TRIZ, Architecture & Engineering - practical assistance for Creative Genius

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Recently when in Barcelona I was a guest of Dassault Systèmes to see how their CAD engineering tools have helped realise the seemingly impractical artistic visions of architects both present and past to the great benefit of Spanish architecture. (see Gareth Beazant "Software at the Cutting Edge", Professional Engineer, 26th January 2005 Vol:18 Issue:02)

The difference CAD has made to our world in a very short time is often overlooked. I am old enough to remember the first CAD tools emerging in the late 70's/ early 80's. I remember it being thought of as a great asset for maker of cartoon films, but not much else. Many of those who recognised its potential made a lot of money and the rest of us witnessed the rare enthusiasm for its speed and power from engineers.

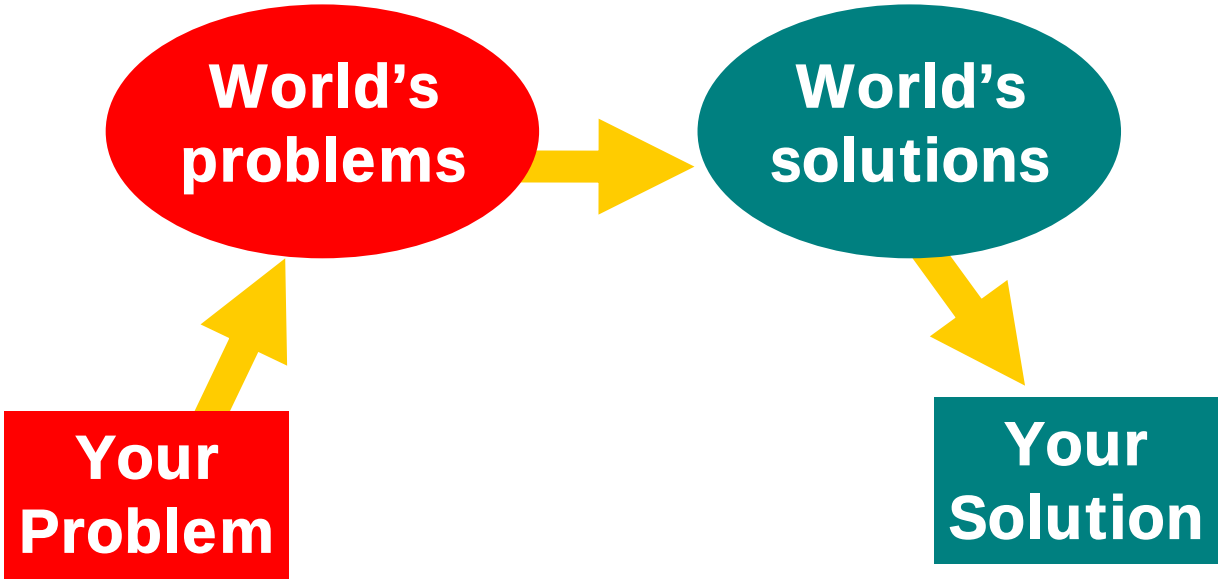
I think we forget how much innovative design in our modern world comes from advances in engineering tools for design and manufacture in the last twenty years. Anything from the fabulous complex curves of today's cars to the wonder of Gehry's Guggenheim museum owe much of their realisation to amazing new engineering advances which now reach beyond engineers to designers and architects and touch all society.

Architects are now joining the party and Frank Gehry Technologies have worked with Dassault to adapt the powerful and progressive CAD software Catia to create the newly named Digital Project. This bridges the gap between architects and engineers as it connects the architect's vision with the practical ways of achieving it. This is most powerfully illustrated in Frank Gehry's Guggenheim Museum in Bilbao, where the Digital Project software enabled innovative approaches for bending steel to match Gehry's vision – a process which may have been possible but much slower and more expensive without the software.

TRIZ, Innovation and Genius

CAD helped engineers to work faster and more effectively. The newly popular or re-discovered engineer's thinking tool TRIZ is now also enabling engineers to exert much greater influence on all aspects of society. TRIZ helps engineers solve problems in all aspects of life and is a great spur to creativity and innovation. TRIZ has been used in Russia since the 1950's but is only now beginning to be widely used in Europe, North America, and Asia. TRIZ originally came from an analysis of the worlds patents, showing there were just 40 solutions in all successful patents. TRIZ was then developed into a tool-kit to solve any problem and bring practical innovation to science and technology.

Great architects or any creative geniuses, great business people and our greatest scientists and engineers all apply the principles of TRIZ as if by instinct. The creator of TRIZ Genrich Altshuller spent his last years examining creative genius to show that TRIZ simply teaches the rest of us the behaviours and rules of genius – how to invent - how to design – how to be creative - but most important how to match good solutions (which probably already exist) to our problems. Success comes from recognising what is needed and how best to deliver it – this is the cornerstone of TRIZ which is given practical expression in the Prism of TRIZ shown below.



The Prism of TRIZ is the basis of all TRIZ problem solving. Frank Gehry unknowingly used this TRIZ approach to overcome challenges of realising his artistic vision. By recognising that the solutions he needed already existed (and that engineers had developed powerful software solutions which architects needed) Gehry helped move the innovation and power of modern CAD tools towards his own discipline.

Architects and civil engineers are now adopting much more sophisticated CAD tools to integrate their skills and effectively share information at all stages of complex construction projects. By intelligently adapting Dassault's Catia for architects Frank Gehry created a powerful architects tool in Digital Project and made it available to all architects advancing innovative architecture throughout the world.

Famous Architects help wider use of engineering tools

Engineers and architects are very different creatures and converging their skills is challenging. They have such different approaches and such different profiles in society. Try this - name 4 famous living engineers or name 4 famous living architects. I believe even engineers know more about architects. The inventor of TRIZ – Altshuller was one of the greatest engineers of the twentieth century – but hardly anyone has heard of him yet. His life's work TRIZ not only helps engineers and scientists become much more innovative and solve problems but it also could be used to predict how engineering tools would realise architects' dreams. TRIZ also tells engineers to learn from other's successes so what could architects teach

engineers? Perhaps we need more rich, famous, celebrity engineers to encourage the others?

Why do we have many famous architects today and hardly any famous engineers? Is it because engineering is now a group activity that makes great engineers so hard to identify individually? By contrast the creativity and genius which causes great strides in architecture can be mapped through the lives of our greatest architects who often need recognition to thrive and succeed. In engineering it is hard to imagine anything similar. Many great engineers are modest, self effacing and unrecognised. This makes them easy to work with, but may not be entirely good for recruitment to the engineering profession.

One of my daughters is nearly an architect and at the beginning of her training she wanted to switch to engineering because she wasn't sure she had sufficient ego to make an architect. She said that when she went to engineering lectures it was 100% engineering, when she went to architecture lectures it could be as high as 80% about the architect giving the lecture with the remainder on architecture.

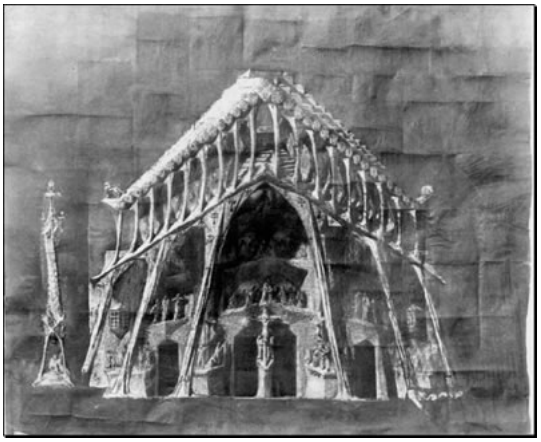
When she expressed an interest in civil engineering, she was advised to avoid the engineering lectures and go easy on the engineering knowledge in case it interfered with her artistic vision as an architect. It seems a strangely dated idea that art and artistic vision needs to be separated from technology, engineering or the realities of building anything. That kind of silo specialisation was a twentieth century phenomenon, as especially scientists and engineers went from generalists in 1900 to specialists in 2000. Perhaps with so much knowledge available to us all so easily on the internet we can see some more generalists emerge again and hopefully art and engineering can co-exist in one person as they once did in our greatest architects, scientists and engineers like Christopher Wren.

Adapting modern engineering software to architecture to help Gaudí

One fascinating application of Digital Product is helping fulfil Gaudí's artistic vision of his great Barcelona Cathedral the Sagrada Família which remains unfinished after 123 years of work. It is now hoped that finally it will be possible to complete the Cathedral according to Gaudí's specifications with these new tools before the 100th anniversary of Gaudí's death in 2026.

Vision of the church from the Passion Façade © Junta Constructora del Temple de la Sagrada Família

Tower detail © Junta Constructora del Temple de la Sagrada Família



Original Gaudí drawing of the Passion Façade © Junta Constructora del Temple de la Sagrada Família

Passion Façade with the J.M. Subirachs sculptures and three plastic provisional models of the superior columns © Junta Constructora del Temple de la Sagrada Família

Gaudí's innovative and distinctive work is so much part of Barcelona and Gaudí's home region in Spain; it is an example of how an architect's individual vision can transform our cities and give new personality to buildings, skylines and whole cities (like Christopher Wren's London). Both Wren and Gaudí are wonderful examples of artists whose vision encompassed not just the building and its context but how every tiny detail was part of the whole. This is something that great artists seem to do instinctively but is taught to the rest of us in TRIZ. This involves one of the most powerful TRIZ tools "Thinking in Time and Space." It is a very simple technique for learning how to deal with complex information and solve problems. In TRIZ terms it is called talented thinking and involves the ability to see the big picture and all the details simultaneously and see how their relationship to each other,

Gaudís work is a simple and powerful illustration of Thinking in Time and Space from the smallest details to whole structures; there are visions of an entire universe. His vision of the Sagrada Família encompassed much of his life and reflects his development and changing approaches towards complexity and simplicity. It is

exciting that we can now finish the job and match his artistic vision of the past and present by applying the latest technology tools available to us today.

The Sagrada Família is an unusual project in that it is financed entirely by donations and it is asked that all donations should result from some personal sacrifice. Gaudí had been only 31 in 1883 when named architect for the project and had been working on the Cathedral for 43 years when he was fatally run over by a tram. The current master of works, Jordi Bonet iArmengol, who is now in his eighties, took the job over from his father who worked with Gaudíon the project for many years. Hence Gaudí's wishes and traditions have been lovingly maintained to produce this huge and inspiring building. The adherence to Gaudí's vision of very complex structures and his specification that granite should be used, had resulted in slow progress using traditional hand tools.

The technology advances for Gaudí's vision were helped when the emergence of CAD was flagged up to Gaudí's team in the 80's by a young Cambridge University Diploma student Mark Burry. Burry - who is now Professor of Innovation at the School of Architecture in Melbourne and has been involved ever since – showed how use of early CAD tools allowed more accurate mapping of Gaudí's models this solved many problems but did not speed up the stone masonry.

Recently when Burry alerted them to Gehry's new CAD tools he showed how these link directly to modern granite cutting tools. Thus some of Gaudí's most /more complex shapes are now modelled in Digital Project which communicates to cutting tools at a Catalan granite quarry. Now for the first time since their design by Gaudí over 100 years ago, certain elements can finally be made, economically, accurately and fast enough to make the completion possible. This link from Gaudí's complex models to manufacture in traditional materials is an important step change – Gaudíhad specified granite and designed fantastically complex curves – the shapes and the materials were in conflict until Digital Project solved the contradiction. It hails a great new development for architects demonstrating how these new tools are offering practical and cost effective methods which enable the realisation of artistic design vision no matter how complex, at a much more affordable price.

Execution of the apse capital in granite stone © Junta Constructora del Temple de la Sagrada Família

Capital of the apse © Junta Constructora del Temple de la Sagrada Família

All the Sagrada Família recent advances, this solving of contradictions and the matching of the engineering technologies and skills can be predicted by anyone familiar Família with TRIZ. TRIZ shows us how to solve contradictions and predicts the merging of technologies, giving us routes forward to future products. The future of industries and technologies can be mapped by using the TRIZ Trends of Technological Evolution. One of the most powerful of these predictive tools called “Matching and Mismatching of Parts” maps the integration of technologies and forecasts the convergence of design tools and manufacturing processes, such as we have seen at Gaudí’s Sagrada Família.

Engineering and architecture are now reunited through software and technology to help realise artistic vision and create practical solutions – engineers are learning more from TRIZ – what effect will such a powerful tool have in the hands of architects?