set of actors involved, their initial targets, their development and their current enforcement.

This step shows that:

- there is no main technological issue within H2 stationary field: there are already feasible solutions for a broad spectrum of needs
- H2 is going to be a complementary vector of energy supply: H2 units exist alongside electrical grids and conventional thermal units
- from a technological perspective, H2 is spreading mostly within hybrid systems



3 Environmentally friendly buildings. Santa Monica (California)

- from an economic perspective, there are always strong public-private initiatives, interactions and incentives
- from a juridical perspective, regulation is remarkably defective.

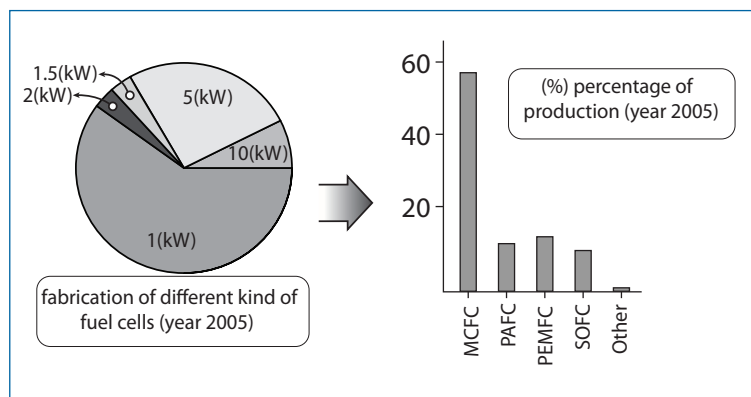
Meeting the targets for this phase has required a strong and costly research effort, mainly because of the lack of reliable data on which underpin the conclusions.

The team has often come against a poor educational level of the final users in energy issues: a diffuse reluctance to improve their informational level has produced several concerns with respect to the final solution.

GENERATING A SOLUTION

The team tries to identify the mainstays of a possible development model in the H2 sector, that would be compatible with P&L’s technical and economic context.

First of all, the team notes the poor attention to energy aspects by some of the actors in charge of facilities with a high consumption of electrical energy and heat. This attitude underlines the necessity for a knowledge spread regarding H2 opportunities and experiences. Education and communication are two key elements in the push for changes. In addition to economic incentives,



4 Production of H₂ in the stationary field (2005)

necessary at least in the early technology diffusion process, the driver of change could be a mechanism of simple imitation, a sort of “fashion effect”. PA in P&L have signed a mutual agreement about the development of a H₂ economy: however, looking at the way they fulfill public buildings’ energy requirements, we discover that electricity comes from the grid and heat is produced in conventional devices. They would probably give a strong signal to citizens starting the use of H₂ devices in public buildings, demonstrating their effectiveness for example with public events. Residential and commercial applications are studied because distributed generation of power seems to be the right line of development for stationary applications. Small or medium FCs are at a pre-commercial or commercial stage of development and their diffusion can be easier than multi-MW devices. Medium sized hybrid FCs can be used in buildings, such as offices, hotels and shops to cover electrical and thermal base loads, while peaks are covered by the grid or conventional sources. Small hybrid CHP-FCs are suitable for residential applications: they provide fair energy and environmental benefits, in the interest of the community, as well as economic savings for the owner. According to this paradigm of distributed generation, with no additional requirements for new infrastructures, the adoption of FCs directly fuel-



5 An actual solution for a 7kW cell for the H₂ stationary market

led by H₂ as back-up systems is interesting for structures whose criticality is to face long black-outs.

Although the technological aspects seem covered, it would be necessary to deepen the normative aspects and draw up a plan of actions that would strengthen the diffusion of H₂ technologies.

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The automotive hydrogen scenario

TASK & SKILLS

Clara Passarino Referent for refuelling: description of hydrogen fuelling stations' typologies, safety and normative issues.

Antonio Andreoli Referent for policies: description of the roadmaps and strategies in foreign countries.

Alessandro Baldari Referent for exergetic analysis: description of the best solution in terms of efficiency and heat recovery.

Fabio Chiapello Referent for vehicles structure: description of solutions for engines fuelled with hydrogen and and vehicle's structure.

ABSTRACT

The subproject aims to define a strategic scenario for the creation of an hydrogen economy in the Italian regions of Piedmont and Lombardy concerning the automotive sector.

The two central elements involved are the diffusion of vehicles fuelled by the new energy vector and the diffusion of fuelling stations able to distribute the carrier

These contrasting topics brings the critical issue of the so-called “chicken-versus-egg” problem, consisting in the choice between activating the offer of vehicles before enabling the demand (and so the fuel offer), or vice versa. Therefore, the preliminary approach is based on the detailed description of offer and demand elements, and their interaction.

As far as the offer is concerned, R&D projects of vehicles producers are mainly divided into:

- ICE (Internal Combustion Engine) vehicles = they have real engines, based on Carnot cycle, but fuelled with hydrogen instead of liquid fossil fuels;
- FC (Fuel Cells) vehicles = they have electrochemical devices able to put together hydrogen and oxygen at the electrodes (without a direct contact of the reactants), generating water and electrical current.

Concerning demand, problem analysis means to understand how to increase the confidence of people in buying and using the new vehicles, in particular trough the creation of the network of stations and trucks distributing hydrogen.

The focus of the project, after the descriptive part, is to analyse the solution to this (apparently) vicious-cycle: a sort of collaboration between public and private, offer and demand, in order to give incentives to the creation of that market which will bring the necessities and required profits, in terms of economic development and sustainability.

Therefore, any step of the solution adopted by the team will be described in detail:

- 1 at first, the plan proposed by the public sector (which means, central government and regions), in order to define: timing,



Automotive

volumes, taxes (for fossil fuels) or incentives, and hypothetical proposal of fleet-vehicles (buses or taxis) and of car-sharing

- 2 then, the starting of production from the offer sector: production and distribution of vehicles and fuel
- 3 finally, the description of the possible middle-term strategy: after an intrinsic lag-time, the mass diffusion of the new network and the built-up of the mass-market.

UNDERSTANDING THE PROBLEM

The central problem of the diffusion of hydrogen in the automotive field is the so-called “chicken-versus-egg” problem: which has to come first, the offer of new vehicles (equipped with extremely innovative technological devices) or the demand on the market-side (connected with the necessary build-up of a network able to distribute the hydrogen itself).

Therefore, the analysis of the group is focused on two different elements:

- 1 the offer-side ? it is connected with what is now offered by all the automotive producers and by their R&D programs: as was shown in the abstract, the vehicles producers are now involved in research & development projects, in order to define the best strategy to get hydrogen on the vehicles. And the best one seems now to be the hybrid solution, which is connecting both the internal combustion and the fuel cells (electric) engines. There are, anyway, a lot of complementary assets, connected with the problem of understanding the new vehicles’ structures and their usability (always keeping an eye to the end-



1 *Prototype of H2 fueling station, Santa Monica (LA)*

users), but also to the problem of stakeholders connected to the automotive sector (and, of course, to their interests).

- 2 the demand-side ? it is connected to the problem of creating a network for the distribution of the new energy carrier: this means analysing different solutions in terms of refuelling systems. It is also connected with the problem of “educating” people to the new economy, working on different elements, such as: safety devices, normative on hydrogen and marketing or training programs (for schools or people in general).

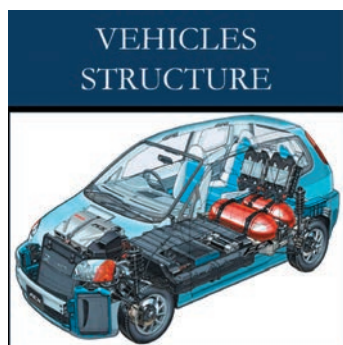
EXPLORING THE OPPORTUNITIES

The problem of defining a hydrogen roadmap can be split into different sub-projects, in order to evaluate the state of the art of the existing solutions: these are connected to the different behaviours of public and private sectors.

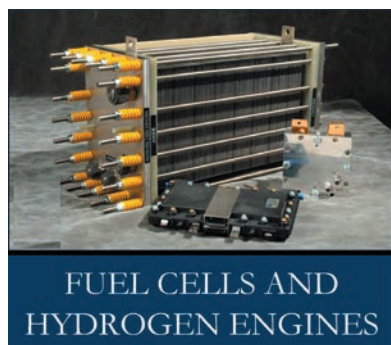
As far as the public sector is concerned, it is involved into two different areas:

- the creation of the network able to distribute hydrogen all over the countries (to the end-users);
- the creation of policies, in order to give timings, costs, incentives and education to the users themselves.

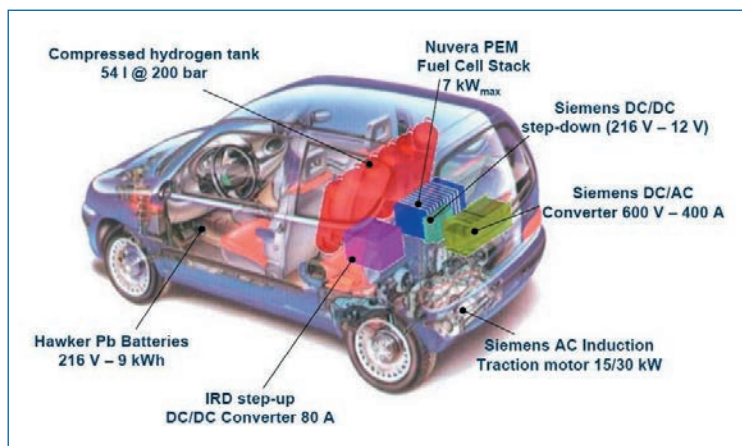
Among these subjects, the activities of the group members were connected with the understanding of what are other countries’



2 New vehicle structure with relevant positioning of H2 cylinders



3 Stack of PEM fuel cell: proton exchange membrane



4 FIAT solution for different power generation elements in the H2 fuelled vehicle

government and public companies doing, in order to promote hydrogen diffusion.

Two activities of the group were undertaken towards this direction:

- a Visiting the Fuel Cell Expo, Japan 2007 ? the group members were able to get in contact with the Japanese reality of hydrogen diffusion, including plans to describe the steps of the transition from electricity to hydrogen.
- b Visiting Los Angeles, August 2007 ? the group members were able to face the Californian reality of hydrogen diffusion via refuelling system, a plan for building a real network of stations, experimenting different production solutions

As far as the private sector is concerned, the problem is shifted towards the offer that private companies can give, of vehicles completely fuelled with hydrogen or hybrid ones. Since the main problem is to understand the new aspect of the vehicles themselves, the group has been trying to face with the following aspects:

- 1 offer of new technologies in the field of fuel cells and internal combustion engines (converted from fossil fuels to hydrogen); the event of the Hydrogen Winter School, Bardonecchia 2007, was completely designated to this topic, since it consisted in a presentation of all the latest development of R&D projects on hydrogen.

- 2 new asset of the hydrogen vehicles, which we were able to analyse taking information from the different producers web sites.
- 3 problem of changing of stakeholders, that is to say all the other industries that do not produce vehicles, but that are connected to this production.

All these elements were the starting point of the group, since they contributed to define the state of the art of the offer, both in the public and in the private sector, on hydrogen technologies.

GENERATING A SOLUTION

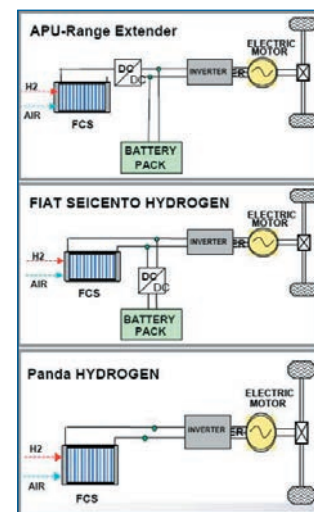
The group found a solution to the chicken-and-egg problem: which has to come first, the hydrogen offer (mainly promoted from the private sector, in the figure of the different firms producing vehicles) or the hydrogen demand (that is to say, the mass market, promoted by a development of a hydrogen distribution network, mainly sponsored by the public sector).

The solution the group considered as the best on the global society is the one adopted in the state of California: creating a partnership, between public and private companies, in order to proceed step by step and side by side in the generation both of

Commercialization targets in Lombardy and Piedmont by comparison factors

	by GDP/Head	by Population	Gross average
Vehicles			
as Tokyo	37	67	54 (104 million €)
as California	75	38	
Stations			
as Tokyo	6	11	12 (12 million €)
as California	19	10	

	California	Japan	British Columbia
Strategic goal	Environment	Competitiveness, supply security	Competitiveness, regional development
Operative goal	Infrastructure	Technology validation	Territorial marketing
Governance	Rules and incentives	Hierarch program	Strategic framework
Demonstration projects	Independent, bottom-up	Single official project, centralized	Single official project, bottom-up
Funding	multi-sources, mainly private	one major public source	multi-sources, mainly public
Timing and targets	Yes	Yes	No
Highway	Yes	No	Yes
Location	Free, regulated	Planned	Planned



5 Different configuration for electrical system in FIAT vehicles

vehicles and network.

What we described, in detail, is the following path, composed of two main steps: these steps are linked, respectively, with the middle-term and the long-term solution.

1 the middle-term solution consists in the transition phase towards the complete diffusion of hydrogen, both on the offer and on the demand side.

What we assumed for the demand is the following: the governments of the two regions (Piedmont and Lombardy) will have to promote and finance the creation of fuelling stations able to deliver hydrogen; in the middle-term, these stations can be linked to floats (such as hydrogen-fuelled buses, taxis or vehicles for car-sharing). Then, they can be build near the existing gas-station, which can be used to generate hydrogen, via reforming: this way, the problem of bringing hydrogen to the stations can be eliminated; these station can be then converted, in a much longer future, into hydrogen-producing stations, via renewable sources (wind or sun).

As far as the offer is concerned, hydrogen vehicles should be produced at first as hybrids, in order to let people understand and get used to the new fuel. Therefore, the obvious market for the first vehicles is the floats one: hydrogen buses, taxis or vehicles for car-sharing; the reasons for this are two: these float are easier to be financed and also to be refuelled (centralized plant).

Therefore, the first impulse should be given from the public sector, mainly in two ways:

a coordinating (with incentives) the offer from the vehicles producers).

b creating the first fuelling stations: the float-ones (in numbers comprised between 1 and 5, in each big town) and the ones with on-site generation (next to the existing natural gas ones, which are now set on the main highways).

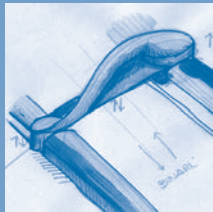
2 the longer-term forecast is the vision of a society completely fuelled with hydrogen. This solution will be reached through two main steps:

- the creation of a real network of hydrogen fuelling stations: each station of gasoline (or diesel) should be converted into hydrogen, and these stations will all have to be connected with a piping line, in order to bring hydrogen from a centralized production plant (much more cheaper);
- from the floats, both producers and users will have to pass to the hydrogen vehicles: there have to be incentives and the change of all the automotive park will require tenth of years.

MAIN BIBLIOGRAPHIC REFERENCES

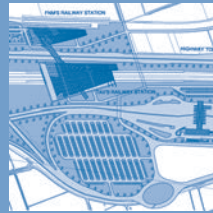
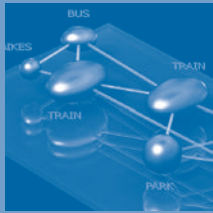
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PROJECT

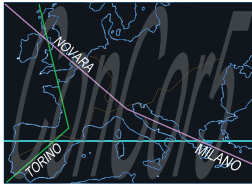
11



Concor5



MALPENSA AIRPORT RAILWAY ACCESS



Concor5 Malpensa Airport railway access

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project 11

*Malpensa Airport railway access:
intermodal connection with the
Milan-Turin high-speed railways
in the framework of the 5th Logistic
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PROJECT DESCRIPTION

THE CHALLENGE

The area around Novara will be located on the 5th European Corridor, connecting Lisbon to Kiev through Turin, Milan, Verona and Trieste. The area, situated within the Turin-Milan segment of the corridor, will represent an important node of the European transport network. It could represent a junction point connecting several important transport lines: Milan-Turin high speed railway, Milan-Turin motorway, and Ferrovie Nord Milano (FNM) regional railway system. In the future, the same area should be crossed by the planned 24th European Corridor (Genova-Rotterdam).

Furthermore the Novara junction point allows for a fast connection with important infrastructures like the international Malpensa airport (through FNM tracks connecting Turin to Malpensa and passing through Novara, actually not present but a future project) and the Rho-Pero Exhibition Centre (through the Milan-Turin high speed railway).

Consequently, considering the potential flow of passengers, the Novara area represents a great opportunity for location of public and private activities. Furthermore, the area may play an important role if the 2015 EXPO will be in Milan.

The objective of the project was the development of an intermodal infrastructure allowing for a fast interchange between the different transport lines crossing the Novara area (high speed railways, MI-TO motorway, A26 motorway, Ferrovie Nord Milano,..) and representing the terminal of fast connection lines to the Rho-Pero Exhibition Centre and Malpensa airport.

THE TEAMS

Two scenarios have been considered: a “minimal” one and a “maximal” one.

Team A dealt with the “minimal” scenario, based on the flow of passengers stemming from the existing potential utilization basin, considering both Lombardia and Piemonte regions and taking into account the impact of Malpensa airport and the Rho-Pero Exhibition Center. The “minimal” intermodal infrastruc-



ture encompasses both transport and supporting services like: hotels, business incubators, shopping centres, congress centres, offices and a parking area.

Team B focused on the “maximal” scenario, based on the exploitation of the attracting power of the area allowing for the location of new private and public activities, beyond the features of the “minimal” configuration. The “maximal” scenario encompasses the development of real estate projects concerning different activity sectors: university, scientific and industrial research, hospital and medical research and business headquarters, just to mention the most promising ones.

THE RESULTS

In both cases, “minimal and “maximal”, a feasibility study was developed, involving different disciplines: architectural design, business strategy, transportation planning, financial aspects and socio-environmental aspects.

It should be noted that the comprehensive approach of the project is modular, since the “minimal” configuration can be firstly realized as a stand alone solution while maintaining the option of a further development toward the “maximal” configuration open, if new private or public activities located in the area can attract greater transport flows.



TAV, FNM, A4, three lines crossing in a single node: Opportunities for Novara

CONCORSO MALPENSA AIRPORT RAILWAY ACCESS

TASK & SKILLS

Sara Bellan engaged her specific knowledge about Novara's territory and her university training to elaborate a well contextualized and formally captivating architectural project.

Francesca Condini initially worked on the context introduction and flow analysis, followed by the attractors' analysis and the financial planning.

Luca Crippa first analyzed the opportunities and the potential and actual flows, then studied the possible attractors, their dimensioning, and the economic and financial analysis.

Anna Giovannini maintained the contacts among students, tutors and the ASP board and actively participated in the elaboration of the architectural project.

Carlo Corti contributed to the first part of the contextualization of the project and analyzed some energetic aspects of the new proposed buildings.

Stefania Vele used the integrated fixed intervals timetable method for the definition of timetables for trains leaving from the node.

ABSTRACT

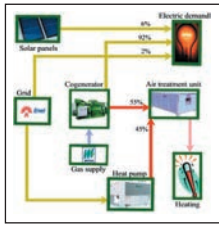
The methodology we used while working on the project was made up of different steps: first we performed an analysis of Novara's context, and identified opportunities linked to its view as a cross between different ways of transportation; then we made an estimate about flows of passengers using the node and, since they were insufficient to justify the node from a financial point of view, we decided to place some attractors. With "attractors" we mean some interventions of landscape re-qualification all belonging to a scenario of minimal impact, that are just incremental, not radical. Interventions, that are not expected to bring radical changes, but just to capitalize on Novara's existing strengths, to better use them in developing new strategies of development. Finally, we performed a financial feasibility analysis about the node and all attractors.

The solution proposed is detailed from the architectural point of view with a masterplan and the project of two stations. The intermodal junction station was developed as a line that crosses the motorway, the new FNM line and the TAV high-speed line. The northern station of the Ferrovie Nord line (connecting to Malpensa) and the southern one of the high-speed line (connecting to Milan and Turin) are also connected to Novara, through FNM trains going directly to the centre of the town.

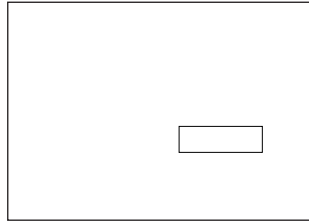
Then we detailed the attractors. In particular, we decided to place a hotel, a business incubator, a congress centre, a commercial centre, some offices and a parking area near the node. Both a qualitative and a quantitative feasibility analysis were performed.

The solutions proposed present some main advantages:

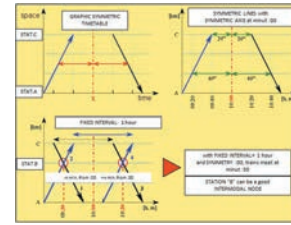
- it is harmonized with Novara's landscape, since it enhances the main strengths of Novara, its accessibility, and at the same time tries to fill its gaps in infrastructure supply, such as hotels, shopping centres and business incubators;
- the solution proposed is highly modular and expandable by adding modules. An interpretation of the solution proposed by team B is the modular development of our solution, since it starts from the latter and adds more infrastructures and more radical interventions on the territory.



1 Diagram of electrical and thermal power distribution among the components of the plant of TAV station during winter



2 Methodology followed in the project development



3 Graphic representation of the integrated fixed intervals methodology to determine the timetable

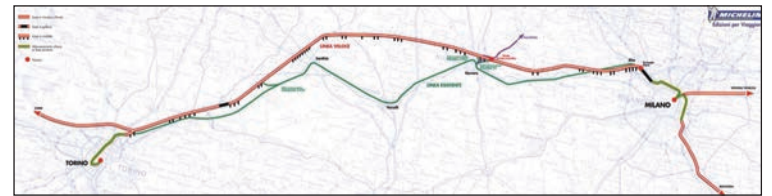


4 Milan Central Station, 4 novembre 2007: Ferrovie dello Stato train



5 Novara is at the cross between the corridor 5, connecting Lisbon to Kiev, and the corridor 24, connecting Genova to Rotterdam

6 Representation of the existing railway line and the TAV railway line (under construction), both connecting Turin to Milan



UNDERSTANDING THE PROBLEM

The first phase was about understanding the problem. We started by identifying the target customer of the node and its needs. We made reference to an ISTAT database, that provided us with an order of magnitude about flows of passengers that would have used the intermodal node to reach their destination. We found that these flows were definitively very low and not sufficient to justify the construction of an interchange infrastructure.

At the same time, we also had to take into consideration a political issue: Novara's population has cohabited with the TAV construction site for years, and, consequently, wants the node to be built, as a reward for its patience. To reconcile the economical inconvenience of the project with the political necessity to build the node, we decided to broaden the scope of the analysis, building not just the intermodal infrastructure, but other buildings near the node (the attractors) that, acting as the flows' catalysts and generating more flows through the node, would justify its economic convenience.

EXPLORING OPPORTUNITIES

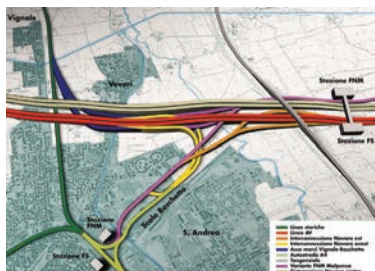
In order to decide which specific solution to adopt, we studied similar cases all over the world and developed some inquiries

about the theme of the high-speed railway stations in Italy and Europe. Particularly, we made some trips to places that showed characteristics related to the project's theme:

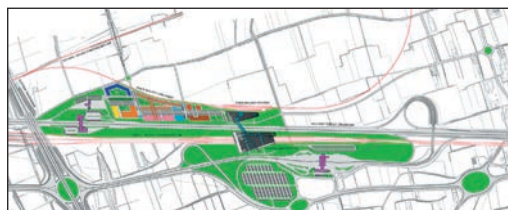
- We participated in a meeting at the Centro Visitatori Alta Velocità in Fontanellato (Parma), where specialized technicians illustrated to us the operation and the layout of the fast railway lines in Italy;
- We went to the new Berlin Central Station (Lehrter Hauptbahnhof), an intermodal node connecting high-speed trains, national trains and urban subways;
- We visited the KM129, an organization located in Reggio Emilia whose purpose is to introduce the projects planned by the architect Santiago Calatrava for the high-speed line Milano-Bologna; the strong similarities between Novara and Reggio Emilia contexts helped us to elaborate the masterplan;
- In France, we visited the modern railway station in Lille and the intermodal node in Villeneuve d'Ascq, examples of connections between national trains, urban subways, bus lines and the highway.

We also individually developed further investigations:

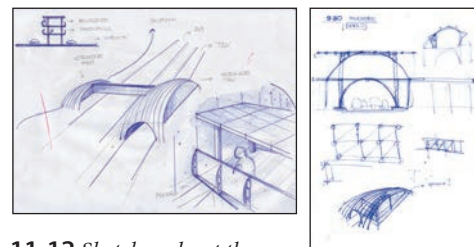
- A trip to Lisbon provided us with the opportunity to visit the



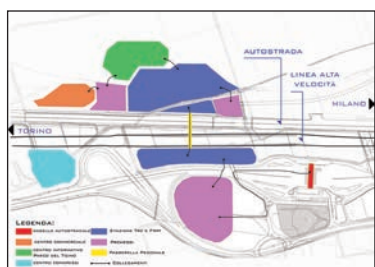
7 Novara as the point of interconnection between TAV railway line, FNM railway line and the motorway



9 Masterplan, with a low level of detail, of the proposed solution. Authors

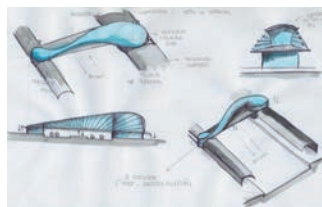


11-12 Sketches about the design of the station.



8 Masterplan of the proposed solution

10 Idea, sketch about the design of the node



13 The two solutions proposed by teams A and B are modular, since the latter is the modular development of the first.



Estação do Oriente planned by Santiago Calatrava, an admirable example of an intermodal node and a multifunctional pole;

- During a trip to Amsterdam, we analyzed the interchange node of Shiplol, that provides a direct connection among airlines, railroads and subways;
- In Rotterdam, we visited the new high-speed central station yard and the Erasmusbrug bridge, a steel structure on which the ordinary road and the tram network flow.

GENERATING A SOLUTION

After this “explorative” phase, we generated our solution. In particular, the architectural project picks up the input received by the economic and territorial analyses and formally translates the suggestions collected during the trips. Starting from the requirement of valorising the inherent potentialities of Novara’s territory, the project of the intermodal node aims at harmonically inserting itself in the territory and finding out the formal matrix into the agrarian parcels and into the existing road network.

The node permits a fast exchange among highway, local road net, the new line of the Ferrovie Nord and the high-speed line.

Designed to be modular and expandable, the two stations (a northern one of the Ferrovie Nord line and a southern one of the high-speed line) have a light steel and glass structure and consist of two levels: the ground floor houses the railway track and the parking areas, the upper floor houses the box-offices and the services for the passengers in transit. Finally, a third level provides a pedestrian connection among the two buildings, disguised as a foot-bridge that stretches over the highway.

Once the architectural characteristics of the buildings were decided, specific considerations on energetic needs were done with an analysis of the thermal loads for conditioning and heating, an assessment of the electric demand and a proposal for the plant needed, also exploring the opportunity of a cogeneration system. After a detailed investigation about services offered by Novara (aimed at finding its gaps), we also selected some services to be placed near the station (the attractors). The masterplan, consequently, foresees some areas destined to these services. In particular, we analyzed five different attractors: a hotel, a congress centre, a business incubator, head-quarter offices and a commercial centre (including a fitness centre and a cinema). To study each attractor, first we made an AS-IS analysis, describing the

ATTRACTOR	DIMENSIONS	INVESTMENT	COST OPERATING	COSTS REVENUES (flows)	ECONOMIC INDICATOR
HOTEL (THREE STARS)	60 rooms	2.910.038 €	1.508.250 €	1.978.552 € (15270 arrivals every year)	IRR = 14,75%
BUSINESS INCUBATOR	3.000 sqm of covering surface	3.705.742 €	500.000 €	390.000 € (166 people working at the incubator)	Financial loss financed by the public
OFFICES	2.500 sqm of covering surface	2.460.000 €	87.500 €	237.500 €	NPV = € 311.920,56
CONGRESS CENTRE	Capacity of 500 people	3.796.890 €	14,5% of revenues	Not available	Break even point: yearly revenues = € 291.466
COMMERCIAL CENTRE (fitness centre, cinema, other complementary shops)	15.000 sqm of covering surface	26.000.000 €	875.000 €	Not available	Pb-T: 6-9 years (yearly revenues of € 4.341.666)

present offer for that specific service in Novara. Then we made some considerations about opportunities brought by the realization of the intermodal connection as a source of wider flows to the attractors. Finally we performed a feasibility analysis, with the aim of identifying the financial and economical convenience of the investment. The table summarizes the results.

The hotel wants in part to canalize the present demand in Novara's hotels, and aims at attracting part of the demand from Malpensa passengers and from FieraMilano visitors. The business incubator is dimensioned to give hospitality to 25 tenants, and represents a source of social and economic improvement for the area. If incubated start-up firms become successful, they could locate their offices in the 2.500 sqm office centre located beneath the node. The congress centre, similarly to the hotel, will partly cannibalize Novara "as-is" demand, and partly find new sources in demand for international congresses and those coming from FieraMilano. Finally, the location of a commercial centre fills the gap of the lack of such structures, with just one commercial centre actually present in the Novara municipality.

A quantitative analysis was made to model the present timetable and to understand its inside structure. A deeper study about new and innovative methods provided the opportunity to improve efficiency in the "from-to" node transportation by the implementation of a C++ program. The implemented algorithm let the timetable of Novara's intermodal node satisfy two important features: symmetry and integration. The term "integrated" is used because the system contains the connections between different means of transport of various operators, managed by different companies. On the other hand, symmetry is a key concept to better organize timetables.

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Concor5 a hypothesis of exploiting Novara's new intermodal station through the development of an excellence centre

TASKS AND SKILLS

Elena Bielli dealt with the territorial analysis, understanding the main features of the area; she designed a master-plan being careful of the impact on the landscape and allowing the most possible integration in the territory; finally, she planned an idea for the new intermodal connection station of Novara.

Andrea Corbetta, Tommaso Palermo, Alberto Riboni, Lorenzo Serino dealt with the attractors and future development analysis. They analysed the present and future opportunities and strengths of the area and they tried to exploit them by giving the best solution for the territory; they finally analysed some possible long term scenarios exploring the possible future developments for the area.

ABSTRACT

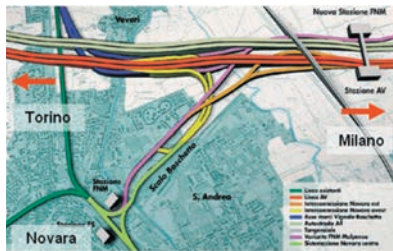
Some extraordinary conditions are imposing a rapid modification of Novara's productive and territorial context. The area is located at the cross of the two main European logistic corridors, the 5th west-east and the projected 24th north-south. Aware of this favourable situation, Novara is trying to realize a complete interconnection among highway, railway and airport on its territory. The project of an intermodal station and the re-qualification of the urban area around it would indeed represent a first step towards a full exploitation of the important European opportunities.

To help Novara achieve this goal, the possibility of introducing some attractors in the area has been taken into account. To maintain the flows attracted to Novara stable and to integrate the attractors with its context, our final proposal consists in structures characterized by qualified work places in different fields, under the general concept of an excellence pole integrated in Novara's territory. The node, developed around the new high velocity station with the different services and structures collocated to grant easy to use and accessible facilities, would be characterized by a fashion city, a scientific and technological park and a healthcare centre integrated with the university: the appeal of the node is improved through the creation of a residential pole and a commercial centre.

We also considered some remarkable future scenarios which could deeply affect the attractiveness of the area, such as the possible organization of the Expo 2015 by the municipality of Milan and the realization of the 24th logistic corridor.

The project also includes a preliminary architectural study of the new intermodal connection station in Novara, based on an analysis of volume, functional distribution and physical flexibility.

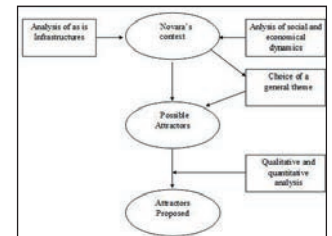
A HYPOTHESIS OF EXPLOITING NOVARA'S NEW INTERMODAL STATION THROUGH THE DEVELOPMENT OF AN EXCELLENCE CENTRE



1 *Novara's territorial localization between Turin and Milan and its highway and railway interconnections*



2 *Novara's central position at the cross of the two main European logistic corridors*



3 *Methodology employed in attractors analysis*

UNDERSTANDING THE PROBLEM

Novara is situated in the north-west of Italy along the Milan-Turin axis. At a local level, Novara is at the centre of different linking ways, both highway and railway, and it's perfectly connected to the new fair area of Rho-Pero, to Torino Caselle and Milano Malpensa international airport. Even more important, Novara's territory is located at the cross of the two main European logistic corridors, the 5th Lisbona-Kiew one, and the 24th, not yet realized, from Rotterdam to Genoa. This centrality at the switch of the two main European axes implies huge opportunities for Novara's province.

Novara is trying to realize a complete interconnection among highway, railway and airports through the development of an intermodal station with the re-qualification of the urban area around the new station in order to exploit these important European opportunities.

EXPLORING THE OPPORTUNITIES

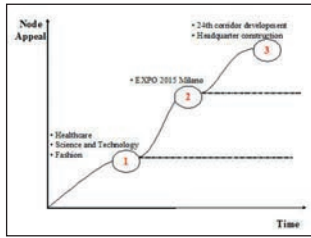
The first key point of our project was the construction of an origin - destination matrix, with the challenging goal of summing up all the possible people flows which would regard our intermodal station. The results of this analysis allowed us to make a first quantitative assessment of the problem, but most of all they clearly proved that, even with optimistic hypothesis, the volume of estimated passengers would not grant the economical feasibility of the intermodal station, which in this scenario would be only a compensation to Novara Municipality for the problems caused

to its territory by the recent construction of the high speed railway connection from Milan to Turin.

We thus decided to take into account the possibility of locating, in the intermodal station, some attractors, meaning any infrastructure able to attract a flow of people: in our vision these attractors, leveraging on the excellent logistic position of the node, would generate a dramatic increase of people flows and, most of all, would allow the construction of a more sustainable intermodal station.

The generation of the possible attractors could not be made without a deep understanding of Novara's economical and social environment: we also decided that, to give a definite identity to our project, all our possible attractors had to be linked to a common idea. We thus selected the theme of Excellence, and more specifically to develop an Excellence Centre integrated in Novara's territory. We therefore focused on attractors characterized by qualified work places in different fields. Each possible attractor was evaluated both from a quantitative point of view, estimating the flow of people attracted, and from a qualitative one, evaluating its integration with Novara's context and our vision of Excellence.

At the end of the attractors' analysis we decided that to better deal with the huge complexity of the problem it was necessary to develop some key scenarios, which take into account the future impact on our intermodal station of important endogenous variables like, for instance, the possible organization of the Expo



4 The three possible development scenarios



5 Scenario 1: proposal of the realization of an excellence pole

2015 by Milan or the construction of the 24th logistic corridor. We basically determined three different scenarios, characterized by an increasing complexity: the first one does not consider the presence of Expo 2015 and the 24th Corridor, while the third one takes into account both these events.

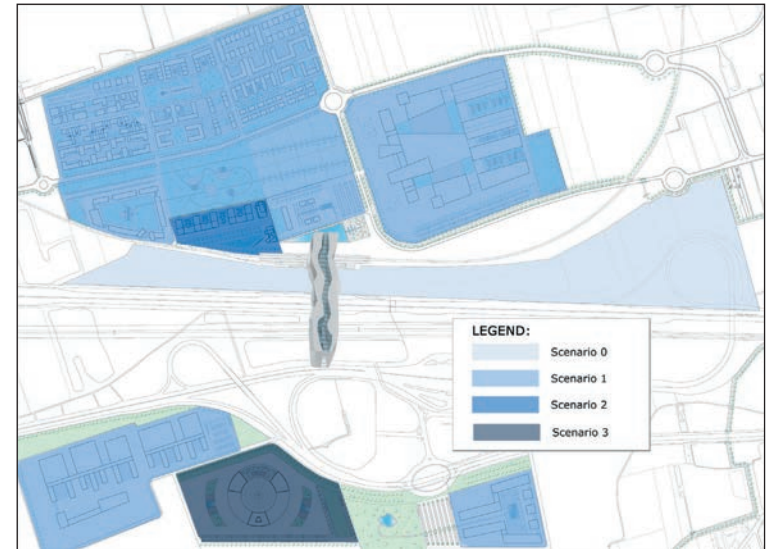
As we are going to see, our final proposal was developed into details for the first scenario: we then assessed the impact on our solution of different scenarios, trying both to understand the effect on the flow of the people caused by possible new opportunities and to adapt our architectural project to new contexts leveraging on its modularity.

GENERATING A SOLUTION

The solution designed for the first scenario consists in the creation of an Excellence Centre near the intermodal station, with the presence of three main attractors:

Fashion City. It could be possible to realize a secondary pole in the node area, connected and subordinated to Milan's Fashion City. We explored the possibility of creating something similar to the projected Fashion City of Milan, that is a pole comprehending expositive, receptive, commercial and industrial areas, all dedicated to the fashion industry, which could then host some secondary events and expositions.

Scientific and Technological Park. The industrial history of Novara has a deeply-rooted tradition in research and development, above all in the chemistry industry, and a strong presence of re-



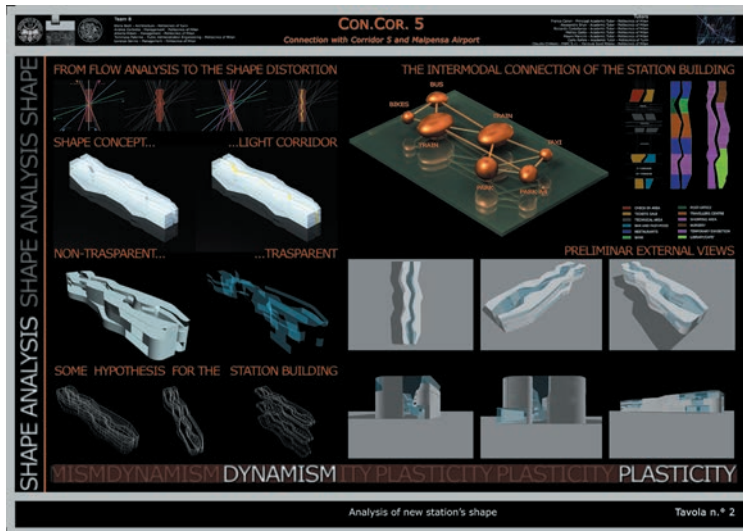
6 Area occupied by the attractors selected in the different scenarios

searchers and innovative firms. An interesting boost for the province's economy could be to present itself as an excellence pole in research and development, through the creation of a Scientific and Technological Park, which could represent both a catalyst for the local development and a coordinator of the relationships between firms, researcher centers and university.

Health care + university: A recent project established that Novara's central hospital, including the Medicine and Science faculty, is going to be moved to a new area, probably in the south of the city. We thus considered two different possibilities: a first low impact solution which consisted in locating a research centre in the node area sustained by the Faculty's resources, mainly focused on molecular biology; and a second bigger possibility, which suggests the node area as an alternative location for all the infrastructures related to the Hospital.

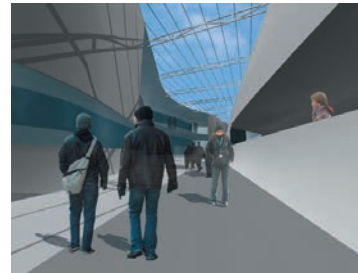
To improve the "appeal" of the node we then deployed an array of complementary services, including a residential pole able to host part of the workers present in the node, and a commercial area.

A HYPOTHESIS OF EXPLOITING NOVARA'S NEW INTERMODAL STATION THROUGH THE DEVELOPMENT OF AN EXCELLENCE CENTRE

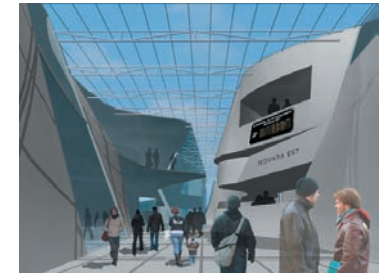


7 Preliminary study for the intermodal station building

As we already mentioned, we then modified the scenario in which we developed our solution. This figure underlines two basic concepts: on one hand, Expo 2015 and the 24th Corridor surely caused an increase of the global appeal of our station, as we will describe later; on the other, starting from the solution developed for scenario 1, Novara could then be able to exploit possible future opportunities (scenarios 2 and 3), leveraging on the flexibility and modularity of the architectural project. Moreover, the future expansion of the node could generate a virtuous loop so that, other potential attractors, nowadays unpredictable, could be attracted into the node area. To give an insight on the possible effects of other scenarios, let's consider for instance that, if Expo 2015 were assigned to Milan, the area could exploit the huge demand for places to sleep unsatisfied by Milan's province leveraging on its proximity to Rho-Pero and to Malpensa. In fact, considering the lack of luxury Hotels in Novara's province and the high target of the Expo visitors, it could be useful to realize two 4- and two 5-star hotels in the area of the node, which could then be used after the end of the Expo, receiving the flows of people visiting or working in the other new structures of the node.



8 A first view showing how the new projected station could appear



9 Another render of the station, seen by the visitors' point of view

The position of Novara also opens up the possibility of locating an important business centre in this area, which could become the headquarters of companies, attracted by the general infrastructural system or by the proximity to the excellence centre structures.

Projecting the territorial plan, we tried to allow as much as possible the integration of the project in the territory, because the project area has important values in terms of landscape and nature.

The second step was to explore all possible solutions for the disposition of the functions in the territorial plan, finding the best collocation for each service. Then we assigned all the areas to the different functions in the project, in order to grant easy to use and accessible facilities. The project includes a preliminary study for the new intermodal connection station in Novara. We also did a study on the volume: the formal idea of the station is based on the concept of plasticity and the building is conceived as a sculptural object. We also did a study on functional distribution and on physical flexibility, trying to imagine how to regulate the flow of people in it.

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