FONDAZIONE
BRUNO KESSLER

QUADERNI DI SCUOLA

SCIENCE AND TECHNOLOGY

SenSAT

The New Generations in an Evolving Trentino

edited by
Pierluigi Bellutti

sens

4

QUADERNI DI SCUOLA

4

Science and Technology

Published with the financial support of

PROVINCIA AUTONOMA DI TRENTO

FONDAZIONE CARITRO
CASSA DI RISPARMIO DI TRENTO E ROVERETO

Finished printing in August 2020
by Esperia Srl - Lavis (Trento)

ISBN 978-88-98989-58-4
eISBN 978-88-98989-59-1

SCIENCE AND TECHNOLOGY

SenSAT

The New Generations in an Evolving Trentino

edited by
Pierluigi Bellutti

FONDAZIONE BRUNO KESSLER PRESS

Table of Contents

Introduction to the English Version

by Pierluigi Bellutti

The Italian version of SenSAT notebook was published in December 2018. Shortly after publication, I put forward the idea of preparing its English version, suitable for the international events organized every year in Trento (Festival della Montagna and Festival dell'Economia) but also, considering the feedback gained from foreign researchers, teachers and entrepreneurs about DomoSens educational model, for an easier dissemination abroad. For this reason, in Summer 2019 Pietro Martini, a student of "S. Scholl" High School, carried out a first version during his school-working period at FBK tutored by Maria Del Huerto Flammia (Translator for the Research Support Division).

In order to let the "innovation intent" arise with the proper "tone", I asked for an in-depth revision of the English version to an US entrepreneur I worked with and I have known for more than a decade. He is Nick. I'd like to thank him for his revision, as well as for our discussion about the model itself that helped to better address further optimisations.

FOCUS

Forward

When we invent, we prove the concept of a clever new device or technology. When we innovate, we create value.

I have been involved in technology development and managing technologists my entire career. I have founded or co-founded multiple small manufacturing companies. I have also acted as a catalyst, bringing people, institutions and companies together to produce both invention and innovation. One of the institutions with which I have worked closely is Fondazione Bruno Kessler, and the person at FBK with whom I had spoken most frequently was Pierluigi Bellutti. During my career, I have become fascinated by the skills and attitudes that seem to be characteristic of successful Innovators, no matter what the environment, and this was a topic Pierluigi and I often discussed.

When we speak of technology, we understand that scientific and engineering skills are required in order to invent. But in today's world technological invention overwhelmingly is funded only when the value that it is intended to produce is clear, practical and significant. This means that economic, social, legal, environmental, and other inputs must come to bear on the decisions as to which inventions are pursued. Such coalescing of the components to develop a fundable idea for invention happens most commonly in teams, brainstorming on ideas and developing concrete plans, with resulting tasks, timelines, budgets, business plans and check points. In turn, skills involving mindsets, communication, dealing with confrontation and compromise, decision-making and more come to the forefront.

Traditionally, our educational system deals with isolated "subjects", such as business administration, mathematics, biology, law, psychology, computer science, graphic arts, among many others. The ability to work in teams, to bring together different disciplines to work on a single goal, is, on the other hand, left to "on-the-job training", with the hope that team and team leadership skills, as well as project management skills and practices, will serendipitously materialize.

The DomoSens program described herein is a significant innovation in itself. The idea to bring together students and teachers with community leaders, scientists and technologists as a component of the high school education with the stated value of improving a key business and recreational activity indigenous to their local area is at once radical and of obvious merit. The idea was a good one, but it was aggressive; it must have seemed a bit out-of-reach at the outset. How do you convince schools that their curricula have space to incorporate something this different and experimental? Beyond the idea, however, the successful way in which it has been implemented is a remarkable achievement, both for the innovators who conceived the program and funded it, and for the teachers and school administrators who had the vision to embrace it.

To the further credit of its initiators, this program had another tenet in its initial charter – namely that it will be structured as a model that could be followed by other forward-thinking communities and adapted to the specifics of their locality. If this happens, and it should happen, one of the many beneficiaries will be innovation itself.

Nicholas C. Barbi
CEO nSynergies, Inc

Editorial

So here we are with a new Notebook in the “Quaderni di scuola” series.

Starting from the DomoSens’ experience project (Notebook n. 1), the Bruno Kessler Foundation has decided to give life to a series that brings together the design experiences made with the schools, with particular attention to new educational ideas for students and update for teachers.

Although they deal with very different disciplinary fields – from science and technology to the humanities – the design experience described in the “School notebooks” are built around a single model.

In the actual experience with students and teachers, the model was designed to be transferrable to different fields and scalable so that it can be adapted to the specific needs that emerge in future projects. In this way, it becomes a reliable support for the school-work alliance that we believe is necessary for the education of the new generations, in a world undergoing a fast-paced evolution.

The model:

- is a novel approach
- integrates skills and cross-disciplinary knowledge between at least two different scientific fields
- allows schools with different focuses to participate in the project, to experiment with teamwork between students, school tutors and other professions
- features a project has a length of at least one school year
- requires that external experts and/or organizations collaborate in the project.

The above characteristics are enhanced by the necessity to include some distinctive elements with-

in each new Notebook, such as:

- discovery, which comes from research
- invention, enabled by technology
- approach to product innovation
- identification of the market, as a mechanism for delivering goods and transforming them into economic value
- development of global and intercultural citizenship (as a perspective that guides education and the construction of skills)
- study of relevant historical precedents, as a point of reference for a conscious interpretation of the present and a novel idea of the future
- effect on society, such that our idea and its implementation do not result in deterioration of inter-human relationships and in the environment in which we live and work.

The series will also include volumes dedicated to the narration of particularly relevant initiatives and cycles of meetings, developed by FBK with schools and with the help of science and research top experts.

FBK will support publication of independent contribution of similar experiences, provided that such experiences are consistent with the above features and distinctive elements.

The Editorial Board

Introduction

by Pierluigi Bellutti

The idea of SenSAT goes back to the 2016-2017 school year, when the DomoSens project was in full swing. In view of the enthusiasm that had characterized the preparation of this project and the increased momentum after the first general meeting – the kick-off meeting – we, at FBK, were encouraged to prepare a new experience to be launched in the following school year. The new proposal would follow the DomoSens underlying structure, but would not merely replicate its activities. Rather, we envisioned a project that would create a scenario similar to DomoSens, but at the same time allow for the exploration of new and unique experiences. In part unconsciously, we were laying the foundations for what would later be identified as a project "model".

So elements that involve other aspects of FBK's research were integrated, to enrich both professional development for teachers and educational content for students. All of this, in a context already identified and proposed by the local institutions through signs that read Trento "Smart City", which received this designation from the Institute of Electrical and Electronic Engineers (IEEE).

The last element that came into play for the definition of the new project was the concomitant publication of the CARITRO Foundation's call for the support of young people's activities, to bring them closer to the job market. The call provided that one of the project partners be a local business. Thus, the idea took shape.

We came up with an idea that was directly applicable and needed for our local area, which we have dubbed "Smart Land".

The idea was centered around the creation of a network of environmental sensors covering a wide surface area, connected wirelessly to an operations center.

The goal of the envisioned network was to control without human intervention, relevant structures of economic interest and of high symbolic value for the Trentino Region: mountain lodges. And it was in this way that the Trentino Alpinist Society, known as SAT, appeared on the scene.

Prologue

by Pierluigi Bellutti

A telephone interview with the president of the SAT Claudio Bassetti took place in early December 2016. A meeting was set at FBK for January 17, 2017 between a delegation from SAT and a team from FBK, including myself and Claudia Dolci, head of the FBK Research and Innovation for Education Unit. Between the phone call and the meeting, on December 28, 2016, a fire destroyed one of the most popular mountain lodges of central Trentino, the historic “Rifugio Tonini” in the Lagorai range, almost as if fate had wanted to emphasize the relevance and urgency of the project.

We started the meeting with the presentation of the ongoing FBK DomoSens project which involves 7 schools in Trentino. We then pointed out the similarities with the previous project and the new elements of the new proposal that we would like to submit to the CARITRO Foundation, which has opened a call for proposals. In this case, the project focuses on the creation of a network of sensors for the monitoring of air quality - including fire - of mountain lodges. At the end of our presentation, it was our guests turn to speak. but there was only silence. Giorgio Tamanini, member of the SAT committee for mountain lodges, and Renzo Franceschini, chairman of the SAT committee for mountain lodges, looked at President Bassetti. He was staring at an area of the office’s wall without posters. The pause grew longer and the idea that our proposal was in jeopardy began to seep into or minds.

Then the silence broke, and Claudio said “could you also ...?”. The proposal had been accepted!

So, the project can start its course by contacting the schools, drafting of the text, planning activities

FOCUS

Claudio's Silence

Just as it has always happened, it is happening now: the most varied proposals arrive to the SAT President's office. Seated at the table, they discussed utopian ideas and small projects, collaborations to be built and partnership requests, on books to promote and talks, on sponsored expeditions and events to be supported. Not all proposals could be accepted. On the contrary, it was often necessary to find the words to motivate a thank you that was polite but firm.

But what we were listening to that day was a proposal that held together many elements often presented separately in the individual proposals. Innovation, planning, teamwork, education, commitment, challenge, mountain, mountain lodge, relationships, concreteness, involvement, community. They were there, all together, and they were fine, in a natural way, not in a forced one, not invented, not artificial. A project that opened up opportunities, that let in fresh air, new ideas. A fortunate combination had brought us to an unfortunate one, i.e. the fire, showed even more enriching and more stimulating perspectives.

All this pops up in our heads, and we will need time, because it is necessary to remove consolidated ways and styles to make room for something more structured, more complex and exciting. And why not, to add more, to try and dare more, to try and use intelligence, skills and enthusiasm to make a product even more complete and useful. That time was necessary for me to sort things out and come up with an answer that was not just a "yes, count us in" but that could express in a nutshell a full appreciation and at the same time the sense of a partnership that gets all of us involved and re-launches because it believes in it, understands its educational function, shares its aims, captures its concrete value, and wishes to do its own part, put its own technical competence, its knowledge on mountain lodge management, its readiness as logistical and cultural support.

And the brutal summary, pronounced in a time that seemed for me so short and for Pierluigi long enough that it got transformed in one of the key points for every presentation after that (this further confirm the subjectiveness in the emotional measurement of objective data) , was "we could also ..." and so on.

I do not know if it will happen to me again (certainly not as SAT President, after concluding my mandate in 2018 in the meantime) to encounter such structured and engaging proposals. I hope so. It enriched me a lot. But if it should happen, I would star by saying that there are silences that are full and words that are sometimes empty. You don't have to worry about the former ones.

Claudio Bassetti
Former SAT President

and participating in the CARITRO call for the funding of the project.

Here below, in memory of that meeting, we asked Claudio to share the thoughts that crossed his mind and characterized that silent pause with us.

This is how the SenSAT project began. After the meeting with the SAT representatives, the project did not only confirm its title, but it was completed with the motto that underlines the role of its protagonists: “SenSAT”. The new generations in an evolving Trentino“, as we read in the photo that shows the view of the Alto Garda from the Prospero Marchetti mountain lodge on Mount Stivo.

FOCUS

The Legal Profession: Trying a Hands-on Approach

Law in itself is something that seems dry, detached from reality and, in some ways, pure philosophical speculation. However, in all its facets, it assumes a concrete connotation especially when it deals with "day-to-day life", not only because it regulates and orients "civil life", but because it regulates and directs "social life". If it is difficult to make law accessible to most people, it is even harder when you want it to be grasped by teenagers.

For the National Forensic Council (CNF) – engaged in various civic education projects – working with the law is not only possible but also necessary and this awareness was the basic idea that also led the Italian lawyers to participate in the SenSAT project.

The key point of the collaboration between CNF and FBK, launched with the signing of the memorandum of understanding on October 27, 2017, is to "bring the new generations closer to common and shared, innovative and participatory work methods. All this in the context of learning activities – steered by and toward scientific, technological, social and economic research – aimed at promoting education on legality, at enhancing active citizenship with an awareness of rights and obligations, at respecting differences and the needs of solidarity and sustainability imposed by a complicated social system ".

In this context, the experience of collaboration between the CNF and FBK represents a unique cooperation in view of "in itinere" education of the student in itself. The empirical-practical approach was the guiding thread of the collaboration. Thus the process started with the consent of FBK to combine abstract with concrete aspects and to make sure that knowledge is empowered in a circular way: from students to legal practitioners and vice versa.

Meeting, staying together, planning and working on a common project in order to produce and develop something requires a more in-depth knowledge of the law than one would think; lawyers would inside the project aims to bring out all the aspects of social life in a precise way and those instances that cannot leave out the law, an effective problem solving tool. The previous experience improved in the DomoSens project has been very useful for the activities proposed in the SenSAT project: knowing the expectations of students and teachers as well as the organization at FBK allowed us to fine-tune operations and contents by proposing, where possible, game-like tasks.

As far as safety is concerned, due to the different background of the students involved, we tried to give the plenary meeting on 24 October 2017 a practical approach with the aim of explaining the concept of safety at the work place as provided for the consolidated document on safety 81/08. We started from explaining the meaning of the regulations key words such as damage, prevention, protection, risk, illness. We also included the examination of the duties and rights as well as the sanctioning system, with the discussion of a practical case. All this with short and easy-to-grasp role play. Actions on intellectual property had instead the purpose of helping students identify the ways that law offers to transform an idea into a product ready to be introduced on the market, an essential methodological aspect in the framework of the aims of the agreement stipulated between CNF and FBK.

Carla Broccardo e ***Nicola Cirillo***
National Forensic Council

1. Project Development

by Pierluigi Bellutti and schools' spokesmen

1.1 *Let's get to know the SenSAT project's program by asking "What is SenSAT?" to Emma Trenti, a student of Trento's "G. Prati " High School.*

SenSAT is a project coordinated by FBK, supported by SAT, that involves 265 students who attend 7 schools in the Trentino area.

SCHOOL	CLASS	TUTOR TEACHER	PRINCIPAL
"A. Tambosi" High School, Trento	4th RA (international relations for Marketing - RIM)	Biagio Orlando De Pascale Elio Lenzi Claudio	Poian Marina
"G. Marconi" High School, Rovereto	4th A (computer science) 3rd BM (mechanics)	Festi Gianfranco Moretti Alessandro	Rizza Giuseppe
"M. Buonarroti - A. Pozzo" High School, Trento	3rd CMA (chemistry and materials) 3rd CMB (chemistry and materials) 3rd CSA (chemistry - health biotechnology) 4th CBA (chemistry - env. biotechnology) 4th CMA (chemistry and materials) 4th CMB (chemistry and materials) 4th ELB (electrical engineering)	Calabrese Agostino Tomasi Filippo Cofler Marino Leonardelli Stefano Baruchelli Piergiorgio Bosco Paola Pegoretti Sabrina Visentini Adele	Zoller Laura
"M. Curie" High School, Pergine Vals.	4th ALS (High School for science)	Degrandi Claudia	Chincarini Paolo
"L. Guetti" High School, Tione	3rd SM (high school for science and mountain tourism) 4th TR (technical-tourism) 4th APA (applied science)	Bosetti Massimo Mittempergher Susanna Moratelli Antonella Bosetti Marco	Sbardella Viviana
"A. Vittoria" High School, Trento	4th D (industrial design) 5ft D (industrial design)	Mariggiò Maria Vincenza Claudia Zanella	Pennazzato Roberto
"G. Prati" High School, Trento	Students from different classes	Ianeselli Sara	Pezzo Maria

From a teaching point of view, the activity is part of the School-To-Work program and the educational aspect lies in the possibility of experiencing an operating situation similar to the one of a company engaged in the development of an innovative product.

It is a path that allows students from different schools, having more or less specialist educational profiles, to have the possibility of becoming aware that today, in order to “stay on the market”, collaboration between different professional figures are necessary, all equally necessary, in a virtuous team game. The path that is thus drawn leads students from different schools, some also geographically distant from one other, to touch the many aspects, such as economic, technical and legal, which complete the whole: the realization of a product designed to be launched on the market.

Regarding the operational goal, the project aims to create gas detectors that will be installed in a number of mountain lodges. The purpose is to monitor the indoor air quality of the structures, including early fire detection, in order to have increased safety for the structure and its guests. These sensors will become part of a monitoring network, incorporating a wireless connection with the **control rooms**, which will in fact allow to remote monitoring of the environment in real time. The presence of a network of sensors spread across a vast territory thus sets up a “smart land” model.

Control rooms station for the remote monitoring of data acquired by a land distributed network.

1.2 *Smart Land? What is meant by this definition? We give the floor to the spokeswoman of the "M. Curie" High School in Pergine, Arianna Casagrande.*

A smart city, or a smart land, is a geographical space where all the members of the community – residents, visitors, or those just passing through – have at their disposal instruments and technologies that contribute to improving their quality of life. An important application of technology in our Smart Land is the collection and elaboration of data to measure parameters that indicate the quality of the local environment at any instant, and output regular status reports and, if necessary, warnings. This system comprises 1) distributed detection points where sensors measure and transmit raw data to a control room; 2) one or more computers dedicated to compiling and storing data and 3) algorithms which provide reports, issue warnings if necessary, and perhaps even recommend further action. We can envision simple cases in which pollutant levels are monitored and reported, or the presence of a small fire is detected. We can also envision more complex cases, such as monitoring traffic and employing algorithms to recommend corrective action such as optimizing the duration of red and green lights or diverting traffic to less congested areas. The distributed sensor network, the data measured and processed in the control room and the algorithms adopted to analyze data and trigger appropriate action, are all parts of a system in our smart land. The latter is the case of SenSAT, which thus becomes a smart land testing project, since the measurement points are distributed across an area that goes far over the city limits.

It should be underlined that, in tech-

nology is not the sole characteristic of a Smart Land. Rather, it is further defined by investments in human and social capital that nurture responsible and sustainable development to increase the quality of life. Trento has for years ranked among the top smart cities in Italy according to the "iCity rate" ForumPA indicator (first among medium-sized cities in 2017). In 2014, Trento was selected by the IEEE, arguably the world's most important organization in the field of technological innovation, as one of the 10 model smart cities in the world, the only one in Europe, in terms of quality f life promotion for its citizens.

1.3 ***Okay, but why are you interested in alpine mountain lodges? The CARITRO call encourages the participation in the project of a local business. How are mountain lodges related with the economy?***

Daniele Salizzoni, spokesman for the "L. Guetti" High School class of Tione answers.

First of all, we have to take a step back in time to remind us that mountain lodges first appeared after 1863, the year in which the Italian Alpine Club (CAI) was founded. The first mountain lodge of the Dolomites was built actually in 1877, dug into rock wall of the Marmolada range.
In 1872, the Trentino Alpine Society was born in Madonna di Campiglio, listed among the CAI sections, but with its own specific autonomy. A few years later the name was changed to the Society of Trentino's Alpinists (SAT). SAT members' goals were to promote visits to Trentino's mountains and to develop tourism in the valleys, with an overall celebration of "spirito italiano", of the Trentino Re-

ForumPA FPA is the company of the Digital 360 Group, which for 29 years has facilitated the meeting and collaboration between public administration, businesses, research and civil society.

gion. The tools used to reach these goals include the construction of mountain lodges, the opening of hiking trails, the financial support to hotel managers, the organization of Alpine Guides, and the publication of geographical and alpine writings. These activities are still being carried out today.

In the years following the foundation of CAI and SAT, many Sections and subsections, with skilled and enthusiastic men and women, have ensured the construction of new mountain lodges that facilitate longer and more complex hikes. At the beginning of the twentieth century, there were about one hundred mountain lodges.

TRENTINO'S MOUNTAIN LODGES

	Alpini	*Escursionistici*	*Totale*
Private individuals	31	55	86
ANA	1	0	1
Public authorities	10	10	20
Foundations	1	0	1
CAI	4	0	4
SAT	31	3	34
TOTAL	**78**	**68**	**146**

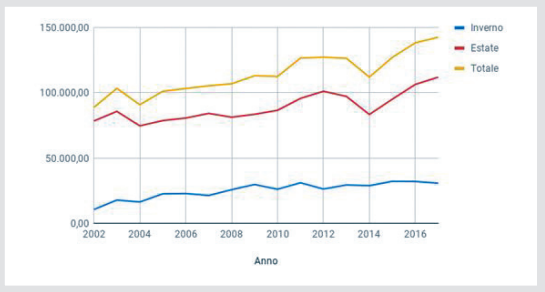
In 1922 more permanent bivouac shelters (alpine structures usually located at high altitudes) from which you can start longer hikes began to appear in the Western Alps. Today, lodges are divided into alpine and excursionist mountain lodges, managed by different operators (see the table on the right.)

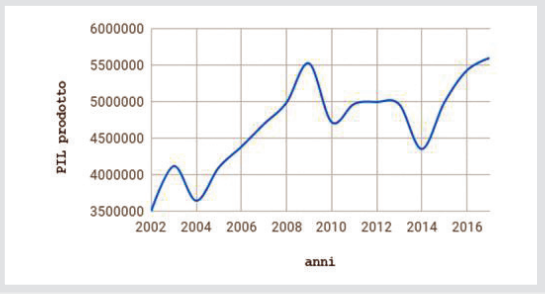
Today mountain lodges are at the service of people who visit the mountains, to provide them with a place to rest, refresh, enjoy a hot meal and share experiences with lodge managers and other hikers. Thus, they have now become structures devoted to hiking-related tourism.

It was very interesting for our class to analyze the lodges in order to have a clear picture of the role played by these particular structures in Trentino. We considered in particular the economic and legal aspect of the alpine and hiking mountain lodges.

At first, we examined the fundamental points of provincial law n. 8 of 1993, which regulates alpine structures. In particular, two key concepts of the regulation elicited some reflections: 1) the fact that these structures are considered to be of public interest, and therefore regulation is required to ensure both the protection of the mountain territory and safety in the mountains, and 2) the concept of "no-frills hospitality" associated with alpine lodges, reflecting the fact that they were created to meet the primary needs of alpinists and not to offer luxury accommodation to mountain lovers.

When we moved on to analyze the data provided by the Provincial Statistics Institute (ISPAT), quite relevant information emerged. For example, from the graph we developed regarding the total number of mountain lodge visitors, we can see how they have increased by about 50,000 units in 15 years and how mountain tourism has been generally increasing. The anomalous drop recorded in 2014, with mountain lodge stays decreasing by over 20,000 units in the summer period from the previous year, is explained by adverse weather conditions, which brought rains and thunderstorms throughout the Trentino Region.





Another significant fact emerged from the total GDP produced by tourists staying in mountain lodges overnight. In 2017, revenues from over-night stays exceeded € 5.5 million; we can see from our chart that significant growth occurred from 2004 to 2009 and from 2014 to 2017. The increased

numbers in mountain lodge visitors and the associated economic contribution to Trentino should not be underestimated. Although such contribution accounts for only 0.45% of tourist accommodation in Trentino, the lodges represent the concreteness of high-altitude hospitality in Trentino as a mountain destination. To make a concrete example, a Tuscan tourist, attracted by mountain lodges, could book their holiday in a hotel in Trentino. The hotel, through wise marketing strategies, could offer the tourist a package including an excursion to an alpine or hiking lodge.

Finally, we asked ourselves: "How would tourism in Trentino change if there were no mountain lodges?". We have come to the conclusion that, without mountain lodges, the image of mountain tourism in our region would be very different and income from tourism in our valleys would certainly be lower.

1.4 ***Mountain lodges therefore play an important role in Trentino's economy. But, like all the structures that share the hospitality of people as their goal, mountain lodges attract tourists also thanks to those who live and work in the lodges to create a comfortable environment. The lodge manager is the structure's "human factor" and his/her job therefore becomes critical, but what do "lodge managers" say about their job? We asked Valentina Dal Pont, representing the 4th year students of the "L. Guetti" High School for Mountain Tourism located in Tione.***

We invited the school the managers of the three SAT lodges that we had chosen for our research program and we listened to their stories: they were all different, but shared the same passion and dedication with which good managers carry out their responsibilities every day.

Each of them pointed out strengths and weaknesses of their type of work, which is challenging, while being rewarding and satisfying, and has the undeniable added benefit of taking place in beautiful

surroundings. We wanted to learn more about them first, and then let them tell us their personal experience about the work of those who live full-time on the mountains.

Egidio Bonapace, from Madonna di Campiglio, a mountain guide since 1983, a ski instructor, mountain lodge manager and, above all, an alpinist. He has been President of the **"Trento Mountain Film Festival"** and of the Mountain's Academy. After thirty years of experience in the Graffer lodge, he has been the manager of the Seganini lodge, in the Presanella mountain range since 2010. A man who lives in the mountains, was born in mountains and who has created a special bond with them.

Marco De Guelmi, manager of the Nino Pernici mountain lodge (Bocca di Trat, straddling the Val di Ledro and Alto Garda) for nine years. Marco has lived in the mountains with his family since he was a child and therefore knows the mountains very well. At 23, he took over the lodge and, despite his young age, the SAT saw in him the right motivation to undertake this adventure with great responsibility.

Roberto Manni, manager of the Graffer Mountain Lodge, in the Brenta Dolomites, is a mountain enthusiast. He transmits his passion to those who meet him, especially young people, whom he

Trento Mountain Film Festival Founded in 1952, the Trento Film Festival is the first and oldest international film festival dedicated to the mountain themes of adventure and exploration. Over the years it has become a true laboratory for visions and thoughts on the highlands of the planet, encompassing a broader horizon, including environmental, cultural and current affairs.

always involves, igniting the enthusiasm for mountain climbing in them. He is a mountain guide, ski instructor and alpinist, and has climbed four 8000-meter peaks: Cho-Oyu (2005) Lhot-se, Broad Peak (2007) and Everest. He missed a fifth peak, Shisha Pagma (2006), by only a few meters due to adverse weather conditions.

Their stories had the flavor of the true mountain region, of being in an environment that is sometimes hostile, but at the same time offers good financial opportunity and, more importantly, opportunities for personal growth that enhance one's soul: living in the mountains has made these men more open and farsighted in their views about the environment and the future. Listening to their words, summarized below, made us understand how important the awareness of living in a land that challenges us with its harshness while inspiring us with its sublime and attractive power.

The mountain lodge

Every day, the lodge rises to the challenge of enhancing the surrounding area and its beauty, so that the visitor may enjoy the mountain environment and take the opportunity to experience unique moments, surrounded by the mountains that are close at hand. It is a place typical of the region and a reference point for the local area. In addition to being a physical shelter, it has also a cultural aspect, requiring that particular attention must be paid to everything that characterizes it. The mountain lodge assimilates the tradition of the mountains by its simplicity and its immersion in the natural environment. And these are elements that attract guests, because the lodge is not an end to itself. It never gets isolated, but it connects with other lodges which cooperate in the surrounding environment. This creates a wide network in the area, which in turn spawns a synergistic and bene-

ficial collaboration among managers, guests, and the mountains.

The Manager

The manager of a lodge has the responsibility of a structure that is a reference point for that area; this means he/she must pay particular attention to everything that the lodging structure represents. It has many of the issues of similar structures located in easily accessible areas. Beyond these, however, there are characteristics specific to the mountain regions. For example, not calling in case of change of plans, damages the business of the lodge and prevents others from benefitting from the overnight stay. More importantly, it triggers an alert as the non-arrival of a guest could mean their involvement in an accident along the way. At any rate, a good manager must know how to keep everything that happens in the structure under control. Seldom will the manager leave the mountains during the most important season. In addition, he/she must have management skills such that a good and mutually respectful relationship with the staff can be established and maintained, requiring good interpersonal and communication skills. Often, in the lodge environment, the team works hard together during the day and relaxes and enjoys the evening together. A unique consequence of working in mountain lodge environment is the nightly social interaction of the manager with his staff. This is at once a very positive and challenging aspect of the manager's job, requiring that the manager have fun with his/her staff, building strong team relationships, while always maintaining their respect. The managers also need the ability to respond to the difficulties, often emergencies, that can arise from being in an environment exposed to risks, such as loss of water or electricity. The manager must deal with such difficulties, relying first on his/her own resources and then on the resources of the network. A positive attitude is required, as is the humility to understand that he or she may be at the mountain's mercy.

The Guest

The type of guests at a given lodge is mainly defined by the type and length of the hike. The lodges with less difficult hikes to the neighbor lodges attract the highest number of guests, and typically the least experienced. During the years, the clients of the mountain lodge have changed: mountain lodges used to be a starting point for popular trails; today, they have become a destination. Because of this, guests often expect too many amenities, perhaps because they do not quite grasp the nature of the lodge, its roots, and its function, and probably have not thought about how hard it is to bring luxury services to high elevations.

As in any business, the customers' expectations must be properly set and managed. Therefore, guests should be educated, through marketing and advertising, about the mountains, helping them to understand the value of the lodge: it is precisely in these places that deep and lasting bonds can often be forged among guests who have the shared experience of reaching a lodge located at the end of a hard excursion, after a big physical effort.

It is also important to remember that guests having limited or no mountain experience may visit the mountains, a fact that should be welcomed and embraced by the mountain lodge industry as a means for continual growth. Therefore, an additional marketing effort is required to educate inexperienced visitors in order to provide them with the knowledge of hiking fundamentals and to inspire them to realistically evaluate their own physical abilities and limits so that they are better prepared to enjoy a safe experience in a mountain setting.

Whether the guest is an experienced mountain hiker or a novice, the lodge is like a watch of the peaks, it welcomes and reassures all the lovers of the Alpine environment.

FOCUS

The Mountains as a Shelter

Traditionally, the mountain environment has represented a challenge for thought and imagination. The grandeur, majesty, verticality, in some cases even the inaccessibility of the peaks, plateaus, and alpine forests, has nourished for centuries the conviction that the mountains represented, if not the antithesis of civilization, at least the extreme boundary of it.

From this point of view modernity, and above all modern technology, have drastically changed the cards on the table. In a short but profound article, published in an emblematic year of recent history - 1968 - it was the great South Tyrolean mountaineer Reinhold Messner who expressed the fear that technical development, with the elimination - to use his words - with the "murder" - of the impossible, could irreparably damage any authentic relationship with the mountain. For if the possibility of failure is eliminated, the sense of the "sacredness" of the peaks is lost.

Although Messner's concern has not lost its raison d'être, the relationship of the people with the mountain has nevertheless remained spiritually rich and multifaceted even today. Indeed, for many people, the mountain in its various forms has ended up embodying an alternative to the modern form of life, with its accelerated pace, wild competition, the search for standing out at all costs and the homologation of tastes. Without idealizing it, many recognize traces of a "Resonant" existence in the mountain experiences, which speaks to them a language that is different from the one they use every day and which reveals unexplored human potential. In this sense, the mountain continues to be a challenge for thought and imagination today. And there is no human reality that can sum up this challenge better than the family profile of alpine lodges: places where those who visit the mountains look for protection and refreshment, but also places where the contradictions of the mountain and contemporary lives are sublimated in the figure of the mountain lodge visitor. The mountain embodies the virtues and vices, the greatness and misery, the joys and the hard work, of that complex and unparalleled form of life which is the existence framed by the presence of rocks, spiers, gorges, glacial or pluvial valleys, woods, meadows, erratic boulders, peats, streams, plateaus, ponds, landslides and aquifers, mountain pastures, wild animals and wild plants.

If observed in this way, the alpine lodge appears as a bridge connecting the past and the future of the mountain, and nevertheless, like any respectable bridge, solidly anchored in the present, to remind us physically that the question "where do we want to go?" is a question that every generation is called to answer in their own terms.

Paolo Costa
FBK - Center for Religious Studies

The SenSAT project

For our managers, the new technologies can also give a hand in increasing safety aspects in the mountain lodge. Fire hazards in lodges exist and rescue operations are often complicated. There is room for technology expansion, but attention must be paid so that technology will not distort the nature of the context but instead become a reliable help factor for those who every day make guests enjoy the mountains to the fullest.

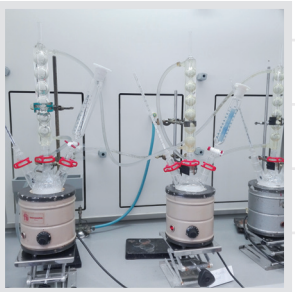
1.5 ***Technology can therefore be a reliable aid for those who experience the mountains in all their dimensions every day. So let's try to analyze the technological aspect of the SenSAT project. We talked about air quality monitoring and fire breakouts in mountain lodges. How do you examine air quality?***

Eva Tarazas explains it to us, on behalf of all the "M. Buonarroti - A. Pozzo" High School's students of Trento which partecipated in the project.

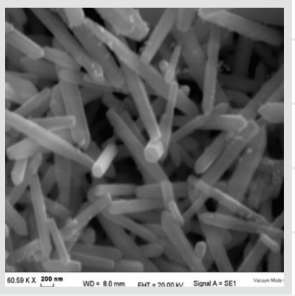
To assess air quality, we created sensors capable of performing this type of measurement. Our classes made sensitive material that can "feel" the presence of harmful gasses in the air. It is a nanostructured material, which is made up of very small crystals (of dimensions equal to the thickness of a hair divided into 100,000 parts!!!).

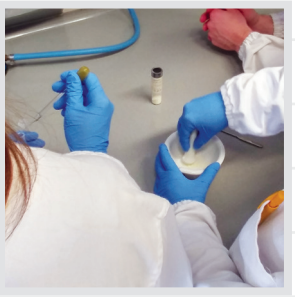
This sensitive material changes its electrical resistance when it interacts with gases present in the surrounding environment: the measure of electrical resistance is compared to the gaseous concentration and therefore to air quality. Our chemistry teachers, together with FBK researchers, developed the lessons enabling us to replicate the preparation of the sensitive material in our laboratories. The chemistry classes of our school were divided into work groups and each group made

material with different metal oxide (zinc, tin, tungsten, titanium, etc.), in order to identify the type of material with the most suitable characteristics for the specific application.



Now let's look at one of these summaries, in particular the one carried out by class 4C MA, engaged in the production of zinc oxide (ZnO) structured in **nano-rods**. We start by dissolving 0.05 moles of zinc acetate in 300 mL of ethanol (solution 0. 17 mol/l) and heat under reflux at 60° C shaking for 30'. At the same time, we prepared a solution of oxalic acid and ethanol (0.140 moles of oxalic acid in 200 mL of ethanol). After half an hour, this solution is slowly added to the first. The final solution is heated under reflux for 60 minutes at 50° C and a "fog" appears in the solution: it is the ZnO, solid, suspended in the solution. The ZnO powder is separated from the solution by filtration and put to dry at 80° C for 20 hours in an oven. The following day the product obtained is **calcined**, bringing it to 650° C for 4 hours in a muffle (oven for high temperatures), in order to give the material a well-de-



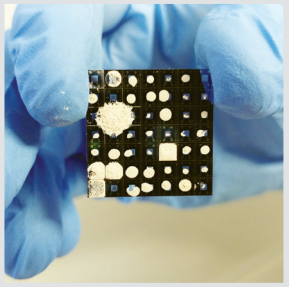


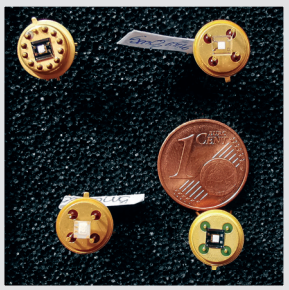
Nano-rods Solid structures in the form of bars of an average size less than 100 nanometers (1 nanometer corresponds to the millionth part of a millimeter).

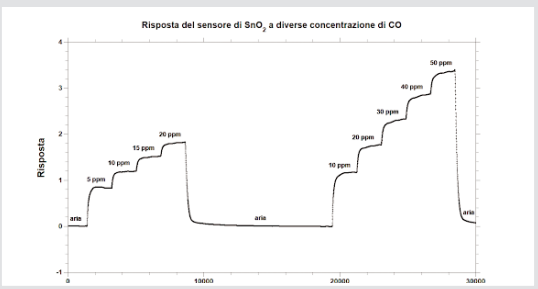
Calcination Calcination is a term, known since the days of alchemy, which defines a heating process at high temperature protracted for the time necessary to eliminate all volatile substances from a solid mixture or from a single compound.

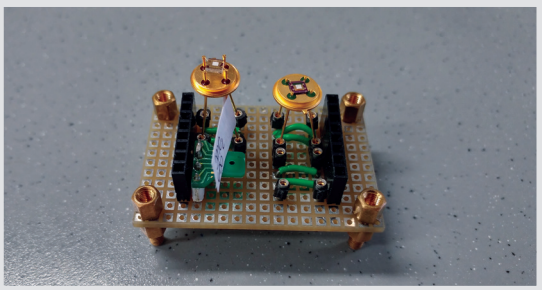
Morphological analysis In-depth study of the external physical structure of an object.

fined nanocrystalline structure and to purify the ZnOn from possible carbon residues. As evidenced by the **morphological analysis** done with the electronic microscope, the ZnO powder obtained is made up of nano-rods less than 100 nanometers thick. After calcination, they were crushed into powder in a mortar to obtain a homogeneous shape, ready to be used in the next phase. At this point, we should remember that the other classes involved in the project followed similar procedures for the production of other powders, with procedural differences specific to the different compounds produced. The powders thus obtained were mixed with products that made them look like soft toothpaste. Using special pipettes and tweezers, the paste was placed on the silicon chip made by FBK. In the picture to the right you can see the results of our material deposition tests performed on a piece of silicon wafer with 7x7 (49) chips (about 1mm ^ 2 in area each), i.e. 49 gas sensors. At FBK, we then separated the individual chips and mounted them on specific supports (packages). The sensor was thus ready to be tested in the test chamber in the presence of air with known concentrations of pollutants (for example carbon monoxide, CO).





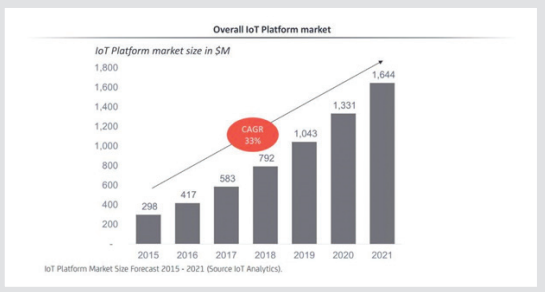




1.6 ***Well, we have created the circuit board with the sensor that measures air quality: but how do we collect the data and get alerted of the situation detected? And how, if we are far from the location where it is being measured? It is the task of Giacomo Ascari, representing the "G. Marconi" High School for Computer Science in Rovereto, to explain the solution.***

In fact, we imagine two different challenges and for each a corresponding unique solution.

The first challenge is how to alert those who are near the sensor that a problem has been detected. This is the easier of the two challenges, as, for example, the sensor could be connected to a buzzer or a light signal which will warn the on-site staff. The second challenge, the more complex, is how to alert people remote from the sensor to the existence of a detected problem. The solution to distance notification involves the transmission of data to a remote monitoring center, where operators can take steps to deal with problem, including alerting appropriate authorities. Given the objectives of the project, i.e. the installation of a series of sensors on an extended stretch of land, we focused on the solution to the second, more complex, situation, namely remote monitoring. The mountain environment makes remote sensing even more complex, because cell phone reception/data connection may be poor or non-existent, thus precluding the use of traditional communication technologies.



In the age of digital communication in which we currently find ourselves, there are new technologies to transmit data and novel software systems that can be programmed into devices (nodes) along the data transmission route. These advances make it possible to deploy sensor modules, which can transmit raw signals to intermediate receivers, which, in turn send them on to a more distant control station. The process described here is included under the concept umbrella called the **IoT (Internet of Things)**.

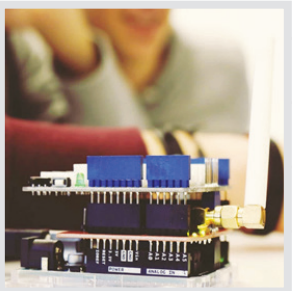
We have been talking about a specific application of a remote detection and monitoring network, for use in the mountain region of our Smart Land. However, the possibility of connecting devices, that detect the status or levels of particular parameters in the area and collecting these data remotely, enables the creation of a multitude of broad new services that can be of great use to citizens and companies. To achieve such a goal, many new applicable technologies must first be explored, studied and understood to identify their pros and cons relative to our application and the best ways to apply them. The aim of this specific work group, led by FBK researchers, was to identify these technologies and develop an interconnected and reliable, even at long distances, sensor network. Certain difficulties did emerge: the geological conformation of the territory made communications on the telephone network difficult. Due to the distances, tests and simulations had to be reproduced in a context more suitable to us, which is the class environment where we found ourselves operating.

We were joined by the group of Tione's "Guetti" High School, in order to carry on a number of parallel

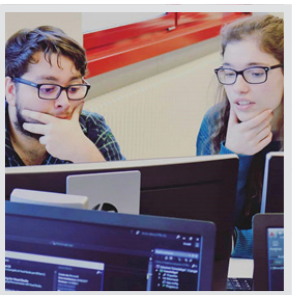
IoT (Internet of Things) is a neologism related to the extension of the Internet to the world of concrete objects and places. Through embedded chips and sensors, objects are able to interact with each other and with the surrounding environment.

activities, the first of which was to conduct test sessions on various antennas, with the aim of understanding which solution would best meet our needs. After some testing and validation operations, an antenna was installed on “Marconi” High School to offer a sensor communication network in Vallagarina.

The next step was to develop the devices that would become the **sensor nodes**, program them to collect the data and set up a control station to sort, store, and display them in meaningful ways. With this aim, various meetings with FBK researchers were organized. We explored new powerful **software** and communication development technologies - with somewhat “obscure” names, such as: AngularJS, NodeJS and LoRa.



The architecture of the project involves the use of a sensor module capable of communicating on the network, reception antennas and special **servers** for data collection and their presentation on screen.



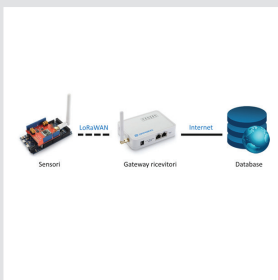
In order to read and send data in the sensor module, we adopted the “Arduino Uno”

Sensor nodes Connected devices capable of detecting information from the surrounding environment (such as, for example, temperature, humidity, brightness level, etc.) and making them available in a digital format.

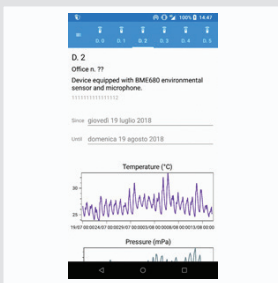
Software In computer science it constitutes the set of programs that manage and specialize the functioning of a computer (the operating system and the set of programs that allow the computer to carry out its basic functions).

Server In computer science, high-performance computers that in a network provide a service to other connected computers, called client computers.

circuit board, which is practical, low-cost, and completely adaptable to our needs. Combined with an external module equipped with an antenna, it allows us to transmit information over distances of several kilometers on a network called **LoRaWAN** (Long Range Wide Area Network) to the receivers.



From this point on, all communications are managed via the Internet. It is necessary to report the environmental data through specific **user interfaces**, in order to make them easily understandable and to allow the operator to make decisions quickly and effectively, being able to perform both historical data analysis (historical graphs) and real time (alarm generation) data analysis. Please see an example of this interface, a simple application (interface created with Xamarin, Forms) in the picture to the right.



To conduct the tests at school, our colleagues of class III BM (mechatronics) designed and constructed using a 3D printer some containers that allowed us to handle the electronics module safely. The shape and the openings of the containers were also designed to ensure the flow of air on the gas sensor.

LoRaWAN Wireless communication protocol belonging to the family of low-power-wide-area-network communication technologies, i.e. communication technologies designed to minimize the energy consumption of connected devices and able to ensure a very wide range of communication coverage.

User interfaces Visual part of the IT application or operating system through which a user interacts with a computer or software. It determines how commands are given to the computer or program (keyboard, touch screen, etc.) and how the information is displayed on the screen.

FOCUS

The Design Process throughout the Project

Within the theme given for the study of a new integrated system of sensors for air monitoring in SAT mountain lodges, the lecture by the Association for Industrial Design (ADI) was intended to stress the value of design but above all the importance of its process, in order to dispel that common thought that design comes in at the end of the process to give the object a "beautiful line, a beautiful shape".

On the contrary, the design process starts right away, even before the project takes shape, and is based on a design process that we tried to explain to the students by simplifying and summarizing in **8 keywords**, creating a sort of path made of essential steps to be respected in order to achieve a good final result.

Beginning with a careful reading of the brief, the document that contains the instructions which outline the required features in detail, the survey with which we search and analyze what already exists on the market started with the intention of updating it and improving it according to the new needs.

It is said that **product design** should be based on the desire to satisfy the needs of the user, therefore knowing his/her lifestyles and behaviors becomes an absolutely indispensable observation operation.

When entering the real planning phase, where the product begins to take shape, it is very important to be critical of oneself and not to be constrained by the first idea; sometimes the **length of the project, of the industrialization and of the production** can become very long but most of the times, where we give space to research, we can come up with truly innovative results also in relation to very common objects. Not sure what these words are trying to say.

The example taken as a reference, i.e. the "Piuma" chair, designed by Piero Lissoni for Kartell, confirmed this concept and introduced the theme of **technologies**, which in recent years have increased exponentially and have paved the way to imagination and to the possibility of realizing much more complex forms and projects.

The continuing curiosity and attention to production methods and processing also brought us closer to **new materials**, that even if unusual in furniture design, if reinterpreted and adapted in a creative perspective, make previously unthinkable solutions possible.

Moreover, if applicable to the project, the team should imagine several versions of the same object right from the start to come up with a complete collection configuration that, from the company point of view, should have greater market penetration strength.

The last stage, equally important for the design process, is **communication**: identifying the right method, channel and language with which to communicate the product.

Sebastiano Tonelli
ADI –Association for Industrial Design

Michela Baldessari
Designer, CEO of the ADI VTAA delegation

So the sensor we obtained from the work of the Buonarroti High School chemistry groups, with the electronics developed by FBK and the transmission module developed by the students of the Marconi High School for computer science, has become the detector!

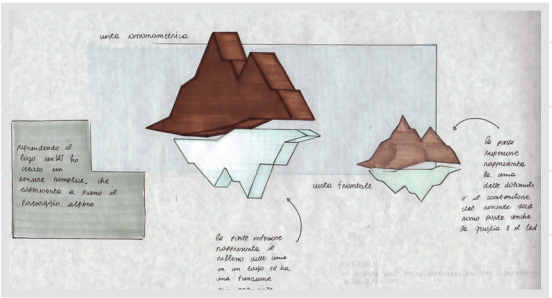
1.7 ***What do you bring to the mountain lodges: a circuit board? Is there a risk that the various components exposed can be damaged if they come into contact with foreign elements or accidentally with guests in the environment? On this point, we hear Mattia Anderle, representing the classes of the "A. Vittoria" High School in Trento.***

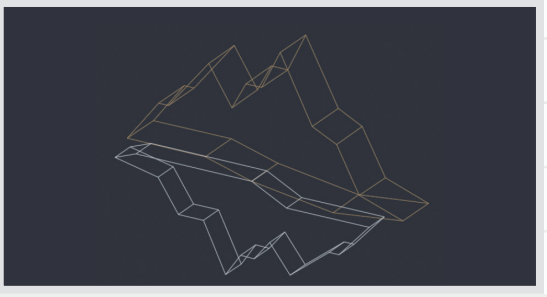
The detector developed in this project is in fact a potential product and, as with all products, the marketing strategy also relies on the design of a **package** having many functions: to facilitate transportation, installation and use of the product; to protect the circuitry from outside influence and the user from accidentally touching the components and live circuitry and to present an attractive appearance to the customer. These are the challenges of packaging design, a key element that will help to convince the customer to buy the product. With the aim of finding the most convincing solution, each class group was asked to develop a packaging model that would meet all of the requirements defined above. From the functional point of view, we set ourselves the goal of developing a package that can be managed intuitively in case of maintenance and, above all, in case of

Product design where the term "product" extends to very large categories of objects and services. The fundamental characteristic of product design is the originality and innovation with which these objects are designed by putting together aesthetic beauty with the highest level of functionality, in order to meet market needs as much as possible.

Package In the marketing language, constitutes the enclosure wrapping or housing of the product. It is a key element for the differentiation and personalization of the product itself, as it helps it stand out among the others by capturing the customer's attention.

danger. All the items proposed made use of fast prototyping methods, which allowed us to have an instant feedback on our design and to shorten completion times. Our work was divided into the following three steps:





1. ***Analysis aimed at the definition of the brief.*** Carried out by a small group (two-three students), this phase was dedicated to the collection of starting data and to the development of interdisciplinary knowledge regarding the project's requirements. In addition to the contents learned in seminar meetings with experts, we carried out web searches about similar products already on the market and about the morphological characteristics of the area, as well as the flora and fauna of the mountain environment.
2. ***Conceptualization.*** The first design ideas, start taking shape with freehand sketches. Each of us, starting from the brief project, worked on at least three different proposals with graphic sketches and annotations.

Brief Summary document containing information and guidelines for the processing of a project.

3. ***Executive development of the project.*** Each of us has chosen and developed, with executive drawings and three-dimensional models, the concept that best meets the requirements of the product. In this phase, the initial proposals were developed and defined in detail, using paper models and virtual models.

The most convincing proposals were chosen and improved through reviews and discussions with the design and laboratory teachers, as well as during the seminar with the designer consultant, **ADI** of Triveneto contact person. The seminar and the specific courses held by FBK researchers on the innovative techniques for 3D scanning, digital model processing and **PLA** 3D printing proved very useful.

The project was presented with the aid of digital graphic design. In the first design drawing, the sensor is represented by the initial sketches of the executive project with different projective methods (orthogonal projections and section drawings, axonometric projections and perspective drawings); in the second one, the images of the corresponding 3D physical or virtual models were included, the interior of one of the recently refurbished mountain lodges as well as the brief describ-

ADI Association for Industrial Design. Created in 1956, it brings together designers, companies, researchers, teachers, critics, journalists which discuss about the themes of design: project, consumption, recycling, training. It is the protagonist of the development of industrial design as a cultural and economic phenomenon.

PLA Polylactic Acid (PLA) is a biodegradable plastic made of renewable natural and therefore environment-friendly resources. It is a simple printing material, suitable for any type of 3D printer.

ing the technical aspects of the project.

For the choice of the representative model of the project, all the proposals were assessed on two levels: contact and editing groups, composed of students, on the one hand, and a joint SAT-ADI committee on the other hand. Both evaluations saw the presence in the final trio of the REFLEX project, which was thus selected as the SenSAT reference design.

It should be emphasized that this choice resulted, although independently, in the selection of the SenSAT project logo. This work, also conducted by our class, took place in the early phase of the project and followed a logical progression that would allow to connect needs to characterize the SenSAT project, its aim (sensor for detecting air quality) and its context of use (mountain lodges). With a methodology similar to the one described for the design process, various proposals were presented to and voted by the contact and editorial team. SAT voted separately. Both committees selected the same proposal.

1.8 ***At this point we are ready to go to the lodges with our detectors and we can then install them, power them and start data acquisition 24 hours a day. is that right? Matteo Amorth (on behalf of the "M. Buonarroti - A. Pozzo" High School for Technology, Electronics Section in Trento, explained:***

Unfortunately, we cannot do this. We can go to the mountain lodges, install the detectors, put them into operation, but we cannot let them operate continuously without being present. The fact is that every product/instrument/system that goes on the market must be certified as "safe" in terms of use, as described in the user's manual. Our detector has not been certified. To be sure that it

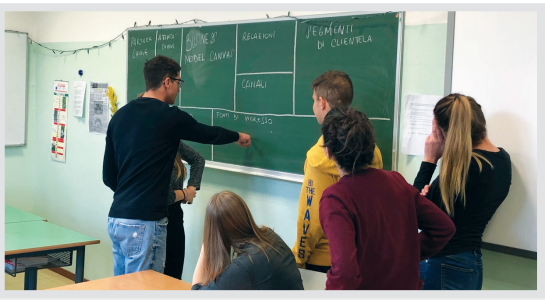
cannot create problems for the hosting structure (it must be considered that the mountain lodges sometimes are not supervised) we need to obtain the certification. So, we took care of studying certification types and procedures in general to understand what our next steps should be. It must be said that our detector is composed of certified components that we bought on the market, but the sensor we have made in the project is not. This entails the automatic non-certification of the resulting detector built as part of the project (actually, even an assembled board with certified components is not enough for the certification of the board itself, since this should be certified by the dedicated certification entities recognized by the Italian national authority called **ACCREDIA**). Back to our sensor, it falls into the category of electrical components and, therefore, the reference becomes the certification procedure for electrical components. This certification is issued by a body that provides EN 45011 or EN ISO/IEC 17020 certification, based on tests performed by an EA (European cooperation for Accreditation) accredited laboratory. The above entity is responsible for issuing a certificate of conformity for the tested component. It is important to remember that the device must be installed by a company registered with the Chamber of Commerce under the electrical system installers category. The company must release the “certificate of conformity” relating to the part of the electrical system involved. The certificate of conformity must certify that the work has been performed in compliance with the standards for the industry concerned. It will also have

ACCREDIA single accreditation body designated by the Italian government to certify the competence, independence and impartiality of the bodies and of laboratories that verify the conformity of goods and services to standards.

to include the list of components used, stating that they are CE certified. The length of our project did not allow for the certification to be issued, so in passing the baton to those who will participate in the next projects, we also trust that this action will be completed.

1.9 *Design, product, customer: all terms that open up to a market scenario. But a business plan is necessar, isn't it? We let Carlotta Rossetti (who gives voice to the class of "A. Tambosi " High School in Trento) answer to this question.*

In fact, the idea that the result of the project can go on the market led the class to set up a work on the business plan for this possible activity. A great help for the realization of the business plan was the exercise conducted with the **business model canvas**, a tool that allowed us to visually represent the business plan, which follows a very precise logic; it was new for us. As a first aspect, the value offered by the SenSAT product and its distinctive elements was compared to other sensors on the market. We then moved on to identifying the customers that could potentially be interested in our sensor and how to reach and maintain the chosen segment. A further step allowed us to determine the channels through which it would be possible to expand the clients. The last aspects analyzed in order to create an



Business Model Canvas Strategic tool for Business Design that uses visual language to create and develop innovative, high-value business models. It allows to visually represent the way a company creates, and distributes and captures value for its customers.

optimal canvas model concerned key contacts and resources and the analysis of fixed and variable costs incurred. After analyzing the business idea behind SenSAT and its feasibility, we focused on the part of the business plan that defines the business plan for the manufacturing of the product. In particular we carefully analyzed, first on a theoretical level and then concretely referring to this specific project – a business's break-even point, i.e. the point where total revenue equals total costs. We in fact analyzed the relationship between structure costs, variable costs and the volume of production and we defined a hypothesis of product sales price (in the absence of a cognitive investigation of the potential expectations of customers) including the profit margin. We then also defined a marketing strategy trying to define quantitative (turnover, revenue margin, etc.) and qualitative (product image) goals. Our work group examined not only the business part of the project, but also of the legal part, with particular reference to the patent process, the protection of the manufactured product and the brand.

Let's check your progress. You told us about the application of a school-to-work teaching model that implements an innovation cycle exercise by involving 7 schools that, having engaged in a team effort where each school contributes their special professional competencies, simulate a company that, having identified a market sector to enter, fields actions in order to reach the market with a product. This product is not only new, but also innovative thanks to the use of nanotechnologies and has also captivating design, therefore it has elements that qualify it as a competitive and winning proposal compared to competitors.

1.10 ***At this point, let me ask you "What if you really started an entrepreneurial project? Have you thought about it at some point?" Samuel Slomp replies for the class (chemistry specialization) at the "M. Buonarroti - A. Pozzo" High School in Trento, that became also engaged in this issue.***

Yes, we thought about it. As a matter of fact, our class accepted the proposal of the Trentino Federation of Cooperation and started the process to establish a **School Training Cooperative (CFS)** . The first thing we agreed on was the social purpose of the cooperative: dealing with the synthesis of semiconductor oxides sensitive to airborne gases and develop partnerships with research institutes for the development of gas detector sensors, collaborating with students of other classes and other schools. It took several meetings to learn how to make the new cooperative work, that covered the social aspects (principles of cooperation, legal and procedural aspects, appointments to social offices, financial aspects and budget planning).

Of course, the support provided by Fondazione Bruno Kessler, a partner research institution in this project, from which the theoretical information and operational indications for the focus of the business idea and experimentation with the production of sensors derived, was critical.

To bring the CFS into operation outside the school, a collaboration was also established with Trento-based cooperative Ecoopera, which has been active in the green industry for some time with a specific focus on the monitoring of air pollutants.

School Educational Cooperative (CFS) Instrument envisaged by the protocol signed on 8/4/2016 between the Autonomous Province of Trento and the Trentino Federation of Cooperation which aims at the "promotion of the school-work alternation in the three-year period of all the second school secondary school curricula degree and vocational education and training ".

A guided tour of Ecoopera allowed the students to learn a piece of the history of this cooperative with the possibility of getting useful information on the development of the “Chemical Technology Cooperative” CFS.

It was interesting to notice that Ecoopera stemmed from a situation similar to the one that could be our situation: people from different backgrounds and experiences who wish to open new roads, particularly in the field of environment monitoring.

In the summer of 2018, as president of the CFS, I completed an internship at Ecoopolis and at the beginning of the new school year, we planned to summarize the experiences of all the other participating classes.

FOCUS

My Experience with the Groups of Students

In the plenary meeting at the beginning of the project, I was struck by the interest that the subjects we presented (some particularly difficult even for specialized audiences, such as occupational safety, intellectual property and the organizational structure of collective enterprises) had aroused in the students, and by the attention they had paid throughout the presentation.

On two subsequent occasions - January 31 and May 14, 2018 - I met a small group of students and teachers from the Tambosi High School for Business of Trento and the positive impression I had from the presentation of the project was confirmed. In a well-organized structure, equipped with all the tools necessary for a computer presentation, I was able to discuss with fifteen students and two teachers the topics that I had only mentioned at the time of the presentation of the project: intellectual property and the organizational forms of collective enterprises. I picked the verb "to discuss" not by chance: it was not a lecture, in which I talked to a group of distracted students about the general principles of the subject, but a round table dicussion, coordinated by me, during which each of the students - all of whom were very knowledgeable in thebasic legal aspects - contributed to the discussion with observations that were sometimes relevant, sometimes not that relevant, but in any case always in a proactive manner and with original and never trivial ideas.

At the end of this journey, which - I am sure of it - has enriched me much more than it enriched the kids I met, I still have a feeling of gratitude and affection for all the people who shared it with me.

Paolo Oliva
CNF - National Bar Council

What fascinated and impressed me was the educational and teaching character of the FBK program: students can see their expectations and their ideas realized, step by step, working and collaborating first-hand, learning to coordinate between them to succeed in the shared purpose.

There is no lack of creativity and fun, probably among the most useful ingredients to make the students protagonists and creators of the skills and knowledge proposed to them. It was an experience rich in content and ideas, even for us lawyers involved in the journey of FBK because, as Massimo Recalcati explains in L'ora di lezione, "Etymologically" 'teaching' "means leaving a mark, an imprint in others; and 'to educate' comes from latin e-ducere, i.e. to drive out of the previous condition […]". And this process is certainly two-directional.

Serena Lazzaro
CNF - National Bar Council

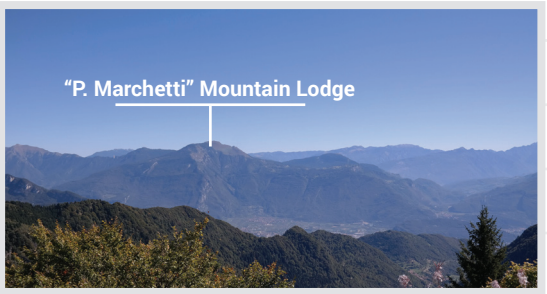
2. The End (A New Beginning)

by Pierluigi Bellutti and Claudia Dolci

At this point, there is no acid proof, i.e. the operation of the sensors at the mountain lodges and the data transmission test.

The final stage of the project was divided into two phases: the final experimentation and the public informative event.

2.1 Final Test



On September 28, 2018 two separate working groups went to the two mountain lodges that had been chosen to test the proposed prototype solution. Each group included FBK researchers, school tutors and students. The classes of the Guetti High School in Tione reached the mountain lodge called "N. Pernici alla Bocca di Trat" and some classes of the Buonarroti High School in Trento and Marconi High School in Rovereto went up to the "P. Marchetti" mountain lodge on Mount Stivo. The testing was limited to two mountain lodges due to the logistical difficulties of having kids cover the technical aspects on additional points. The selected mountain lodges had the characteristic of being visible to each other (the respective views are shown in the

photos above) paying homage to the incredible view of the Alto Garda area during a beautiful day. From Mount Stivo, an outstanding overlook, in addition to seeing the major Dolomite peaks, we could also catch a sight of the Apennines!

The condition of mutual visibility was necessary to make sure that the LoraWan system was operating correctly. It should be noted that, with this technique, the FBK researchers had tested transmission distances up to 7 km, while on the occasion of this test the distance covered by the signal reached 13 km, allowing our research to obtain a very interesting result.

At the “Pernici” mountain lodge, the system was set up in the area facing the structure, while on Mount Stivo we picked the top of the mountain, in an attempt to verify the transmission of data also towards the valley floor on the opposite side with respect to the Pernici, in particular transmission toward the Marconi High School in Rovereto. Supported by mobile phones to agree on actions, data transmission tests began between the two mountain lodges, alternating reception and transmission phases. The tests carried out exceeded the expectations; in fact, the exchange of data packets between the two mountain lodges was recorded without problems and, unexpectedly, it was possible to send data from Mount Stivo to the FBK main offices in Trento, that are at a distance of 22 km! Thus, a distance record was established for the LoRaWan system among all the tests performed so

far as part of the research activities of FBK. With this good result, the SenSAT project ends and we return to the valley.

This context elicits a reflection on a specific aspect of the project, i.e. teamwork, an element that helps to overcome the barriers of the "particular, singular situation" highlighting the value of collaboration as a factor enabling the completion of complex projects. The mountain is in fact the home of "rope team", where solidarity creates a bond, an environment that helps to experience a suitable training to work, explore, live beyond easy categorizations and trivializations. A new environment for many participants, representing the new generations of the Trentino Region. The hope is that all this, or a good part of it, will remain in the participants.

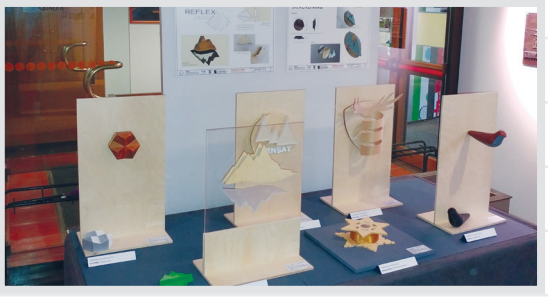
2.2 Project Closeout

On Thursday, December 6, 2018, at the Auditorium Santa Chiara in Trento, more than 400 students gathered for the final event of the SenSAT and "Città degli Elettroni" projects and also for the launch of the new "cheAria" project.

For the SenSAT project, the spokespersons of the High Schools that took part in the project climbed onto the Auditorium stage and talked about their specific contributions.

The foyer of the Auditorium hosted the exhibi-

tion of the models proposed by the students of the Vittoria High School in Trento for the final detector model. Attendees included representatives from The “Dipartimento Istruzione e Cultura” of the Autonomous Province of Trento, the CARITRO Foundation, and both the principals and teachers of the 10 High Schools involved. The event included the description of the integrated DomoSens School-to-Work model proposed by FBK and was highlighted by the presentation of the first issue of the “School notebooks” series, a copy of which was given to principals and to the SenSAT contact and editorial teams.



2.3 The SenSAT Exhibition

To give greater visibility to the design experience, in agreement with SAT, we featured an exhibition of the materials produced within the project, including some design studies of sensor models, a working prototype and information videos. The exhibition “SenSAT: nuove generazioni in un Trentino che evolve” (new generations in an evolving Trentino) was inaugurated on 10 April 2019 at the SAT headquarters of central Manci Street, downtown Trento.

FOCUS

Project Management

There is an entire field of art and science called “Project Management” that provides details and methodology well beyond the scope of this project and its summary document. Fortunately, project management can be broadly understood by highlighting its simplest principles. It is also fortunate that these basic principles match well the methods that tend to arise out of the instincts of a good multi-disciplinary team on its own.

We start with the foundation that there is an idea to create a product or service to solve or alleviate an identified problem. The first step is to recognize the group of “stakeholders”, a term which includes the people who are impacted at a high level by the project. These are the “investors”: representatives of the teaching community, FBK management, a regional political representative, and, initially or later, possible funding sources. This group can be called the “Program Team” or “Executive Team”, and also naturally includes the main creators and evangelists of the idea. One of these evangelists will assume the role of “Program Manager”, whose job it is to instill enthusiasm within the Executive Team, and later, to make sure nothing is missed in the functional specification, and still later, to ensure that all the pieces of the project fit together. Pierluigi Bellutti is our de facto “Program Manager”. You can see how the “executive team” activities were played out in our case in the Editorial, Introduction, and in the Prolog of this document. Whenever a program manager brings a proposal to a group of stakeholders, he has at least a skeleton of a business plan in his pocket: what are we proposing to do, what problem are we trying to solve, what will the product look like, what it is the targeted cost and selling price, how long will it take, who will buy it, and what benefits do we receive by expending the money and effort (usually financial, but in our case there is the underlying benefit to enhance student education and professional development of teachers).

Once the buy-in of the executive team has been secured, it is time to put together an initial “multi-disciplinary project team” (MDPT). The MDPT make-up can be modified over the course of time, according to the needs of the project. The team should include people who represent the functions of marketing (including lodge managers), sales, electomechanical engineering, sensor design, software, packaging design (including ergonomics and aesthetics), field testing, service, regulations and safety, legal, and others, depending on the project requirements and where the project is in time. In practice, several of the engineering functions can be in turn represented by a single “engineering project manager”. This group produces a document often called “functional specifications”, or the “brief”. The Functional Specifications document is not an engineering document, but rather a specification defining what the product must do, what it must look like, how it is to be operated, what its price range must be, etc. These might also be called “external specifications”, meaning how the product is viewed and used by customers. It is also the function of the MDPT to develop a business plan that matures as the project matures. From these specifications, the engineering project team (EPT) produces its own set of engineering plans and specifications under the leadership of the engineering project manager.

The MDPT may produce a block diagram that ensures that all the functions are recognized and shows how they interact together. This often leads to the recognition that project “phases” can be created, meaning that all issues do not have to be dealt with at the same time. For example, an engineering “alpha” prototype is often built in an inexpensive way for speed and ease of testing and modification, and may not have the aesthetic or safety features required for the beta units. The beta units, in turn, may not have the certifications required for the final product. Once project phases have been

recognized and established, the issues of time (timeline) and budget for each of the phases emerges. It is not only engineering effort that can be partitioned into phases, but during each phase, the marketing activities can produce more information and better estimates. In this way, a compete project plan is built.

There are many tools that can be used to create detailed project plans. Using the tools, one can create a list of project "milestones" that can trigger activities such as component purchasing, or final housing design, such that all the pieces come together at the right time. All of this allows the project to be broken down into phases.

In parallel, we can also put more flesh on our business plan skeleton, as we presumably have obtained more detail and better estimates.

At the end of each phase, the project should be reevaluated: the executive team should hear a report, be able to evaluate a more detailed business plan, and decide if the project is continued as is, changed, or cancelled. If the project is continued at the end of a phase, we say that it has passed through a "Gate" and we can enter the next phase. Thus, the process is named a "Phase-Gate" process, or a "Stage-Gate" process.

Nicholas C. Barbi
CEO nSynergies, Inc

3. Photo Calendar

7 SEP 2017

Teachers and FBK tutors meet | at FBK

24 OCT 2017

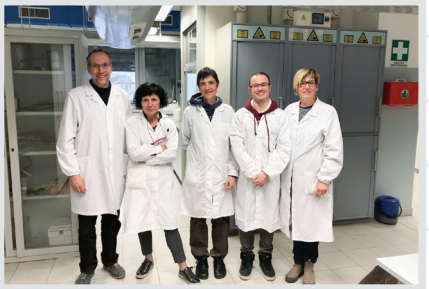
Kickoff meeting | at “M. Buonarroti - A. Pozzo“ High School

12 DEC 2017

Meeting of editorial and contact groups | at FBK

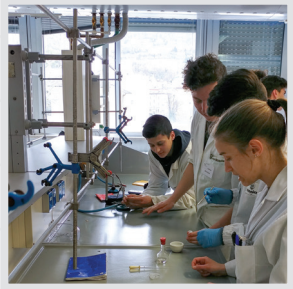
9 JAN 2018

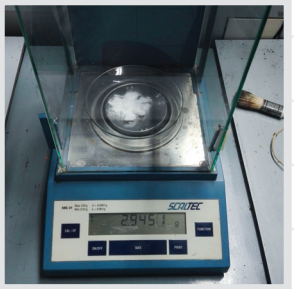
Meeting with chemistry professors | at “M. Buonarroti - A. Pozzo“ High School



16 JAN 2018

Preparation of the sensitive material | at “M. Buonarroti - A. Pozzo“ High School





29 JAN 2018

General meeting | at “M. Buonarroti - A. Pozzo“ High School

31 JAN 2018

The National Forensic Council meets the students | at the “A. Tambosi“ High School

7 FEB 2018

Students meet the 3DOM unit | at “A. Vittoria” High School

8 FEB 2018

3DOM meets the students | at the “A. Vittoria” High School

19 FEB 2018

Editorial and contact groups meet | at FBK

1 MAR 2018

Evaluation of logo proposals | at “M. Buonarroti - A. Pozzo“ High School

1 MAR 2018

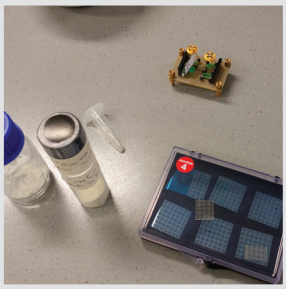
Project Status General meeting | at “M. Buonarroti - A. Pozzo“ High School

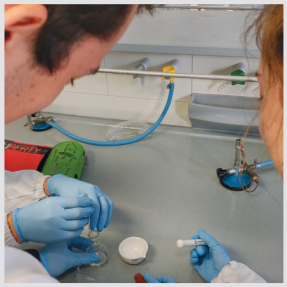
26 MAR 2018

Lecture by designer Michela Baldessari | at “A. Vittoria” High School

10 APR 2018

Preparation of the sensitive material with dr. Gaiardo | at “M. Buonarroti - A. Pozzo” High School



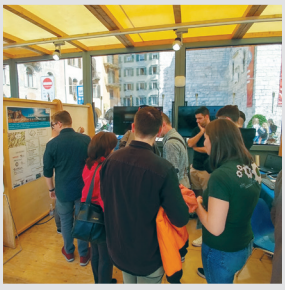


12 APR 2018

Smart City Week | Trento, piazza Duomo

14 APR 2018

Smart City Week | Trento, piazza Duomo



2 MAY 2018

FBK meets the students | at the “L. Guetti“ High School

14 MAY 2018

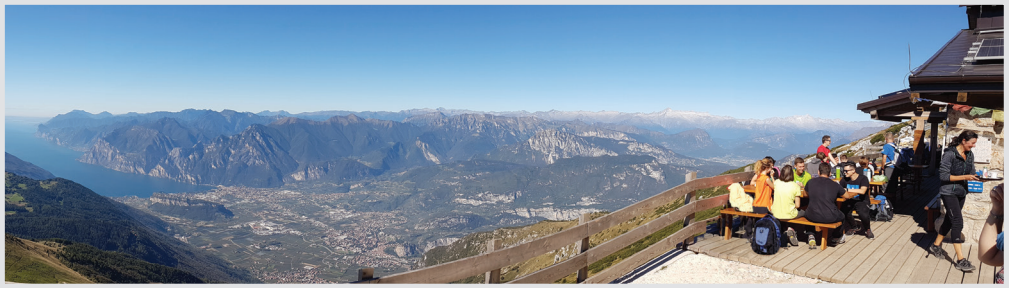
The National Forensic Council meets the students | at the “A. Tambosi“ High School

28 SEP 2018

Sensors testing at the “Nino Pernici“ mountain lodge | at “Bocca di Trat”

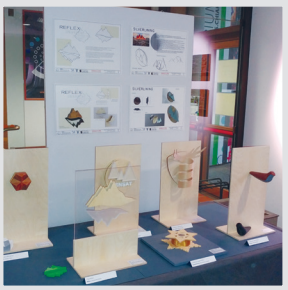
28 SEP 2018

Sensors testing at the “Prospero Marchetti” mountain lodge | Mount Stivo



6 DEC 2018

Final event | at the “S. Chiara” Auditorium



FOCUS

The SenSAT Project: A Step into the Future

Our young people are our passion, our strength, our future and it is with this in mind, with this theme and program horizon that I have drawn up the program of my three-year presidency after my appointment.

Precisely for this reason, one of the first acts of my presidency was to confer the capacity of advisory board to a working group that had been formed during 2017-2018, which already worked on relations with the schools of Trentino at all levels.

This considerable commitment, not only made by me, but also by my predecessor Claudio Bassetti, was put into practice through an agreement that SAT stipulated with IPRASE and which concerns both the participation of SAT in School-To-Work projects, and training for elementary, middle school and high school teachers and students, with the aim of tackling mountain-related topics in a cultural and scientific context.

The SenSAT project represented the flagship in a context of School-To-Work projects in which SAT participated in the 2017-2019 three-year period. The technical and scientific value of the experimentation method adopted was very high, as it included the collaboration with FBK, a world-class research organization, and the participation of multiple Trentino-area high schools.

The SenSAT program comprised partnerships among seven high schools (for a total of 200 students) as well as organizations including the National Forensic Council, ADI (Association for Industrial Design), University of Ferrara Department of Physics, Federation of Trentino Cooperation , and, as a result, provided a total experience that was very precious to all involved.

This was a significant growth opportunity for SAT. The most sincere wish that I can make, together with the entire Council, to the School and Training Committee and the Mountain Lodges Committee that have actively participated in all the project phases, is that SenSAT may soon become a start-up. The usefulness of this innovative sensor for controlling air quality in mountain lodges (but not only mountain lodges) that collects data “remotely” is indisputable and the possible applications are multiple.

When we see SenSAT and its evolutions in production, we will know that SAT, in addition to the spread of mountain culture, the management of mountain lodges and trails, the publication of mountain guides and books and the support to solidarity projects, together with their partners, has fulfilled a new mission: namely, to combine new technologies with new generations in the environmental monitoring of our mountains, hopefully with impact in terms of jobs for Trentino students. Then we will be able to say that not only our young adults, but also SAT, have firmly put a foot into the future.

Anna Facchini
SAT President

4. Final Considerations

by Pierluigi Bellutti and Claudia Dolci

This is the end of the fourth Notebook in the "Quaderni di scuola" series created by FBK for high schools. Compared to the first pilot project, SenSAT has had an increase in the number of activities and participating classes: we can say that we wanted to do a **stress test** right away to see if the structure held up.

And the structure did hold up. The project picked up enthusiastic comments from those who participated, relevant technological issues were addressed, elements of economic and local impact were introduced, a structure to get to the market was hypothesized, and all this was done in one school year or little more. The stress test also worked well; in fact, critical issues, which had already been seen in DomoSens, emerged even more clearly. The analysis of these critical issues will be the object of further study and discussion with the school tutors who have been involved in these experiences. We are still convinced that the model, in its characteristic articulation, is an element of novelty and is proactive in terms of solutions for an education system that must deal with a world that changes at a very fast pace. Thus, we would like to close by recalling the peculiar elements of the "DomoSens School-Work" educational model created by FBK.

Stress test Functional verification of a component/system, under extreme operating conditions with respect to usual operations, to ascertain the quality as well as identifying weaknesses highlighted by the special operating conditions adopted in the test.

The model provides for the subdivision of the project into workpackages and tasks, assigning to each participating class a job that falls within the school's main focus. This allows, through the involvement of expert tutors, to come into contact with new elements. School tutors can, thus, use them as continuing education, and class(es) groups, guided by the reference teacher, can enrich their education with references to the state of the art. In order for this to be best achieved, at least three relevant elements must be observed:

- the school tutor must play an active role in the project and not act as a mere activity and formal documentation supervisor. Therefore, it is important that their specialization is consistent with the type of activity assigned to the group;
- the work group must coincide with a class (although project constraints may dictate that only a subset of the entire class is able to participate) in order to allow school tutors to integrate the project activity into their institutional curriculum. In this way, it will be possible to make the most of the time dedicated to the project without significantly interfering with the curriculum. Such integration requires taking charge of the tasks, workpackages and relevant procedures well in advance of the project start date for appropriate planning and implementation;
- the time devoted to carrying out the activity must be at least one school year. This allows program commitments to be distributed in time, to find the best way to integrate the new concepts into the teaching action.

So, the definition "integrated School-To-Work model" can be explained with this overarching work statement: we aim to build relationships where academic and business worlds support the school system and find the ways to bring to it up-to-date knowledge.

There is more to this model than just technical knowledge since we also aim to work on soft skills; in fact, the value of the overall activity is ensured by the interaction among different classes, with different specific areas of knowledge. Classes and knowledge make up a ring and the plurality of these rings makes up the value chain of what we want to bring to the market. Sharing the common final goal means experiencing the customer-supplier relationship, which comprises product and service quality, meeting delivery dates and in fac all of the customer's expectations, and properly recognizing and dealing with liability issues. This requires working as a team, and teamwork leads to discovering and training soft skills as well as technology and engineering. And so, the motto proposed for this project, i.e. "The new generations in an evolving Trentino Region", is designed to emphasize the possible contact of young people with the Trentino mountain tradition through the introduction of new technologies. The motto further embraces a school system that in this type of project, can find ideas to develop viable ways to connect knowledge with a world in rapid and constant change.

See you at the next "Quaderno di scuola"!

Biographies

Pierluigi Bellutti graduated in Physical-Chemistry in 1984, from Padova University. After his military service, he began a long and rewarding career in semiconductor research and technology. At the end the 1990's, he was appointed manager of the microelectronics laboratories at FBK, a role in which he both contributes to R&D activities and leads the technology team to manufacture the sensors inspired by the internal research. The laboratory, under his direction, serves national and international companies, research institutions, and space agencies, producing devices for industrial automation and control, large physics experiments (at CERN, for example) and space exploration. Although the goals of these individual customers vary broadly, they share a common need for devices tailored to their specific application and a common appreciation that such a device can be realized through FBK's expertise and state-of-the-art facilities. Over the years, Pierluigi has also gained experience in the area of Technology Transfer by leading teams to replicate the FBK-developed technology to produce a given device in the customer's own facility. This broad experience has made clear to him that innovation is not exclusively a process linking research and business only, but ideally should include the high schools where the process of preparing tomorrow's innovators starts. This realization has motivated him to help develop a process to promote and guide the development of a process in which students, their teachers, and research and industry professionals form multidisciplinary teams to create something of real value from ideas, i.e., to innovate.

Claudia Dolci got a Bachelor and Master in Forestry Science at University of Padova (Italy) in 1998, and a Qualification for the Independent Profession of Forester in 1999. From 1999 to 2001 she attended a Joint Master program at the International Institute for Geo-Information Science and Earth Observation of Wageningen University (the Netherlands, Master thesis: “Using a digital elevation model as geo-data source for forestry policy”). Then, she moved to ETH Zurich (Switzerland), where she worked as GIS expert consultant from 2001 to 2008 (GIS consulting, hands-on learning sessions support, supervision of Master and Bachelor dissertations and of semester projects). Meanwhile, she gained a PhD in Geodesy Photogrammetry at ETH Zurich (2004-2008, Ph.D Dissertation “GIS Modelling and Visualisation of Dynamic Processes in Traffic Nets”). In 2009 Claudia started working at the Bruno Kessler Foundation (FBK) in the Research Unit Predictive Models for Biomedicine and Environment (MPBA) as Project Manager & GeoICT Expert. At MPBA she was responsible for coordinating the design and development of many WebGIS and statistical data platforms. Among her major assignments, she coordinated and managed the development of IET (Interface to Economic and Territorial data), the WebGIS ClimAtlas for Climate Observation, the CancerAtlas Trentino and the MITRIS project for the Autonomous Province of Trento (PAT). Areas of expertise included projects management and technical integration of geoICT data and analysis services for health problems related to the environment. Since 2009 she has co-directed the

WebValley Data Science Summer School (https://webvalley.fbk.eu/). Since June 2017 she has been leading the RIS Unit (Research and Innovation for School), which accomplishes FBK commitment to collaborate with schools, with the aim of strengthening research contribution to the training and guidance of younger generations. Each year more than 500 students are involved in networking projects among local institutions, including individual traineeships, annual projects based on DomoSens model and camps (more infos on fbkjunior.fbk.eu).

Acknowledgements

We would first like to thank the students who participated, the teachers and principals of the high schools involved.

A special thanks goes also to all those who contributed to the completion of the SenSAT project, supporting the planning and acting as external expert tutors. In particular:

- **SAT**, with Claudio Bassetti, Renzo Franceschini, Giorgio Tamanini, Elena Baiguera Beltrami and Maria Carla Failo;
- **National Forensic Council**, with lawyers Francesco Logrieco (CNF vice-president) and Carla Broccardo (national councilor for the district of Trento and vice-president of the Italian Bar Foundation), Tullio Bertolino (lawyer, Bar Association of Trani), Nicola Cirillo (lawyer, Bar Association of Rome), Domenico Facchini (lawyer, Bar Association of Trani), Serena Lazzaro (lawyer, Bar Association of Siracusa) and Paolo Oliva (lawyer, Bar Association of Pisa);
- I**ndustrial Design Association** with designers Michela Baldessari, Valerio Facchin and Sebastiano Tonelli;
- **Consorzio Lavoro Ambiente,** with Leonardo Benuzzi;
- **Trentino Federation for Cooperation** with Carolina Tomio;
- **Caritro Foundation** for the contribution assigned to the project as part of the 2016 call for proposals "Qualified training and work programs for young people";
- **Authors of the Focuses**: Nicholas C. Barbi, Claudio Bassetti, Carla Broccardo, Nicola Cirillo, Paolo Costa, Sebastiano Tonelli, Michela Baldessari, Serena Lazzaro, Paolo Oliva, Anna Facchini
- FBK researcher Alessandra Potrich and intern Giulia Zini (RIS - Ricerca e Innovazione per la Scuola), for their work and dedication, the accuracy of their contributions and comments, in particular for activity report and photo calendar (see Chapter 3);
- finally, FBK colleagues, with Andrea Gaiardo, Evgeny Demenev and Luca Herzog (Micro Nano Facility); Raffaele Giaffreda, Andrea Maestrini and Paolo Spada (OpenIoT); Gabriele Zacco (Service Oriented Applications); Kazhamiakin Raman (Smart Community Lab), Fabio Remondino (3D Optical Metrology); Rachele Villani (RIS - Ricerca e Innovazione per la Scuola), Annalisa Armani, Alessandro Girardi, Viviana Lupi, Moira Osti and Giancarlo Sciascia (Digital Communication and Big Events).

TRENTINO

ISBN 978-88-98989-58-4