Simulating tomorrow's future today: Forty years of EnginSoft and counting

by Stefano Odorizzi
EnginSoft

If I had to say in a nutshell why the numerical approach to the physical continuum in the various domains has the quite clear centrality and impact in engineering applications that it does, I would have to nominate the extreme simplification and incomparable amplification of the practical application possibilities resulting from turning a system of partial differential equations into a system of algebraic equations.

From apples and pears…

If this were true, as a young boy I would have foreseen that I would found EnginSoft, especially after I discovered the solution to a simple mathematical word problem before we were taught it at school: on Monday my mother goes to the market and buys 2kg of apples and 2kg of pears, spending 2,000 lire; on Tuesday she buys 1.5kg of apples and 1kg of pears, spending 1,200 lire; how much do apples and pears cost per kilogram?

It was exciting, especially because the mechanism (today we would say algorithm) I had found seemed to work irrespective of whether my mother bought grapes or plums as well as apples and pears – it only required more effort.

Later, when the teacher gave us more information about systems of algebraic equations and tried to stimulate us by mentioning the six hundred equations that were solved to define the wing profile of the G91, I imagined a crowd of mathematicians armed with chalk and erasers hunched over a blackboard the size of a town square.

Much later at university in the early 1970s, when I had access to CINECA's CDC 6600 – then the world's fastest supercomputer with performance of up to three megaflops – I dreamed enthusiastically of ever-expanding frontiers, although I never imagined that working with a few tens of millions of equations would become the routine that it is today.

In the beginning, and in my thesis, these ever-expanding frontiers mainly took the form of civil engineering applications, where it was relatively easy to describe structural frameworks because interaction with the computer was only possible via punched cards. It was much more complex to work formally with finite elements, which were just starting to emerge.

EnginSoft was founded in 1984 as a more structured expression of an earlier team that formed in 1975. I would like to describe this nucleus as if I were telling the beginning of a fairy tale. The starting point was work done for the two nuclear power plants at Mantua and Trino Vercellese for which we had to document the readings from numerous piezometers around the target sites with summary tables and highlight them with contour plots. The data was collected by a large number of casual workers, mostly students, and transcribed onto punched cards by an equally large number of casual workers - a process that made filtering out errors a challenge; even ensuring that the tens of thousands of punched cards did not deteriorate was a problem.

That was the beginning.

From there on, still in its embryonic stage before the establishment of EnginSoft, the initiative developed in two directions: the use of a supercomputer for finite element modelling; and the use of one of the very first fully algebraic desktop calculators, the HP9825A, purchased by the company in 1975.

Onto expanding horizons

For finite elements, the "commercial" packages available at the time were:

- NASTRAN, produced by NASA in the late 1960s.
- SAP (Structural Analysis Program), originally released in 1973 first as SAP II and then as SAP IV, produced by the Earthquake Engineering Research Centre of the University of California in Berkeley.
- STRESS and ICEM for applications closer to civil engineering.
- ANSYS, first released in 1971, but which came to Italy much later.

I mention SAP (described as "A Structural Analysis Program for Static and Dynamic Response of Linear Systems", and that later included non-linear parts in the 1974 NONSAP version) because it included the source code: there were just over 600 Fortran instructions for SAP2, just over 2500 Fortran instructions for SAP4, and just over 4000 Fortran instructions for NONSAP!

It seems incredible but even with such a minimal core it was possible to develop models of a few thousand equations from one to three dimensions in static and dynamic analyses (even seismic, both in time and frequency domains!) and with some material and geometric non-linearities.

In addition to the SAP commercial computer code, those of us in the sector who dealt with finite elements ended up producing their own codes, either using a sort of meta-language to perform recurring operations on the matrices (SMIS in our case), or using semi-analytical or semi-numerical methods (finite prisms and finite strings, e.g. PRISM) or using programs intended for specific applications e.g. LUSH, FLUSH and later PLUSH probabilistic software for seismicity in a nuclear environment – codes originally developed by Prof. J. Lysmer of Berkley and approved by the International Atomic Energy Agency (IAEA) in 1975.

These were all programs whose source code was available, and which could therefore be adapted for the application or extended with new functions and algorithms. For our own developments, coming from the school of Olgierd Zienkiewicz, we almost immediately discovered (and it was like finding Columbus's egg) iso-parametric elements based on the elementary idea of using the same shape functions to approximate the expansion of displacements within the finite element, and to map the element itself in space.

A radical simplification, coupled with the idea of using polynomial shape functions and performing the necessary integrations numerically, made it possible to reduce the construction of the resulting stiffness matrix (and thus the resulting system of equilibrium equations) to just a few Fortran instructions and a few recursive operations: this opened the door to a universe where it was easy to quickly construct one's own finite elements according to the specific application required. In those early days we used the aforementioned CDC 6600 for our calculations.

Seeds of innovation

Alexander von Humboldt was at first astonished by a letter he received from his great friend Goethe responding to his doubts. For many months, von Humboldt had been unable to form a complete and organic view of the immense amount of data he had collected measuring, observing, and cataloguing the diversity that South America's rich natural world had offered him. Goethe had suggested to him that the only way to make sense of this ocean of numbers and notes was through... poetry.

As a passionate researcher and scientist, von Homboldt found it difficult to process this valuable advice immediately, but in his great and highly motivated admiration for Goethe, he reflected deeply on its meaning. Over the past few decades, I have often wondered how such advice would resonate with managers or business leaders, both of whom are overwhelmed by ever-changing technology and the relentless race for results against the competition.

Von Helmboldt finally succeeded in understanding and translating Goethe's meaning leading to the creation of a new vision of his own. Nature as we knew it ceased to exist. The cultural and scientific consequences of this breakthrough were as immense as the amount of work and effort involved: maps of new territories unknown to Europeans and the classification of thousands of new animal and plant species, but above all a new vision of the interplay between all the elements of nature and a new approach to the complexity of the world.

It was the beginning of the eighteenth century, and even today the value of Humboldt's discoveries should be reassessed. Certain innovations take a long time to transform the culture of one or more civilizations. There remains the very relevant testimony of both the *method and the process that made it effective and, in a sense, eternal.*

Today, like then – and even more so – rivers of data and calculations flow into process control and management, adding to the oceans of numbers and calculations generated for every activity. While there is no shortage of technology, and indeed we are producing ever faster and more effective technology, one senses that the "poetic" contingent is decidedly inadequate.

By "poetic" I mean the ability to imagine and describe a structured holistic vision of reality by combining information and analytical elements with one's own personal intuitive hypothesis about the possible trajectories of a new reality.

Goethe urged von Humboldt to develop an over-arching idea by giving free rein to his intuitive capacity to initiate a synthesizing process capable of intelligently incorporating the objective data derived from his observation of the phenomena he was studying. The technological field, however useful and often astonishing, exposes us to the danger of underestimating the importance of feeling and human intuition.

For a few decades now, we have been living through an anthropological transformation of enormous proportions, resulting specifically from our ability to generate and disseminate information through images of all origins. Some scholars have already classified this new condition by changing the label from homo sapiens to homo videns.

The cultural impact of this new dimension will be better observed in the coming decades, but the change that is taking place is already evident, both in the quantity and the speed of its diffusion.

In these few lines, I do not intend to address the monumental question of the nature of knowledge and the ways in which it can be distinguished. However, it is incumbent upon us to remember that the question of knowledge from the ancient Greeks to the present is far from being exhausted and resolved, and it will certainly not be technology and the incredible developments of its most advanced applications that will free man from his inescapable role as a thinking being.

In contrast, today's innovation might be to return to writing with a fountain pen or quill and inkwell, rather than stimulating our five senses with sensations and experiences we have never had before. One could implement personalized and gradual periods of screen reduction to achieve a kind of planned visual "diet" over time, as the effects of overexposure to images are already changing the cognitive attitudes of new generations. In short, we need to realign human priorities in the face of continuing technological dominance.

The tsunami of images and information that is sweeping over us all has noticeably and generally reduced the moments of reflection and assimilation of knowledge, and this new pervasive norm does not facilitate the development of authentic personal development paths.

One statistic in particular should give us pause for thought: the growing phenomenon of the so-called "return to illiteracy", which particularly affects highly qualified professionals such as doctors, engineers and architects, who have been identified as the categories most prone to the inability to translate and interpret more or less complex texts outside their specific field of expertise.

Experience has shown that the digitalization process and the transition to 4.0 have encountered enormous difficulties in many companies, and that the process of retraining and adapting the available and necessary human resources to organize work comfortably and efficiently is still long and bumpy.

In recent years, I have appreciated the many initiatives that EnginSoft has launched to promote the exchange of ideas and experiences among companies and professionals involved in digital transformation. They have always been very stimulating occasions, characterized by the awareness that a mix of different skills and experiences offers a great opportunity to understand both the critical issues and the most beneficial and useful ways to address the great cultural revolution that is underway.

In particular, I have always appreciated EnginSoft's natural inclination to emphasize creativity and human intuition in the process of analysing and solving the "challenges" that needed to be addressed from time to time.

The ability to observe, measure, and develop simulation models of processes in different domains requires a multidisciplinary approach that encourages the exchange of different skills and, consequently, a holistic view, even if it is aimed at areas of great specialization. In the experience of EnginSoft, I see a continuity of the approach and method I mentioned earlier in reference to Alexander von Humboldt and his extraordinary discoveries.

Without detracting from all the aspects that need to be considered when we talk about innovation (the time, cost and critical mass needed to face the challenges of increasingly sophisticated and predatory competition), I think it is really necessary to pay more attention to the mother of all innovations: humanity.

by Giovanni De Luca
Former Director of RAI Veneto

At the same time, and in a slightly different way, we were using the HP9825A (marketed as a fully algebraic desktop calculator). A very expensive gem at the time, it had language (HPL) and computer-like capabilities that made it a kind of precursor to desktop computers. It offered array functions (that could be multidimensional and dynamically defined), cross-references, subroutines with parameter passing, local variables and multiple returned parameters, and more, such as keywords like prt (print) and gto (go to) which could jump to line addresses or labels.

This marvel that had "up to" 600 indexable memory locations ("r" registers), an interface consisting of a display with "up to" 36 characters, and a tape drive (actually a magnetic card) capable of storing 250kb, enabled us to perform real miracles. For example, starting from the basic assumption of finite elements i.e. imposing geometric congruence by deriving equilibrium as an application of the virtual work equation, we firstly developed the beam on a bed of independent springs (Winkler model), then the slab for airport pavements (Wieghardt model), and then with the same 1D logic connecting beams and rings treated with the Boyle-Mariotte law, the analysis of tanks with axial symmetry, and so on.

Taking inspiration everywhere

Inspired by the static condensation used in FEM models, we were able to deal with the dynamic response of complex buildings by reducing them to three degrees of freedom per floor, constructing a stick model for the cyclic condensation of frames and, in the case of stair or lift cages, applying Rosman's method. In a sense, we were also able to develop the first applications of digital manufacturing, for example to plan production of casting lines for precast concrete slabs or to optimize machining sequences for custom-made window frames.
Another memory illustrating our ability to make do with what we had is how we managed to "transform" a dot-matrix printer – one of the first to appear on the market in the 1970s – into a graphics printer by cyclically programming the dot-matrixes, which in turn were treated as sub-matrices of the successive lines of special characters available on the sheet.

Based on this knowledge and these methods, which we understood and had tested to the limit, Alberto Mezzena, Gino Perna, and I founded EnginSoft in Trento in 1984, with Cementi Riva as our industrial partner, convinced that the time had come to offer independent computer simulation services. Initially we conducted the calculations remotely on CINECA's CDCs (with card readers) or we would pay a group visit to Bologna to CINECA's headquarters when the urgency or formal complexity of the models to be developed made this necessary.

Shortly afterwards, we equipped EnginSoft in Trento with a VAX-11/750, one of the first to be marketed in Italy, making us completely self-sufficient. Admittedly, this step was a demonstration of our conviction, determination – and an enthusiasm bordering on recklessness, given the exorbitant cost of the computer and the difficulties of managing it.

To me, EnginSoft is a "faith" that you hold on to because you believe in it – it is and always has been for me, despite the storms I have encountered over the years. In fact, it is only this faith and trust that allowed me to always find an open door here -- even after certain decisions have taken me away from a place I have always considered my home.

EnginSoft is a work-life project entailing far more than just the economic aspect. It is a project that brings people together to work together for common purposes and not just as a place to pursue a career, a project bringing together different minds to deal with different issues on a daily basis, with the only common denominator being an approach very close to that of applied research (EnginSoft's involvement in various capacities in different national and European research projects is proof of this).

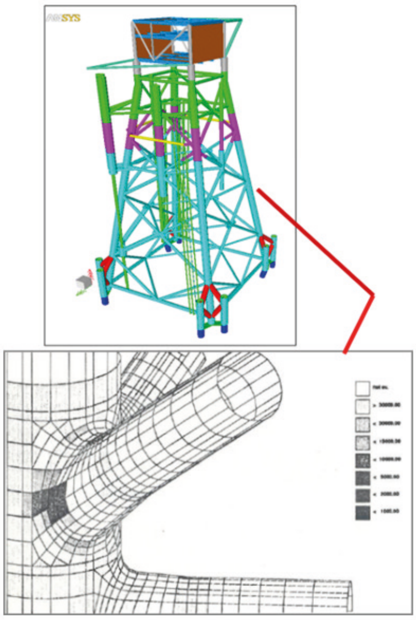
The company was born from the resolute and firm conviction of a single individual (Stefano Odorizzi) that numerical simulation was the touchstone to support, grow and guide the various forms of engineering projects, processes and product choices. And I believe that, as a project, it cannot be ignored, precisely because of its multifaceted nature, which is the lasting legacy of its founder's courage and foresight in creating a company that is a leader in the sectors in which it operates: the sale of software with high scientific content, technical-scientific consultancy, training, and the development of research projects.

Odorizzi's overall vision is still profoundly necessary to transform EnginSoft from what it is today to what it will become, without abandoning its fundamental and founding characteristic, which is first and foremost (at least for the author) technical-scientific and dedicated to the dissemination of knowledge so that its customers can grow in competence and competitiveness.

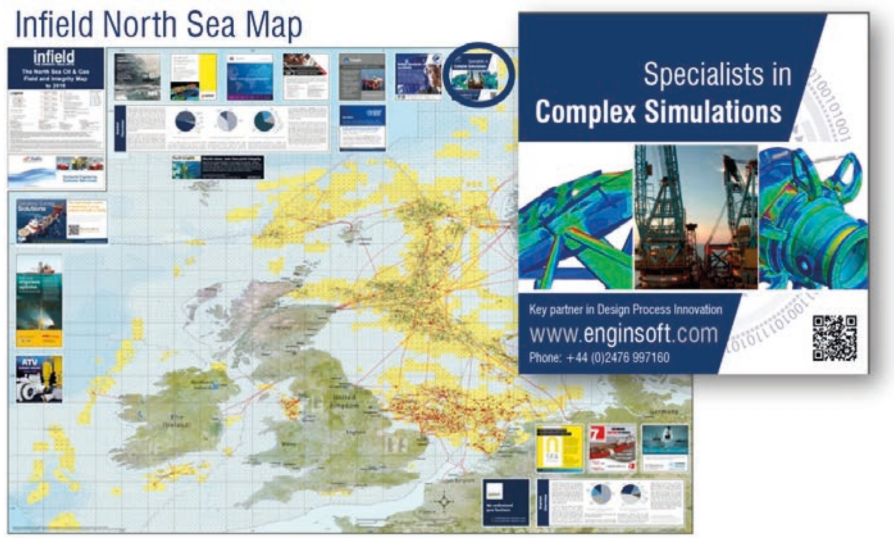
So, before losing our memories and focusing our gaze only on aspects of mere economic growth (which should not be overlooked anyway), I believe it is important to remember that the history of the company, the laboratory of ideas and the real opportunities on which we have bet and are betting by investing ourselves, is created in the first person by those who have the heart to seek, the hands to do and the head to think.

by Livio Furlan
EnginSoft

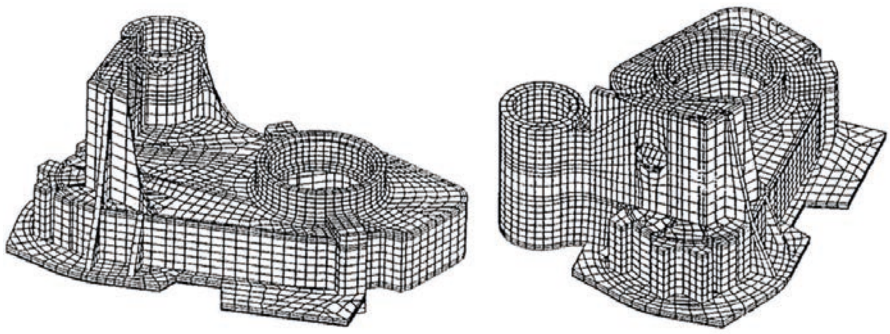
As we were all qualified civil engineers, we initially focused our efforts on the civil sector, where the use of simulation methods (in particular FEM) was envisaged and/or permitted in the following fields: seismic engineering, nuclear engineering with a focus on seismic aspects, and offshore engineering, mainly as a result of the initial exploitation of oil reserves in the North Sea. Back then, FEM was beginning to be mentioned in the technical specifications for installations crafted by highly scientific commissions and even in some regulations such as those issued by the American Petroleum Institute (API) and by Det Norske Veritas (DNV).



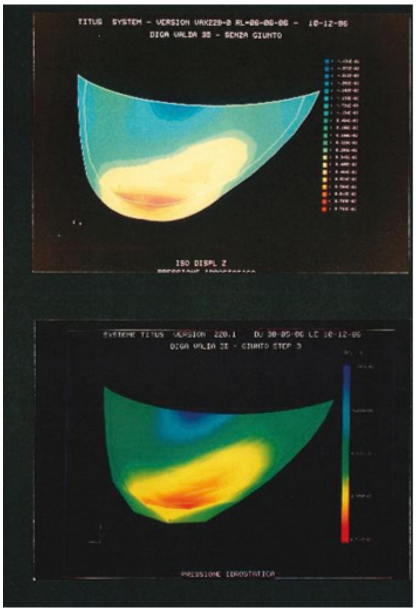
1989: Fatigue analysis of forged nodes for a jacket structure. Damage calculation from the bivariate (Hs-Tz) distribution of sea states. The black and white figure is the fatigue life in years and refers to the original application, which then became the ENI-Tecnomare method.



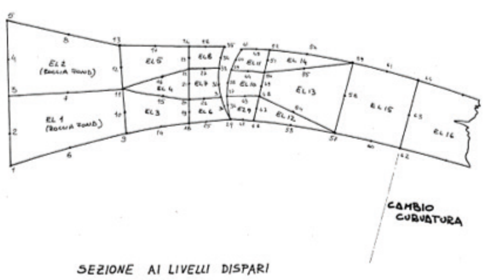
Recognition of EnginSoft's expertise in offshore projects in the North Sea.



1992: Fatigue analysis of a gearbox (Systus appl. 12179 parabolic elements). The model was aborted after running on a Digital Vax workstation for one week due to a power failure and was… restarted.



1987: Analysis of edge joint effect on a dam (TITUS).



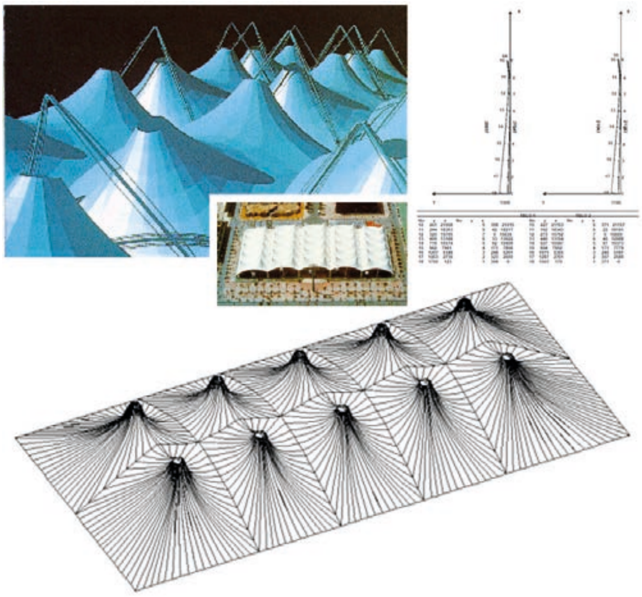
At the time, we were contacted by Framasoft, a subsidiary of Framatome (now Areva), an international leader in the nuclear sector, inviting us to promote their Systus software in Italy (which was then known as TITUS). We immediately accepted because we deemed the demand for specific applications for the nuclear sector to be considerable, and because we were familiar with NONSAP, the original Systus framework. We were convinced that Systus could be the European answer to commercial CAE software. In addition, Systus had been installed almost immediately on the first graphics workstations (produced by Apollo Computer, a company later acquired by Hewlett Packard in 1988).

Different kinds of shells

I cannot help but recall a few anecdotes from those early days.

The first concerns Ferrero's Mon Chéri chocolates. I was contacted by a Ferrero technician who asked me cryptically if we "had any experience with shells". In FEM, the shell is a special element because if the surface represented tends to zero curvature, there is numerical instability in the so-called drilling degrees of freedom. At the time, this was a problem that "experts" knew how to solve with more or less plausible workarounds. Assuming that it would be applied to a mechanical component, based on my previous experience, I replied: "Of course." Imagine my surprise when I discovered that it was the shell of the Mon Chéri, whose geometry had to be slightly corrected to extend the time between production and consumption to avoid the tendency of the sides of the shell to become concave due to the evaporation of the alcohol inside and the ambient conditions!

Still on the subject of shells, this time in non-linear applications, I remember the models for the plastic containers of Coccolino fabric softener (still used today) and problems of



1982: Canopy project for Ortona Tensostrutture Note the sheet cutting list, which is crucial to avoid wrinkles in the canopy upon assembly.

deformability, labelling and storage. A more complex challenge was the model for the mirror of the Giotto satellite, launched in 1986 to follow Halley's comet, which had to be optimized for lightness while simultaneously meeting the rigidity requirements essential for optical quality.

From those early days I remember how we developed one of our computational codes (derived by Gino Perna from a code I had written to calculate tensile cable structures) to study shapes, right through to the executive design (including shape design, cutting and joining of the fabric) of structures composed of sheets and cables, which was widely used, especially in Spain.

The graphical user interface and (somewhat later) 3D geometric modelling facilitated the creation of complex geometric models typical of mechanical engineering. The demand for FEM applications in mechanical engineering was – and still is – much higher than in civil engineering because design in that sphere is driven by the urgency of time-to-market and being the preferred product in the marketplace over competitors. Furthermore, with a few exceptions, the designed product is a slightly optimized variant of its previous version with respect to optimality criteria that may be either technical, functional, aesthetic or cost related. The data obtained from direct experimentation can be supplemented or replaced by the computer model.

That is why, at the time, we spoke of digital prototyping and/or digital testing as an extension of geometric digital mock-up. At EnginSoft, we coined the term iDP (intelligent digital prototyping) – and even included it in the company's mission statement – to emphasize the added value we offered over "conventional" DP, using the model in a kind of "design by analysis" guided by the pursuit of specific objectives.

While the interactive graphics were good, it was more difficult to produce colour versions of the calculations. Anecdotally, we solved the problem by photographing the computer screen, avoiding reflections and so on by wrapping the camera and monitor in a light shield made of black rubbish bags, and optimizing the lens aperture and exposure times accordingly.

CFD adventures

Shortly after the formation of EnginSoft, we began to use simulation in non-mechanical areas. In computational fluid dynamics (CFD), Professor Spalding was the reference and his software, PHENIX, was the tool used. PHENIX had its first commercial success when it was promoted by CHAM, a company founded by Prof. Spalding himself. Initially we only used it in a university environment and later used its more user-friendly derivatives (such as easyFLOW) for consultancy and services.

Among the very first applications at that time, I remember the problem of fire detection and suppression in spacecraft, which was particularly complex because it involved a zero-gravity environment. After easyFLOW, CFX-4 (produced by AEA Technology and a successor to Flow3D) was the first code chosen by EnginSoft because it was sufficiently rich and structured to be fully used in CFD applications.

To complement it we started using TASKflow (later acquired by AEA itself) in the early 1990s particularly for turbomachinery applications as well as various meshing tools and applications in specific contexts. CFD quickly became a flagship for EnginSoft due to the high level of expertise required (and expressed by us) to carry out applications in various fields, from aerodynamics to combustion and process chemistry.

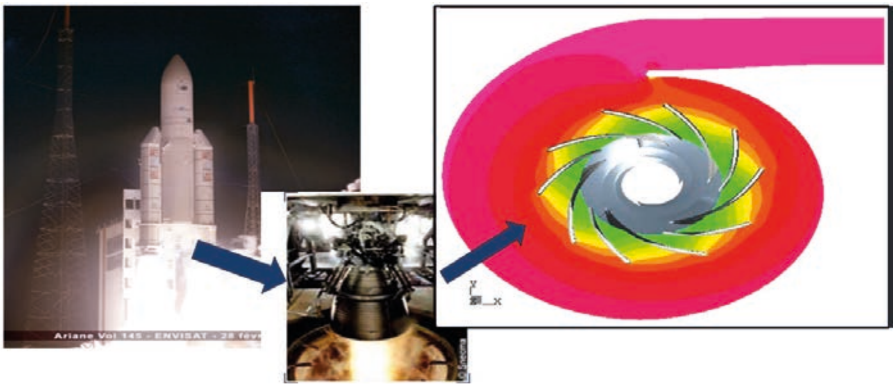
In the field of acoustics, we opted for LMS International technology in the early 1990s: SYSNOISE for the study of sound radiation and RAYNOISE for the study of room acoustics. SYSNOISE uses the boundary element method (BEM), which is suitable for solving linear partial differential equations formulated as boundary integrals. It is almost impossible to use FEM in this field because sound radiates

Do you remember the days
when we used to use Boolean operations?

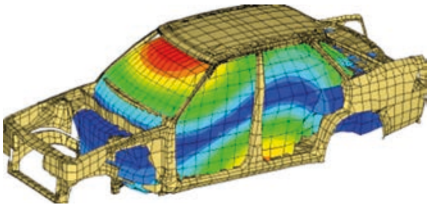
This question, dear Roberto [Gonella], is a testimony to our strong and long-standing relationship since the early 1990s. Back then I was working at Riva Calzoni (the first Ansys client in Italy) and we worked together on industrial applications problems that would not have received the necessary, and in some cases indispensable, in-depth study without the aid of finite elements – an absolute innovation in the engineering approach available at the time.

Looking at the evolution of the software – which has been impressive yet is based on the same principles and approximations as in the beginning – one wonders how essential the vision and passion of people like us has been in making engineering simulation a "method" (if not the method) in industrial design processes.

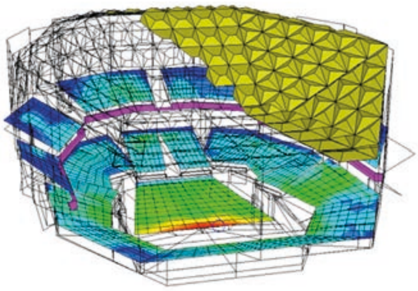
by Roberto Borsari
Former Director of Forming Technologies at Tetrapak in Modena



1999: Arianne LOX turbopump.



1991: Vehicle cabin acoustics (SYSNOISE).



1991: Acoustic response of a theatre (RAYNOISE).

outwards into space, which cannot be discretized with FE; RAYNOISE uses the ray tracing method. For acoustics in large open spaces, techniques based on the statistical treatment of acoustic energy are used instead.

About FEM, how to FEM, and beyond FEM

The extension of applications to different physics and domains, but also within the same domain, involves the use of different numerical methods, which in turn require different skills and different modelling methods. FEM dominates the problems of the mechanical continuum, finite differences, and control volumes those of fluids, boundary integrals those of acoustic radiation, and so on… To highlight this aspect, I would like to mention two cases that have become particularly important for us among the various initiatives and partnerships with software technology producers that we launched at the time.

The first is the RASNA software package. Founded in California in 1987, RASNA was one of the fastest growing private companies in the US. We came across it by chance and were intrigued by the basic idea of the technology: that of replacing the shape functions used in conventional finite elements with series developments in which the number of terms in the series is increased in an iterative process, evaluating their convergence by deformation work. In a sense, it extended the "old" finite prism or finite string methods to three dimensions.

The person who had briefly introduced the method described it as quite simple but easy to use, and therefore suitable for general studies and for non-experts. Gino Perna and I could not resist our curiosity and went to the RASNA office in the USA to find out more.

It was an exciting week. Exciting for us, because we realized that the correct choice of subdomains and the correct control of convergence made the method potentially much more accurate and precisely controllable than traditional FEM. Exciting for our hosts, who said they had never met people so mentally prepared and able to identify the exact commercial fit of the method, its merits and its flaws. We celebrated this combination of interest and curiosity at festive dinners over the lobsters and crabs proudly proposed to us by the CEO, accompanied by an expensive Barrique Chardonnay. And so, we began to use and promote RASNA.

It must be said that the same classical schools of FEM later christened the method the P-element or geometric element method (the traditional one being the H-element method) and recognized its "super convergence".

1989: Models developed with RASNA Pro-MECHANICA compared with FEM models developed with Systus according to the modelling guidelines (images obtained by photographing the screen).

In the dynamic domain, for example, in the case of the H-method, the eigenpairs usually extracted by iterative methods such as subspace iteration – necessarily and only converge to those possible for the mesh used and may therefore be far from the physically true ones. It is possible to find out how far apart they are by repeating the calculation several times, but with gradually refined meshes that respect a convergence criterion such as that of Melosh: a path that can be formally quite complex and artificial compared to the most users' habits.

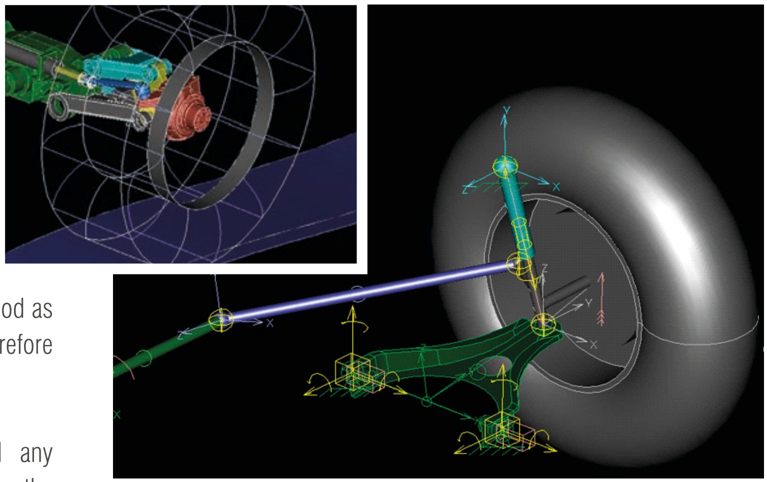
With P-elements, convergence to the physically correct solution is almost "automatic" by the nature of the method, which would seem to favour this method and make it very easy to use. Obviously, this is not the case for three reasons: 1) because the matrices produced are much denser than those of the H-elements, 2) because of the convergence checks necessary to avoid impractical computation times and endless loops, and 3) because of the choice of subdomains.

RASNA also made it possible to create models of multi-body structures without considering the deformability of the components but allowing optimization studies to be conducted.

For EnginSoft, RASNA was a unique experience: we were the first to use it in Europe, and we were the most successful distributor with a specific marketing approach that earned us worldwide recognition (we went so far as to organize the first international congress on the method in Venice in 1994).

But RASNA also turned out to be an adventure that eventually presented us with serious practical problems. In 1995, RASNA was acquired by PTC, which tried to promote the method as an automatic downstream use of the geometric model, and therefore without limits and difficulties for anyone.

This approach effectively killed the technology, crippled any professional use of it, and ultimately caused it to disappear from the market.

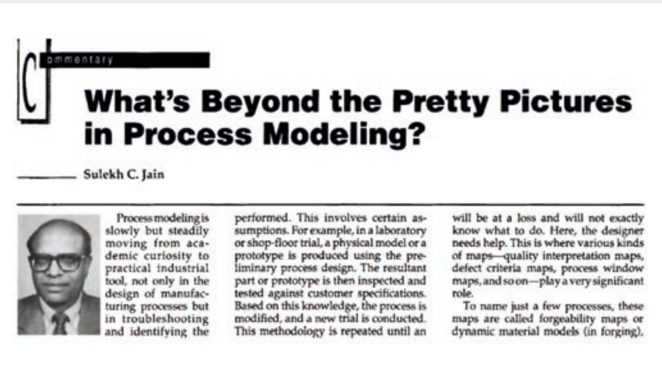


1991: Studies of suspensions (ProMECANICA/Motion).

Numerical simulation and the foundry industry: a brief history of an interdisciplinary journey

In the early 1990s, the possibility of using numerical process simulation at an application level in metallurgy began to emerge. However, a degree of scepticism may have prevailed, both because of the objective difficulty of the subject (the need to combine fluid-dynamic, thermal, and mechanical models with the appropriate metallurgical equations) and because of the decidedly empirical approach that dominated the field.

An editorial published in the prestigious Journal of Metals *in June 1992, entitled "What's beyond the pretty pictures in process modelling?" very aptly described the situation:*



Commentary

What's Beyond the Pretty Pictures in Process Modeling?

Sulekh C. Jain

Process modeling is slowly but steadily moving from academic curiosity to practical industrial tool, not only in the design of manufacturing processes but in troubleshooting and identifying the performed. This involves certain assumptions. For example, in a laboratory or shop-floor trial, a physical model or a prototype is produced using the preliminary process design. The resultant part or prototype is then inspected and tested against customer specifications. Based on this knowledge, the process is modified, and a new trial is conducted. This methodology is repeated until an will be at a loss and will not exactly know what to do. Here, the designer needs help. This is where various kinds of maps—quality interpretation maps, defect criteria maps, process window maps, and so on—play a very significant role.

To name just a few processes, these maps are called forgeability maps or dynamic material models (in forging),

It was therefore a rather pioneering scenario, and it was a pleasant surprise for me, then a young metallurgical researcher at the University of Padua, to discover that an engineering company, EnginSoft, also based in Padua, was offering software for the simulation of metallurgical processes, with particular reference to foundries.

A few meetings with Stefano Odorizzi and, in the following months with Nicola Gramegna and colleagues from EnginSoft, revealed a remarkable affinity and a common will to work in a cutting-edge field using scientific and interdisciplinary methods and to bridge two disciplines — numerical calculation and metallurgy — that were at the time rather inaccessible to each other.

In 1995, we published a review on numerical simulation of metallurgical processes with Odorizzi and immediately realized the breadth and novelty of the areas of work, including:

- *the experimental validation of numerical models of casting processes,*
- *the implementation of metallurgical equations to predict microstructure and properties,*
- *the potential of using simulation as an optimization tool,*
- *the integration of numerical simulation in the design chain,*
- *the essential role of interdisciplinary operator training.*

Some examples are:

- *The Foundry Project (1997-2000), involving the Venice Research Centre, to experimentally validate fluid dynamic and thermal simulations.*
- *The Leonardo COPROFOUND project (1999-2001) to produce training material on the simulation of foundry processes for cast iron, steel, and light alloys.*
- *The EU IDEAL project (2002-2005) on the use of numerical process simulation in the design chain of aluminium alloy automotive castings.*
- *The EU METRO project (2004-2006), which developed online teaching modules on the simulation of metallurgical processes (anticipating modern MOOCs by almost 20 years).*
- *The EU NADIA project (2006-2010), in which EnginSoft coordinated 26 partners representing the entire production line of aluminium and magnesium alloy castings for automotive applications — the work carried out in NADIA also led to the development of two European standards (2014) on defects*

in aluminium castings and on the mechanical potential of aluminium alloys for foundry use.

- *The EU MUSIC project (2012-2016), which demonstrated that process simulation can be fully integrated into the monitoring and control of light alloy die casting processes through the introduction of machine learning approaches.*

The natural consequence of this dense network of collaborations has been the intensification of scientific relations with leading international institutions: the Swedish University of Joenkoeping (Prof. Svensson) and the Norwegian University of Trondheim (Prof. Arnberg).

At the same time, the collaboration between EnginSoft and my department at the University of Padua, the Department of Management and Engineering (Dipartimento di Tecnica e Gestione dei Sistemi Industriali), has also had a strong territorial aspect that led, in 2016, to the creation of SINFONET, one of the first regional innovation networks, which now has almost 70 member companies and which over the years (2017-2022) has managed and coordinated several collaborative projects (GAP, FORSAL, AGILE), all related to foundry and its modernization.

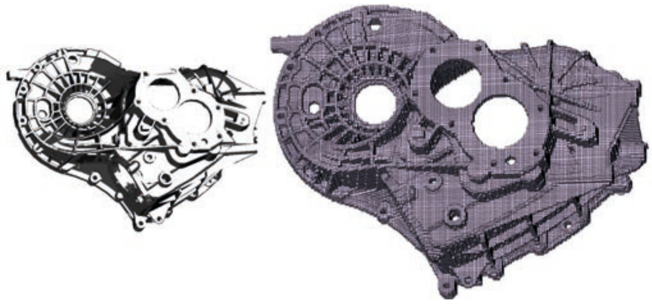
Almost 30 years after our first joint publication, it is only natural to take stock of this ongoing collaboration. It has been a harmonious journey of searching for innovative solutions and contributing to the training of several dozen engineers and foundry technicians. These have been years in which the quality of the people, the sincerity of the relationships, and the spirit of innovation have always been the driving forces behind each project.

Rereading the title and the content of that 1992 Journal of Metals *editorial today reveals a prophetic vision:*

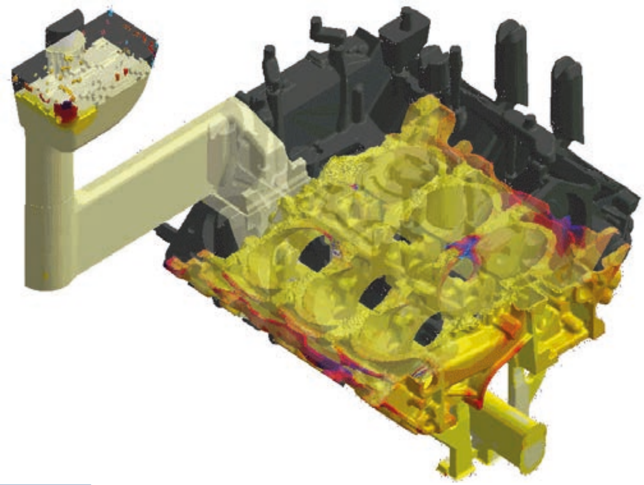
> *"Further benefits of these numerical techniques include identifying process windows, optimizing the process, and designing process control strategies. This is a new and positive trend in the use of numerical modeling techniques in process design."*

I believe that, together with EnginSoft, we have succeeded in transforming a "positive trend" into consolidated multidisciplinary engineering expertise open to increasingly complex technological challenges.

by Prof. Franco Bonollo
University of Padova - DTG



1995: First application of Magma – Gear housing.



2013: Example of a recent application of MAGMA. In presenting it at our conference "Engineering Simulation Today", we commented: ***"…Simulation will not just be 'simulation as usual' however;*** *rather, it will be focused on the modelling of complex, inter-related engineering systems and on the acquisition of results that meet specified standards of precision and reliability. Hence engineering simulation will develop new methods, devices, procedures, processes and planning strategies. All these will be* ***key elements for achieving progress in engineering and science."***

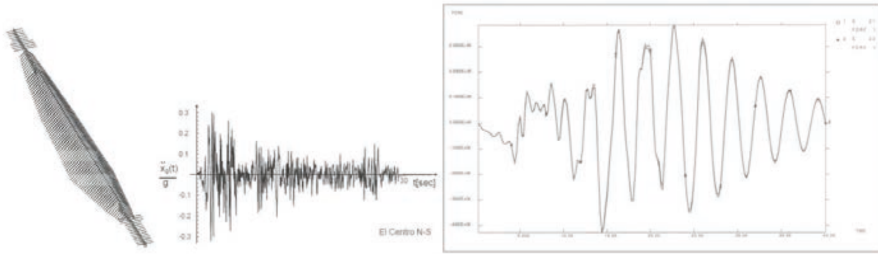
The second case is MAGMA. Founded in 1988 by Prof. Peter Sahm as a spin-off of the Foundry Institute of the RWTH Aachen University, MAGMA Giessereitechnologie deals with the simulation of casting processes in all the various forms from gravity casting to high pressure die casting for both ferrous and non-ferrous materials.

Without delving into the extreme complexity of simulation in this sector, I would like to mention the practical methodological approach used to create the models: it applies the Control Volumes (CV) method, which greatly simplifies meshing by "brushing" the volume containing the object to be meshed in the three coordinate directions with a "ray" that recognizes a solid the first time it hits a surface of the model, a void the next time, and so on. All the components of the casting system (feeders, runners, coolers, filters) are then automatically described from the parameters that define them.

However, the calculation is extremely demanding from a modelling point of view, both in terms of the number of CVs, the physics to be processed, and the integration over time. As a company, EnginSoft became involved in simulating casting processes from the beginning and collaborated with the University of Padua to contribute to the implementation of models and methods in the field.

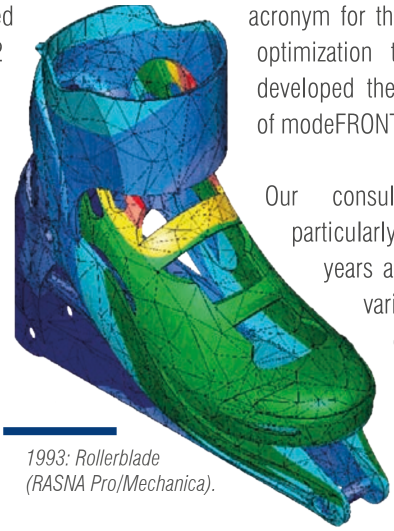
The beginnings of optimization

In the 1990s, we put a lot of energy into optimization, which was then conceived as a way of exploring the parametrically described design space to guide the choice of an optimal solution with respect to defined objectives and design constraints. Today, everyone talks about optimization and artificial intelligence (particularly in the form of machine learning), but back then these were the first implementation ideas.



One of the different solutions studied for the suspended Archimedes bridge: time domain analysis, including large displacements, vortex shedding effects and the application of earthquake-induced displacements at the anchorage points of the stays. These displacements were obtained by integrating the accelerations recorded in the El Centro earthquake.

In 1992, EnginSoft participated in the European SPINOZA2 project, which created the OPTIMUS software, and later in an advanced phase of the FRONTIER project (started in 1995), which resulted in the modeFRONTIER software. OPTIMUS, produced by LMS and later marketed by Noesis, was very good for Design of Experiment (DOE) and treated optimization as constrained optimization of a single objective.

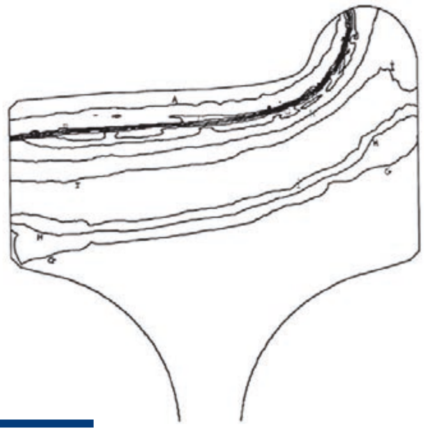


1993: Rollerblade (RASNA Pro/Mechanica).

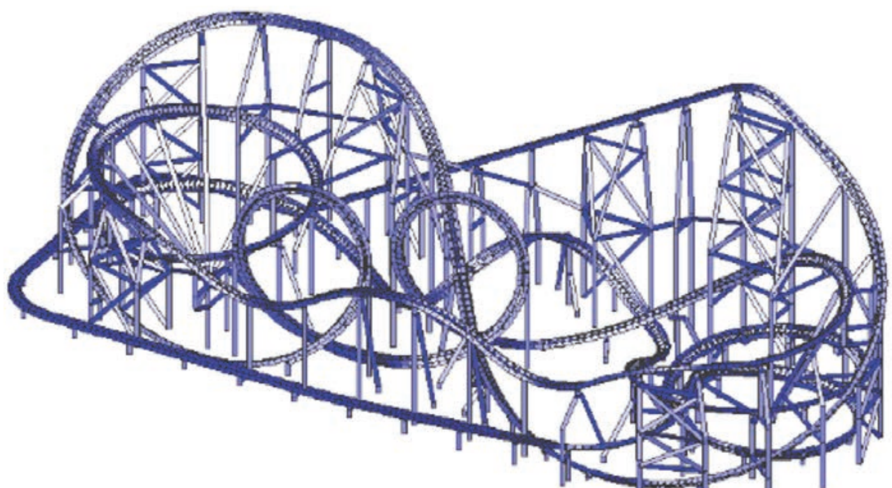
modeFRONTIER, on the other hand, directly addressed the problem of multi-objective and multi-disciplinary optimization, solving it with Genetic Algorithms (GA), a sub-category of Evolutionary Algorithms (EA), and introducing the concept of the Pareto frontier as the optimum frontier with multi-criteria decision techniques to act on it. EnginSoft was initially a distributor of OPTIMUS and went on to co-found ESTECO (an acronym for the Italian of EnginSoft optimization technologies), which developed the commercial version of modeFRONTIER.

Our consulting activity was particularly intense during these years and developed around various initiatives carried out by the three offices in Trento, Padua, and Bergamo. The most important of these, both in terms of content and the commitment required of the company, were the models developed for the design of the Messina Strait crossing with a suspended Archimedes bridge. This is not the place to discuss the merits of the project proposed by the ENI-Saipem-Tecnomare consortium as an alternative to the bridge, however, the technical merits of this solution are undeniable. To give an idea of the impact of using simulation models, I will just mention that EnginSoft alone was contracted for 60,000 hours of work in the preliminary phase.

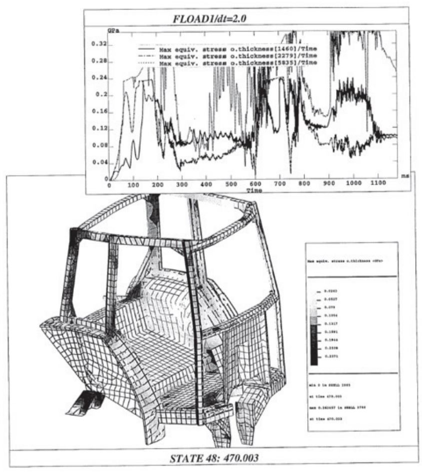
A subject in which it is decidedly complex to find optimal solutions from different perspectives is the regular work we do for manufacturers of "flying structures" of all kinds: roller coasters, balloon races, merry-go-rounds and the like. It starts with simulation of the dynamics of the systems and goes right down to the detail of the



1994: Wheel quenching (LOVERE SIDERMECCANICA, then privatised and purchased by the Luccini Group). Figure shows the distribution of pearlite.



1995: First model of a rollercoaster with completely automated pre- and post-processing.



1996: SAME-DEUTZ-FAHR Tractor – reproduction of series and crush tests (PAM-CRASH).

ENGINSOFT

verifications. For example, to optimize a roller coaster track the work entails using all the energy from the fall to perform different types of evolutions to stimulate rider sensations without causing discomfort (by avoiding accelerations outside the median sagittal plane of the human body) while also simplifying the construction itself, and moves on to testing at the final installation site, etc. The first fully developed model was for the first roller coaster installed at the Prater in Vienna. Apart from the excitement of tackling such a unique problem, the colleagues at EnginSoft still remember the sensations experienced during the tests, and even more so during the physical experiments to obtain useful data for the calculations.

The start of SBES

We thus entered the third millennium with an exceptional range of skills and technologies in the various fields of CAE (we would later call it Simulation-Based Engineering or SBES), materials processing simulation and associated technologies for optimization, integration, and its use in collaborative engineering environments, complemented by related IT services. It was a unique proposition that positioned us, in every sense of the word, as capable of real technology transfer to industry. In recognition of this, we changed our previous slogans – referring to iDP or design chain solutions – to "key partner for design process innovation".

Our ability to carry out real technology transfer in the field of SBES (also officially recognized in the Official Gazette No. 298 of 22 December 1994) rested on four pillars:

- the type of technology chosen for its applicability to different industrial contexts;
- consultancy services focused on the specialization of technology implementation and its integration into the design process and any related tool chain of the customer company (our other motto was "design chain solutions");
- education and training;

It was the early 1990s. Computer science and electronics had moved beyond the confines of basic research and were rapidly spreading into the industrial world because of applied research and innovation. Few people realized it, but we were moving from an era of knowledge for knowledge's sake to an era of expertise, where knowledge must be enhanced through application.

Information technology and electronics were – and are – cross-cutting technologies for the various spheres of human endeavour. Even then, it was easy to predict that they would revolutionize the entire world of work, not only through technological changes in the way people design, experiment, and produce, but also through their impact on organizations and their cultures.

IT offered tools and methods to reduce the time and cost of developing products, processes, and services by one or more orders of magnitude, requiring the creation of new professional profiles and greater delegation to different organizational levels. It became essential to reduce the hierarchical levels of the past and make room for the creativity, enthusiasm, proactivity, and scientific rigor of the IT-skilled newcomers entering the public and private workplaces.

For the Centro Ricerche Fiat (or FIAT Research Centre), applications of computer science and electronics were distinct skills to be developed as a priority. In order to develop them to excellence, we had to search universities and research institutions for people with unique profiles that were very rare at the time: these people had to be able to apply and implement scientific knowledge in business, not just produce excellent academically valid scientific reports that would stand up to peer review, but also get their hands dirty in the industrial world, speak the language of customers, and combine their scientific skills with economic and market knowledge. In short, they had to be both professors and entrepreneurs.

In this period, we were fortunate to meet Prof. Stefano Odorizzi, an expert in the field of computer applications, especially in the development of predictive numerical simulation, with whom we shared visions, challenges, and successes for many years.

With Stefano we also shared the desire to find other excellent partners to train young engineers in new technologies and, thus, the TCN Consortium (Technologie per il Calcolo Numerico or Technologies for Numerical Computing) was born together with the Centro di Ricerca, Sviluppo e Studi Superiori, CRS4 (Centre for Research, Development and Advanced Studies) in Sardinia, chaired by Carlo Rubia, Nobel Laureate for Physics, and the Istituto per la Ricerca Scientifica e Tecnologica, IRST (Institute for Scientific and Technological Research), today known globally as the Fondazione Bruno Kessler. The consortium achieved outstanding results, such as winning European projects, which facilitated the subsequent development of training courses that were groundbreaking at the time, including the first master's degree in numerical computing.

Finally, for me and thanks to Stefano, another very important achievement was the introduction to the beautiful province of Trento, where innovation is as ubiquitous as the air of home starting from the Regional Council with its young presidents and ending with the dynamic Lorenzo Dellai, when CRF opened a branch in Trento.

Those were exciting years, remembered now perhaps a little wistfully, but mostly with gratitude for Stefano and the other remarkable people I met during that time. Thank you again, Stefano; and thank you to all the friends from Trento.

by Giancarlo Michellone
Former Chief Executive Officer of Centro Ricerche Fiat

The field of mechatronics

In the 1970s, mechatronics emerged as a cross-disciplinary field combining mechanics, electronics, computer science and automation. It was not very popular at first. Later, however, it began to appear in university curricula and, subsequently, became a subject of interest to industry.

At the beginning of the third millennium, therefore, it was also important for EnginSoft to clarify to the industry whether and where there were interesting synergies with the mechanics being approached.

At that time within TCN — our training structure — we were organizing "mini masters": intensive training initiatives halfway between a traditional course and a master's degree. We therefore organized a "mini masters" for mechatronics, a kind of treasure hunt, and hired a renowned Columbia University lecturer to coordinate it. The initiative was so successful that it was repeated several times. Organizing it, however, was rather complex and bizarre: the lecturer wanted to bring a huge trunk (a kind of mini container) full of physics experiments for the students to practice with.

The lecturer also insisted that the students turn up in shorts and short-sleeved shirts, because that was what he wore, and it was summer (the mini masters were held in the summer). There were two problems for us: getting the mini-container through customs, to the client (who on one occasion returned it to the sender) and back to Columbia University; and secondly, getting the unusual clothing accepted in contexts where the custom was very different — especially among non-students.

We used to shrug and say, "What you have to do to survive!"

by Mirella Prestini
EnginSoft

- applied research carried out in industry-led partnerships to feed the chosen technology with the necessary data on the physics involved and to provide articulated proofs of concept of the possibilities, benefits and limitations of the applications.

Here I would like to focus on training, for which we created a specific structure together with Centro Ricerche Fiat at the CRS4 and the Fondazione Bruno Kessler: the TCN (Technologies for Scientific Computing, Higher Education Centre).

The TCN produced teaching materials for face-to-face and online courses, publications on specific topics, e.g. contact mechanics, and learning systems for practical use, as well as offering mini-grants – through EU-funded projects – to participate in third-party initiatives across Europe (European Atelier for Engineering and Computational Science, EUA4X).

From this solid base and with this business model we experienced a very strong growth in the early 2000s, both in terms of the expansion of our organization (opening a total of six offices in Italy and branches abroad in Germany, France, England, Spain and Northern Europe, and shortly afterwards in the United States and Türkiye) and in terms of the growth of our IT infrastructure, and the expansion of our offering of technologies and services, training and industrial research.

From a technological point of view, Ansys had a major impact. At the time, Ansys produced software addressing only mechanical analysis problems and had been distributed in Italy by ItalCAE since 1987. In 2002, following the death of ItalCAE's founder and owner, Antonio Mancino, the opportunity arose for EnginSoft to acquire the company. We were immediately interested – especially after the RASNA misadventure – and we appreciated the strong affinity between the staff of the two companies and the business models promoted by the founders and directors.

Little did we know at the time that Ansys would experience such enormous growth, achieved through the systematic acquisition of third-party technologies developed to solve problems in areas other than mechanical engineering and beyond. We gradually found ourselves with almost a single point of contact for SBES issues outside of the highly vertical/specialist ones. In fact, the technologies that Ansys was steadily acquiring were the very ones that EnginSoft was already working with independently, demonstrating EnginSoft's ability to anticipate market demand and identify the best technologies. Whenever we signed a new contract to promote a piece of software, we jokingly wondered how long it would be before Ansys acquired the application.

I will not go into too much detail about this phase of EnginSoft's life, which, however, expresses the full blossoming and consolidation of the company's identity in its authentic and useful role for the industry it serves, because this newsletter, *Futurities*, which began publication as the EnginSoft *Newsletter* in 2003, is a faithful record of it, full of case histories, testimonies, interviews, information and updates on technologies, training proposals, and news/opportunities to participate in co-financed industrial research projects or to join centres of excellence and networks for the dissemination of knowledge on methods.

Besides the *Newsletter*, the international conference (and accompanying exhibition) that we have held every year since the founding of EnginSoft, accurately reflects developments in the world of simulation, enriched by contributions from key players among technology producers and users – with examples of relevant applications in industry, as well as their needs and obstacles – and from the world of research and academia.
In addition to EnginSoft's 40th anniversary, this year marks the 40th anniversary of the International CAE Conference, the 20th anniversary of the publication of this newsletter, and the milestone achievement of our 100th industrial research project won within consortia mainly at international level.

2006: Company kick-off meeting.

2008: CAE Conference Perspective – We will get to a point of science fiction becoming science fact within the next decade or two where design engineers will be spending all their time imagining product variants and product innovations whilst computers will be churning away in the background spitting out predictions for the engineers to review in real time.

At this point, I would like to emphasize the research aspect and place it in its proper context. The problem of technology transfer from the places where knowledge is developed and formalized (universities, research centres) to industrial users seems almost insurmountable: instead of a disciplined flow, there is constant talk of distance, of a gap, of extremes that never meet. EnginSoft has had, and continues to have, the genuine ability to bring these two extremes closer together, to improve and make the most, in practical application, of what is produced in the abstract by pure research – wherever, however, and whenever this is reasonably practicable. While many boasts that they know how to do this, few actually do.

EnginSoft has been recognized by the European Commission as a Key Innovator for its cutting-edge contributions to four European projects.

The most recent of these is the OPTIMA project, which focused on developing a customized high-performance computing (HPC) solution for computational fluid dynamics (CFD). Another project, SYNCH, saw EnginSoft develop the Brain Neuromorphic Synapses Builder, an innovative tool designed to explore the potential of artificial neuronal networks for in vivo applications as neuro-prostheses to replace damaged brain networks. Further progress was made in the FORCE project, where EnginSoft developed a Decision Support System (DSS) to address complex chemical formulation challenges, and in the RECAM project, which focused on versatile manufacturing systems and agile production planning. This recognition is testament to EnginSoft's ability to drive innovation across a wide range of sectors. By leveraging its extensive expertise and capacity for cross-fertilization and multidisciplinary collaboration, EnginSoft consistently delivers highly impactful solutions that bring significant benefits to European Innovation Leadership.

In a world that, in the space of forty years, has gone from its first uncertainties to a wealth of content unimaginable at the time of its creation, following a combined process of transversal expansion, democratization of technologies and vertical development with appropriate solutions for specific problems, Enginsoft has been able to ride the new and the evolution of the new with mastery and perfect balance, while remaining true to its mission.

In addition to general applications for problems in the fields of FEM, CFD, acoustics and electromagnetism, which we have primarily solved within the Ansys platform, there have been and are many specializations in specific topics or specific numerical approaches.

Among these, I would like to mention a few, not only because of the particular receptivity they have had and have in the market, but above all because of the valuable contribution they make to specific application areas, providing a solution that leads me to speak of the elegance of software whenever I have the opportunity, due to the orderliness of the approach to a specific application within a reference physics, the numerical approach, the solution method chosen and its implementation.

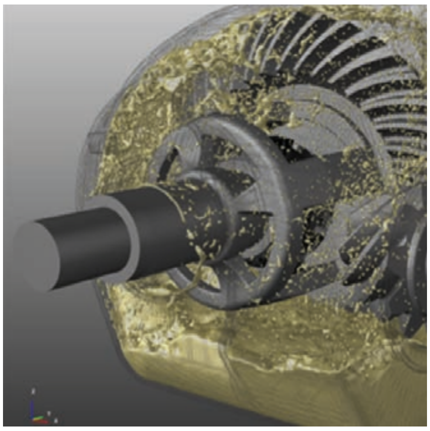
As it was almost 20 years ago when we started collaborating with EnginSoft before we started the NADIA project. It has always been a fascinating journey in design optimization and digital innovation. I particularly enjoyed each International CAE Conference (a fantastic event to meet specialists from all over the world) and other special meetings; thank you for the opportunities to present there, too. I can say that the teamwork is excellent, and I have learnt a lot (actually, I still do!). The team brainstorming and innovation for advanced simulation tools was inspiring: to see how everyone's expertise came together to share insights into cutting-edge optimization techniques. Per laborem ad astra – et ultra.

by Prof. Michael Gasik
Seqvera

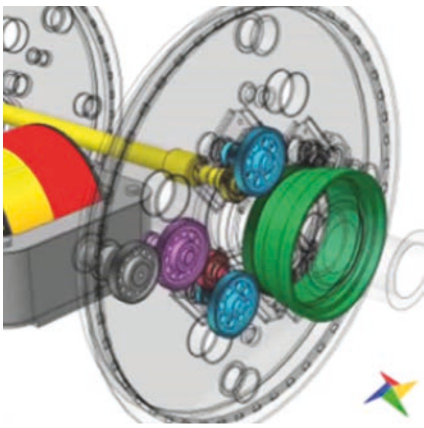
Particleworks, produced in Japan by Prometech, offers an approach to CFD based on the moving particle method (MPM), i.e. meshless, where integration over time is solved using a semi-implicit algorithm. Unbeatable in the simulation of lubrication and high viscosity fluid situations, the software is suitable for a wide range of other recurring and complex simulation problems: cooling of electric motors, vehicle behaviour on flooded roads, water splashing, sloshing, injection moulding, scrap metal flushing, powder-liquid mixing, conjugate heat transfer, painting, etc.

RecurDyn, produced in South Korea by FunctionBay, addresses the problem of multi-body dynamics and allows the treatment of flexible – even highly flexible – bodies.

Cetol6σ deals with 3D model-based tolerance analysis and links to 3D CAD environments such as PTC Creo, Siemens NX, CATIA or SolidWorks.



2019: Particleworks simulation of the lubrification of a gear.



2018: Recurdyn multibody example.

And many others, for which we refer you to the relevant reports and examples in various editions of the *Newsletter* and *Futurities* and to the website of EnginSoft and related companies.

As an extension of SBES, EnginSoft has also approached the world of digital manufacturing and automation, using both third party technologies (such as industrialPhysics and MapleSim) and its own platform, smartPRODUCTIVE, created to build simulation environments of production processes to enable, for example, predictive maintenance and/or to determine the risks and consequences of failures leading to plant downtime and/or to optimize initial choices with respect to target requirements, up to building the digital twin of the plant. Digital manufacturing has its own hierarchy of issues, which is similar and, in some ways, parallel to that of engineering simulation.

Therefore, all the boundary technologies typical of AI and IT for data management, optimization and in general, can be naturally applied.

In 2023, with the intention of allowing it to fully pursue its mission and maintain its identity, EnginSoft spun off its subsidiary EnginSoft Simulation Software Italia to allow it to focus on the commercial promotion of Ansys. EnginSoft retains all the technical expertise on the software, which is made available to customers and to the subsidiary itself.

As a result, EnginSoft can be viewed as a key partner for industry in the digital transformation of its design and production processes, without any of the strict commercial constraints that could distract from the substance of the problems faced by the customers it serves.

Digitalization is a key challenge for companies wishing to remain competitive and innovative in the Italian industrial landscape. This context, together with the impetus created by the Ministry of Economic Development as part of the Industria 4.0 plan and the funding received from the National Recovery and Resilience Plan, led to the establishment of eight competence centres (or competitiveness clusters) in Italy.

Structured as public-private partnerships, the competence centres focus on creating an ecosystem that fosters real synergies between universities and researchers, manufacturers and technology providers, and start-ups on the topic of digital transformation.

SMACT is the competence centre of the Tri Veneto region in Italy. The name represents the five technologies treated: Social, Mobile, Analytics, Cloud and The Internet of Things. It currently has over 100 partners (EnginSoft is a founding member) and provides an environment where companies can experiment with innovative solutions, test prototypes, and receive expert feedback. This approach reduces the risks associated with implementing new technologies and accelerates the innovation process.

EnginSoft's active involvement in SMACT is a positive example of how specialized technical expertise can be made available to companies to support their digitalization. EnginSoft's specific contribution to SMACT concerns digital manufacturing, which aims to optimize production processes by combining the fundamental elements required to create a digital twin, namely: guided collection of useful and targeted data, the process simulation model, and artificial intelligence. All of this activity considers the characteristics of the industry in question, which is supported with great value in terms of the quality of the product in relation to the cost of development and, above all, in relation to the technical choices to be made in terms of the go-to-market strategies required to beat the competition

by Matteo Faggin
General Manager of SMACT

The longest journey starts with the first step

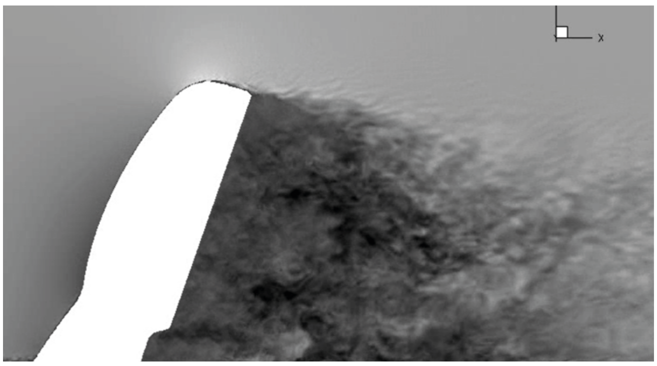
It has been a long journey, which I think is well described in the words of the Head of our Consultancy Services and CFD divisions. He explains: Our CFD adventure began on a chilly night in 1992 spent in the middle of winter in an unheated room at the Bear Hotel in Wantage in Oxfordshire in the UK where we had signed a contract with AEA Technology to use and promote their technology. We then had to explain to potential clients that CFD did not stand for “Contract for Difference” as in banking, but was a software technology for simulating fluid problems, and that it cost a lot of money, we are not sure why.

Then came a miraculous first sale and the first case where the results matched the measured data… again with no real understanding of why. We then decided to promote the technology in a structured way. Compared to its FEM counterparts, CFD presented problems both in terms of true/reliable modelling and convergence of the solution. We were stuck in a backward trajectory, spending days watching the vortex form in the face of a dramatic change in geometry, with constantly varying results in terms of the mesh, the turbulence model, the finite difference scheme, and its solver. We used to joke that the best finite-difference scheme was QUICK, which does not mean 'fast' (if only!) but is the acronym for Quadratic Upstream Interpolation for Convective Kinematics; in practice, a third-order algorithm that would converge exactly – but only on perfect meshes, so… never!

Without giving in to the difficulties and in overcoming all the psychological resistance, we reached the end of the second millennium, well able to carry out, for example, CFD simulations of turbogas to limit emissions and pollution – before the focus on the climate issue that exploded shortly afterwards: we did not know it, but EnginSoft was already making the world a better place.

Then came the first meeting of people interested in CFD: three days in 2000 in a villa on Lake Garda; three rainy days during which we took stock with the participants of the potential of CFD and its possible developments. From there, we began a real transfer of technological knowledge and also began to broaden our horizons through research projects co-funded by the European Community.

Launched in 2006, NEWAC was one of the first of these projects: the aim was to reduce CO_2 emissions by 20% by 2020 (amongst ourselves we called it the 202020 target). It was a major challenge



2012: The turbulence produced by a side rear-view mirror (charLES).

It is now 15 years since the establishment of the Distretto Tecnologico Aerospaziale (or Aerospace Technology District) in 2009, of which EnginSoft was a founding partner. At that time, EnginSoft had recently opened its office in Mesagne and immediately, thanks to the mutual collaboration with University of Salento, shared the ambition and determination to create in Apulia an initiative that would gather around it public and private partners, industrial and scientific entities, with the aim of creating a network that would later become the Aerospace Technology District.

Over the past 15 years, it has proved to be an excellent experience, capable of becoming a winning practice across the European cluster landscape. It has been a long journey in which EnginSoft, like the other partners, has brought its expertise but also its market challenges to the table for shared value.

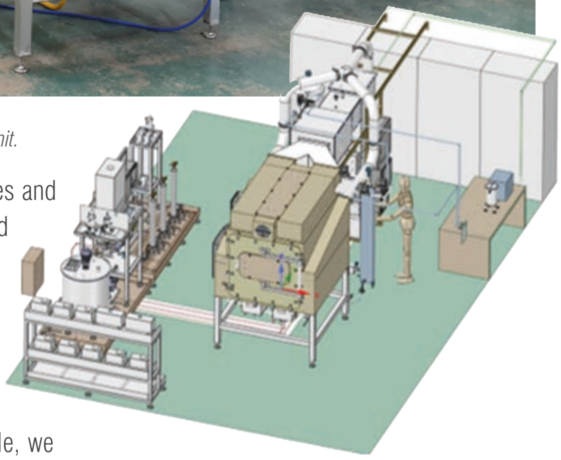
They have been years of extensive and intensive research and development that have fostered the development of new services or approaches to the market. One of these was the fleet management project led by partner Ge Avio Aero, in which EnginSoft participated by researching and developing new opportunities.

During these years, EnginSoft has contributed to the professional training initiatives of the district by participating in numerous postgraduate master’s courses, from which it has drawn some of its employees. In addition to some more specific collaborations, aimed at generating value for the company itself, it has participated in numerous orientation activities for schools and students, as well as national and international events dedicated to the aerospace community and citizens. We are very happy with what we have done together and with the contribution that EnginSoft has made to the project of building the aerospace ecosystem in Apulia, instilling a strong collaborative mindset and the habit of thinking and acting in complex systems.

I still remember the aperitif in a bar in Mesagne with Prof. Paolo Cavaliere, from the Department of Innovation Engineering at the University of Salento and Prof. Stefano Odorizzi, President of EnginSoft, and the subsequent meeting with EnginSoft’s CEO, Marco Perillo, a professional with whom I have a friendship as well as a collaboration. Those were the days when we tried to shape the future and combine it with our ambitions to make Puglia's aerospace industry more competitive and modern. It is satisfying to look back today and see that this has become a reality, and that time has done nothing but strengthen our collaboration, our commitment, and our friendship.

by Giuseppe Acierno
President of the Distretto Tecnologico Aerospaziale in Apulia

2019: Inauguration of the MELiSSA PaCMAN unit.



for aeronautics, combustion processes and CFD...even if emissions did indeed fall in the target year, thanks to the pandemic.

In the meantime, we gained a lot of expertise, and our skills were recognized internationally: for example, we received an invitation from the prestigious organization within Stanford University that deals with turbulence modelling. And we continued to grow, as EnginSoft itself continued to grow, as easily as a champion surfer rides the waves in which few others can even stand up.

That was the secret: EnginSoft has always perceived the “nine waves” before they arrived, which is why it has been able to ride them for almost half a century.

What does the future hold for us?
EnginSoft has now landed in both Europe and the USA. All that remains is to go to the moon. And indeed, according to the well-known principle of the biggest wave, we have been selected by the Melissa Consortium to study life support systems for astronauts on the next mission to Mars. And many acronyms and simulations later, we have built the first state-of-the-art facility to study crop cultivation (in the MELiSSA project's PlAnt Characterization unit for closed life support system engineering, MANufacturing and testing (PaCMAN) unit) in space mission scenarios: CFD – but also cutters, screwdrivers, and wrenches!

Coming full circle

Like the head of our CFD department, the heads of our other divisions may have stories to tell – and it would be instructive to listen to them. Overall, it may seem like a nice fairy tale, all triggered by a problem relating to the prices of fruit. But it wasn't.

What it was, and what it continues to be, is a wonderful adventure made possible only by the shared objectives, the shared spirit and the shared methods (I would say, above all, the shared style) of the colleagues and collaborators who, with great enthusiasm and each in his own field, have contributed with constant dedication, commitment, intelligence and initiative to the growth of the company, while preserving its identity.

Concluding with an image: EnginSoft has provided and continues to provide fertile soil, but it is its people, in freely expressing their creativity, who grow the most beautiful flowers and nurture them with love.

EnginSoft

From this land,
you were a child full of grace,
taking your first steps.
Then, your fingers on a keyboard,
sowed the seeds of a spark
a passion that grew
a young seedling reaching skyward
member of an expanding family,
heeding the call
and from that smoke
a flame was born.

From the branches you gazed at the sky,
A burning torch, blazing brightly.
A boot moulded you
from its mountains to its olive trees,
a daughter of the infinite stars,
growing, you soared free
in the blue origami sky,
a world with its moon,
unfettered mind
part of the numerical
path of philosophy.

You became a plant,
and among the currents of its movement
the struggles of advancing genius
pushing forward with solutions
amidst the noise of a turbojet
I devoted all my time to you.

Now you are woman,
daughter of Athena,
child of genius,
in the full splendour of your being,
poised to speak to me of neural networks,
of grand themes and diverse projects,
of the firmament and every adventure,
from your hands,
and your mouth,
and of those perfect forms,
of your feelings for others,
of grand dreams, bold and brilliant,
a technological galaxy,
you are always at the edge of engineering.

by Davide Daloisio
EnginSoft

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