Virtual Construction for our industry – an advantage now, a necessity soon

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Summary
Some key facts about the economic environment of construction industry are explained. It is shown that construction industry is very heterogeneous and has changed drastically during the recent years due to a rapidly moving commercial environment. Two examples of todays's use of virtual construction tools in construction projects are presented. The first example is the document control for a large international project. The second is the application of 4D modelling in the preconstruction phase of a dam project. It is shown that virtual construction, is a major international trend that currently takes up speed. Some generic industry needs for Research and Development which aims at short and medium term results are presented.

1 Introduction

Ladies and Gentlemen, **1**

Thank you very much, Prof. Beucke, for giving Wilfred van Woudenberg and myself the opportunity to present here in the ENCORD session to the entire forum of this important international conference. The conference aims at bringing together academics and practicing engineers. As for us, we represent the practicing engineers and within the next 1 ½ hrs we will present an industry view of a topic which we believe will have a big influence on our industry in the near future.

My name is Wolfgang Katzer, I am a civil engineer and have been working with HOCHTIEF for the last 21 years. My present position is project manager for innovation management at the Corporate Headquarters of HOCHTIEF in Essen. I am also HOCHTIEF's representative to ENCORD.

This is the overview on my today's presentation. **2**

- In the introduction I will introduce HOCHTIEF, the company I am working for and ENCORD. I will also explain what we mean by virtual construction.
- In the second part I will present some key facts about the economic environment in which we as an industry are working and also show how our industry has changed during recent years. I think this is important in order to understand the way our industry picks up R&D results as innovation.
- In the third part I will present two examples of the current use of virtual construction technologies in HOCHTIEF projects. In this part I would like to give an understanding of how far innovation has already reached industry and what the drivers for innovation are.
- In the last part of my presentation I will show industry trends and also industry needs for future developments.

HOCHTIEF has changed dramatically during the last years from a traditional German construction company with just a handful of international projects to a leading international construction services provider. With a workforce of 34,000 the HOCHTIEF Group today designs, finances, builds and operates complex projects of all kinds worldwide. HOCHTIEF is present in all key world markets. **3**

HOCHTIEF's new strategic alignment can be seen in the internationalization of the corporate structures. Today HOCHTIEF is organized in five Corporate Divisions. HOCHTIEF Airport is one of the biggest independent airport managers worldwide. HOCHTIEF Development develops commercial and industrial properties as well as infrastructure projects and operates facilities, properties and toll projects world-wide. HOCHTIEF Construction Services Americas with Turner at the top manages building construction and civil engineering projects in the USA, Canada and Brazil. HOCHTIEF Construction Services Asia Pacific with Leighton at the top focuses all activities in the Asia-Pacific region. Its performance spectrum ranges from traditional construction to the constantly increasing offer of services, for example in the field of contract mining. HOCHTIEF Construction Services Europe pools the company's core business of construction in Europe and offers its expertise in the infrastructure business the world over. **4**

HOCHTIEF has an annual work-done volume of approximately 12 billion euros. **5**
The company has grown considerably in 2000 and 2001 and today carries out nearly 85% of its work outside Germany. About 50% of our sales is generated in the US, mainly by Turner, and about 25% in Australia and the Asia-Pacific region, mainly through the Leighton Group.

This conference session is called ENCORD session. HOCHTIEF is a member of ENCORD. **6**
ENCORD stands for European Network of Construction Companies for Research and Development. ENCORD's strategic objective is to be Europe's forum for the promotion of industry-led research, development and innovation in the construction sector.

The 17 members of ENCORD are major European contractors and suppliers of construction materials. Activities of ENCORD include exchange of best practice, workshops on important topics, communication with the European Commission, networking with the construction research community and participation in European Commission advisory groups and other initiatives. If you want to know more about ENCORD please have a look at www.encord.org. **7**

The six ENCORD member companies Ballast Nedam and BAM from the Netherlands, HOCHTIEF from Germany, NCC from Sweden, Taylor Woodrow from the UK and YIT from Finland have founded the so called Virtual Construction Platform. Together with my colleagues from the Virtual Construction Platform HOCHTIEF organized, in conjunction with this conference, an international workshop on Virtual Construction. The one day workshop took place yesterday and we had very interesting presentations and discussions. Together with my Dutch colleague Wilfred van Woudenberg from BAM I will today report on our experiences and needs from an industry perspective. In my presentation, I will mostly take a HOCHTIEF perspective whereas Wilfred van Woudenberg will tell you about his experience with BAM and also of the results of our work of the last 2 1/2 years in ENCORDS's Virtual Construction Platform. **8**

What is meant by virtual construction? It basically means building digitally first. **9**
The most important key words to describe virtual construction are:

- Building model, product model
- Visualisation, Virtual Reality, walk through
- 3D design, 3D with data base, object oriented
- Design coordination, clash detection
- Simulation (construction, building performance)
- 4D (plus time)
- Automated cost analysis (quantity take off)
- Interoperability, integration
- Communication, collaboration

The long-term vision for virtual construction is the building model, the product model or, as it is also often called, the Building Information Model. By using visualization, virtual reality and walk through, building designs can be presented realistically and impressively. With the help of 3D design and engineering, the generating of drawings will be automated and design coordination improved. Design quality will also improve. By means of various simulations on the model, construction sequence and future building operation can be optimized. With the help of 4D CAD, i.e. the connection between model and schedule, complex construction processes can be simulated and communicated better than in practice today. By combining 3D CAD tools with estimating software, computing of quantities and cost will be automated. For all this to work we will need extensive interoperability and integration of software applications.

Basically, Virtual Construction will drastically improve communication and collaboration. Model based electronic data will enable process automation, simulation and visualisation to a much greater extent than today. The business driver for us as an industry is that design and construction will become cheaper and faster, the processes will become more secure, i.e. with less risks and mistakes.

2 Today's market situation – some key facts

I will now present some key facts about the economic environment in which we as an industry are working. As this conference is taking place in Europe I will focus on facts and statistics from the European construction industry which makes up roughly 30% of the world's construction market. The biggest national construction markets in Europe are Germany, the UK, France, Italy and Spain. They make up about 65% of the European construction market as a whole. **10**

If you want to check the healthiness of the national European construction markets, this "investment metre" shows quite well the status of these markets in the year 2003. All national European construction markets are positioned in the 4 quarters growth, dampening, recovery and decrease. That means all countries in the left part of the circle developed positively in 2003 and all those in the right half of the circle were in a downward (negative) development phase. The top five European national markets are marked red. All five markets are in the right half of the circle and therefore developed negatively in 2003, being either in the "dampening" or "decrease" quarter. **11**

For the future the picture is more positive as the big national markets - again marked red - will probably switch from negative to positive growth again, except for Italy. In 2005 they are in the quarter "growth".

For a more detailed characterization of the situation in 2003 and in the years before, I will show some figures for Germany. Construction investment in Germany has been declining steadily for more than a decade now; this slide shows the figures for 1995 to 2003. The decline was felt in practically all areas of the construction industry. **12**

At the same time the number of people employed in the German construction industry fell from more than 1,400,000 to about 800,000. That means a decrease of appr. 7% every year and, in total, a reduction of nearly one-half of the workforce within a period of 8 years. **13**

The situation in the German construction industry has been marked by decline in every respect: a decline in sales, hours worked, number of workforce, new orders, order backlog, number of companies and gross value added. This has led to a buyers market with fierce competition for fewer contracts with traditional, conflict oriented project delivery methods favouring a purely price-based market. The companies' margins are very low (or non-existant) and the risks are enormous. **14**

In addition to this economic development of large parts of the European construction industry I would like to point out one more major aspect in the construction industry: its fragmentation. You often hear people say that the construction industry is highly heterogeneous and fragmented. But what does that really mean?

The following figures show just how fragmented the construction industry really is. In Germany the biggest construction companies have a market share of only about one percent. **15**

In other European markets the situation is similar. In the UK there are only three companies that have market shares of 1.2 % or more. In France the situation is slightly different, with the top three companies holding market shares between 4.4 and 8.5 %. **16**

Our industry mainly consists of very small companies. The figures of this table make this very clear: 85.1 % of all construction companies in Germany have less than 20 employees. And only 0.1 % of the construction companies in Germany have more than 500 employees. **17**

The market shares of the big companies are very small. That means that no single company and no other major global actor can enforce the use of standards. This makes collaboration and integration very cumbersome and the development of standards nearly impossible. Fragmentation also means that there is no driver for innovation of our industry as a whole! All a single player in this market can do is to optimize the role he is playing.

Due to the rapidly moving commercial environment during recent years our industry has changed drastically. The major changes currently occurring in the construction industry are: **18, 19**

- Drifting apart of corporate groups (general contractors, system vendors) and small-size companies (suppliers, subcontractors)
- Shift from production to provision of services
- Shift from traditional construction to maintenance, conversion, servicing and operation
- Increase in public-private partnerships (PPP) and operator models. Here, skills other than traditional ones are crucial – for example financing expertise.
- Increasing industrialisation of production
- Increasing product diversity
- Continued division-of-labour process, that means that the actors are specializing more and more.
- Accelerated construction operations. The pressure is for shorter and shorter construction times.
- More stringent requirements on occupational health and work safety
- Sustainability is a major trend.
- Huge documentation need
- Strong influence of information technology (IT), thereby influence on labour market and training

These are some of the major changes occurring in our industry and these bullet points therefore give some important hints for future areas of Research and Development.

I hope the picture I have drawn of our industry is not too pessimistic. This was not my intention. **20**

I just wanted to point out that our industry is quite conservative, very heterogeneous and has been working in a very tough business environment. So to come back to the title of my presentation: At this stage I feel that we perhaps have to add a question mark to the title:

Virtual Construction for our industry – an advantage now, a necessity soon (?)

3 Current use of virtual construction technologies in construction projects – two examples

I will now present two examples of today's use of virtual construction tools in construction projects. **21**

3.1 Document control for large international project

The first example is document control for Lot C250 of the Taiwan High Speed Railway project. The high-speed rail link between the Taiwanese cities of Taipei and Kaoshiung will have a total length of 345 kilometres. To be completed in 2004, it is one of the world's largest infrastructure projects. As leader of a joint venture, HOCHTIEF Construction is responsible for designing and building the 40-kilometer long section C250 worth 750 million euros. The railway line has to cross valleys, rivers, rice fields, roads and railroads, so 90% of the link consists of bridge structures.

Some basic facts on this project: **22**

- 27 km viaducts built with precast elements
- 10 km in-situ concrete bridges
- 1.8 km steel bridges and composite bridges
- 0.7 km cut and cover tunnels
- 2.7 km earthworks with structural elements (retaining walls, etc.)
- 9 operation buildings

With a view to structured project implementation, the overall work was divided into 108 design units. Altogether there were seven design stages all design documents had to go through in order to be finalised. Altogether 48,000 drawings had to be managed. Including the revisions, we are talking about 127,000 drawings. On top of that there were 49,000 check reports and documents as well as approximately 1,000 structural analyses and other reports. Under the leadership of HOCHTIEF, the design work for the structures was carried out in Germany, India, Taiwan, the UK, Italy and Japan. The design review engineer was based in Denmark, the client and the construction site were in Taiwan. **23**

Such a large and complex international project, which also was under extreme time pressure so that the design works had to be carried out in parallel to work preparation and construction, requires efficient management and efficient management tools.

An electronic document control system is a must. The central link between the many parties involved was the document management system EPLASS. Within EPLASS all design documents and all relevant design information were stored and managed. As much as 12 parties located in Taiwan, Germany, Denmark, the UK and India were connected to the system. Of course all design documents had to be digital. (Mind you, this is still not the case in many construction projects.) **24**

Of great importance was the electronic workflow of the design documents. Individual workflows were established right at the beginning, on total 12 different workflows were implemented. This slide shows one of these 12 workflows as it was visualised by EPLASS. Visualisation is an important aspect of virtual construction. Usually the main emphasis is on the visualisation of the product itself. This is an example of the visualization of the process. **25**

This slide shows an additional advantage of digitalising project information: the system also delivers the data for design controlling. The lines show planned progress compared to actual progress. These curves were produced on the basis of the data available in EPLASS and were analysed regularly by the project team for every design unit as well as for the whole project. Difficulties in keeping to the planned schedules were spotted immediately. **26**

The major functionalities and benefits of the implemented system are: **27**

- efficient collaboration between parties carrying out their design works anywhere
- availability of all design drawings, analyses, reports etc.
- transparent status for each particular document
- high acceptance due to easiness of use
- use of standard IT hardware
- savings on personnel resources
- powerful document management system with excellent support.

One may argue that such a management of (2D) documents has nothing to do with virtual construction. On the other hand a fully digital 2D design is a first step towards building digitally. I also wanted to show that the future is not only about 3D models but also about 2D CAD, document management and workflow/process management. This situation will not change in the foreseeable future. Therefore we need both: developing and introducing 3D product models and, at the same time, efficient document management and workflow management. **28**

This example also shows clearly that the main drivers for innovation in industry are direct business needs. We would not have had a chance to complete this big international project in time without EPLASS or a comparable system.

3.2 4D modeling: Simulation of construction sequence for dam project

The second example I will present is the 4D modeling of the Burnett River dam in Australia. This project is part of our worldwide innovation programme ViCon (Virtual design and Construction) which runs from 2004 to 2006. ViCon is supported by our top management and aims at promoting the use of virtual construction techniques worldwide in HOCHTIEF's business units. **29**

We have structured ViCon according to our masterplan into the topics **30**

- Visualisation
- Cost analysis
- CAD planning and design
- Simulation
- Interoperability and integration
- Implementation

In the Burnett River dam project a 4D model was developed during the tender phase. The proposed Burnett River dam in South East Queensland is intended for regional water supply and irrigation. The project could be rated as a high-risk project, as it incorporates a number of challenges that must be overcome within a tight timeframe. **31**

The scope of construction options and related sequencing of work is somewhat extensive and is focused on probable flooding over a construction period of less than two years. The regional catchment is large and can boost the annual flow rate of one million mega-litres to at least 55,000 cumec/sec. Success is therefore dependent on managing the construction process in line with this major risk of flooding. Difficulties could also be encountered with unacceptable foundation material on the right abutment, interfacing the "Roller Compacted Concrete" of the dam to rock, as well as with possible design changes to the intake/outlet structure to accommodate fish management policies. Such possible variations to the scope could prolong the construction programme. Because of these risks 4D modelling was chosen as a tool to help designers and planners build and communicate design and construction options as well as foresee potential sequencing issues. **32**

After an initial workshop on 4D modelling with the project team, the modelling team worked in parallel with the designers and schedulers to produce both the 3D and the 4D model, as most of the design was being done using 2D. Several revisions were necessary as the schedule, design, and 4D model were evolving. **33**

(4D video clip) **34**

The client and the entire Burnett Alliance team were very impressed by the level of detail introduced into the model and everyone could see the advantages of using this technology on the project and future projects. 4D modelling aided even experienced project workers and all of the bid-team's 60 members to get a better feel for the work programme. Design innovations and potential construction sequencing problems were identified through 4D modelling, thus improving constructability and reducing costs. The 4D model proved to be an excellent communication tool both within the project team and to the Client. At Thiess in Australia 4D modelling has since been used in several other projects and more and more people start to realize its potential. **35**

This example, I think, should make us a bit more optimistic again with regard to the future of virtual construction in our industry, so I suggest that at this stage of my presentation we remove the question mark again from the title of my presentation and replace it by a fullstop: **36**

> Virtual Construction for our industry – an advantage now, a necessity soon.

4 Industry trends and industry needs

Let me now come to the last part of my presentation, where I will show some industry trends and also industry needs for future developments. What can we expect with regard to virtual construction in the next years, and what are the industry needs? I will try to give some answers to these questions. My colleague Wilfred van Woudenberg from BAM will also address these questions in his presentation. He will present what the six European construction companies of the Virtual Construction Platform and his company regard as future trends and industry needs. I will keep to a more general level, in order to avoid duplication with Wilfred's presentation. Our presentations together will give you the whole picture. **37**

Maybe the best source to find information on future trends for virtual construction are the publicly available final reports of the ROADCON project. In 2002 and 2003 a large effort was put into this project throughout Europe and world-wide. ROADCON was a "Strategic RTD roadmap" project funded by the EU and its aim was to develop a vision for ICT in construction.

Altogether 500 people from 300 organizations from the fields of research and industry in 30 countries around the world participated in this project. The vision developed by the ROADCON project is:

> The construction sector is driven by total product life performance and supported by knowledge-intensive and **model based ICT** enabling holistic support and decision making throughout the various business processes and the whole life cycle by all stakeholders.

Model-based solutions and the product model are at the core of this vision. According to ROADCON the building model of the future supports various engineering applications in marketing, architectural design, structural design, prefabrication, building services, quantities evaluation, construction and use maintenance services. **38**

The next slide shows the ROADCON target ICT system architecture. The figure is too complex to be described here in full detail, but let me point out some of the major elements: **39**

- The three houses at the top represent individual companies. In these companies there will be model-based applications with in-house knowledge data bases.
- These companies will act together in projects as virtual project enterprises.
- The red pipe represents collaboration and data exchange via the Internet.

At the bottom:

- Inter enterprise collaboration platforms with document servers and model servers.
- Trust center.
- Web services.

One other interesting statement by ROADCON which I would like to mention here is:
"Several trends and opportunities ….. are to a large extent generic, i.e. applicable to several industry sectors. …. The challenge for RTD in construction is to identify the opportunities to collaborate with and use results from other sectors while focussing its own resources on sector specific issues."

So to sum up, according to ROADCON, virtual construction is a major trend for our industry and beyond.

Virtual construction solutions have been picked up by major property owners and building owners like the US Coast Guard and the General Services Administration, two of the largest facility owners in the US. Most of the automotive companies like for example Daimler Chrysler are on their way to the digital factory and thus also to demanding virtual construction for the building part of their factories. The same applies to other major manufacturing companies such as Intel. Other clients like the British Airports Authority (BAA) in the UK, Senate Properties in Finland and Walt Disney Imagineering are also using 3D modelling for their construction projects. These are only some examples of clients who are demanding new ways of collaboration with the help of virtual construction technologies. **40**

There are even more reasons which indicate that virtual construction is a major international trend that currently takes up speed: **41**

- All major CAD vendors have introduced Building Information Modelling solutions as their key strategic tool
- Many new software companies come up with new products

- Major general contractors are realizing the potential of virtual construction for their business. Examples are the six members of ENCORD's Virtual Construction Platform. As I explained earlier on at corporate level at HOCHTIEF we have defined virtual construction as one of our key subjects for innovation.
- Most universities and research institutes teach and work in that area
- Young engineers coming from universities have the necessary knowledge
- …….

At the end of my presentation I will now point out some generic industry needs. Traditional research and development at universities is in the first place long-term basic research and development. However there is a huge gap between long-term basic research and real life in industry. In order to close this gap we also need research and development with short-term results. I think this type of target oriented, short-term research is a chance for both sides: for the research community to work on high-impact problems. For the industry to improve their business. We as an industry need the help of the research community as we often don't have the time and resources to do R&D work. **42**

We as an industry can only take part in R&D from which we will get something in return very soon. We always make up the business case for our company. Will we be able to earn more money with the R&D results? Will there be a return on investment to compensate the development costs? The decision whether or not we will start a certain development is taken by the Management of our companies, based on the facts and proposals by our technical experts. And the Management asks exactly these questions.

Some ideas for future research and development from the point of view of industry needs are:

Generic solutions
- Use of generic solutions which are not construction sector specific
- Learn from other industries, work together with them (e.g. car, manufacturing, shipbuilding, aerospace)

No greenfield approach
- We don't need greenfield approach solutions or breakthrough solutions without a realistic roadmap for the change process. We need a smooth transition from the actual way of working to the new way of working
- We have many software tools in use and cannot afford to throw them all away
- We need to use existing technologies in an intelligent way
- We need interfaces between software available on the market and data exchange between them. The professionals who use existing CAD, cost estimating and project management software need to be able to share and re-use project information more effectively.
- We also need to consider today's implementation problems

New ways forward **43**
- Take incremental steps and not only search for breakthrough solutions. This again refers to the smooth transition process I mentioned before.
- Fast prototyping instead of long development with result at the end. We have learned to avoid IT projects running for several years.
- We need easy-to-use, simple desktop applications (compete with Excel)

- Needs of users must be considered in a thorough and detailed way
- New technologies must not be introduced to industry in a premature stage
- Prove 3D to be economically successful for engineering design

Resume

I believe that the current structural change in the construction industry I explained in the first part of my presentation need not be an obstacle to innovation. The situation has, on the contrary, to be seen as an incentive and driving force for developing and researching new solutions. Only by permanent innovation can the new challenges be mastered and exploited in a positive way. **44**

For us, industry innovations like virtual construction as the result of target oriented R&D work are:

- a tool for differentiation
- an element of technical competence
- an element of acquisition activities
- an agent for reasonably priced and quick construction
- a driving force for development
- added value for both client and contractor
- an instrument for the standardization of the processes; the aim is fully transparent processes.

Virtual construction has the potential of covering all these aspects and therefore, for good reason, is a major trend in our industry. I believe that already today companies which use virtual construction have business advantages over companies which do not use virtual construction. In the near future this will change. Companies which do not use virtual construction will have a business disadvantage. **45**

Or, to put it short:

Virtual Construction for our industry – an advantage now, a necessity soon!

With an exclamation mark at the end!

Overview

1. Introduction
2. Today‘s market situation – some key facts
3. Current use of innovative ICT in construction projects
   - Document control for large international project
   - 4D modelling: Simulation of construction sequence for dam project
4. Industry trends and industry needs

HOCHTIEF

What in the world is HOCHTIEF up to?

HOCHTIEF is an international construction services provider. With a workforce of 34,000, the HOCHTIEF Group designs, finances, builds and operates complex projects of all kinds worldwide.

Operating through our global network, we are present in all key world markets.

HOCHTIEF

HOCHTIEF Group Organizational structure

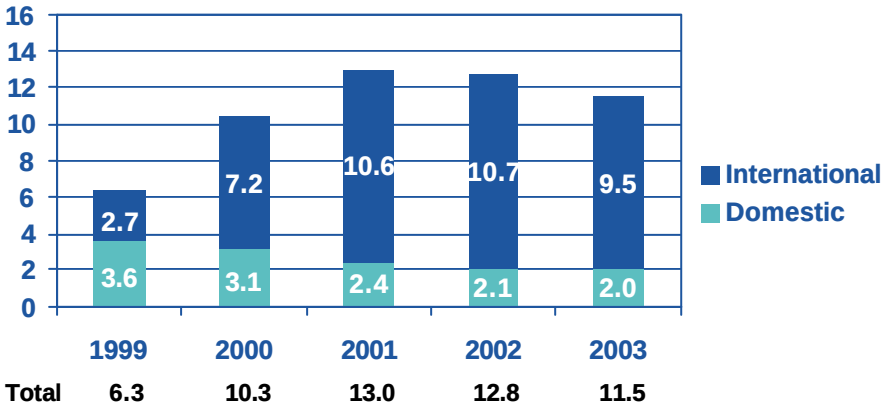
HOCHTIEF Aktiengesellschaft

Corporate Headquarters

- HOCHTIEF Airport
- HOCHTIEF Development
- HOCHTIEF Construction Services Americas
- HOCHTIEF Construction Services Asia Pacific
- HOCHTIEF Construction Services Europe

HOCHTIEF

HOCHTIEF: Work done in EUR billion



	1999	2000	2001	2002	2003
Total	6.3	10.3	13.0	12.8	11.5

HOCHTIEF

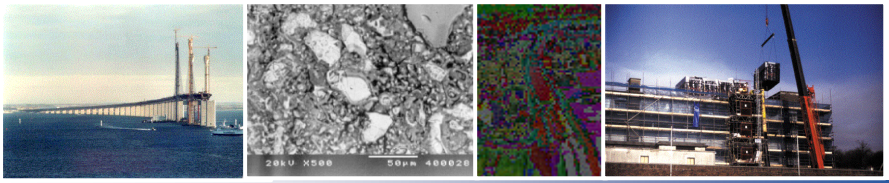
ENCORD

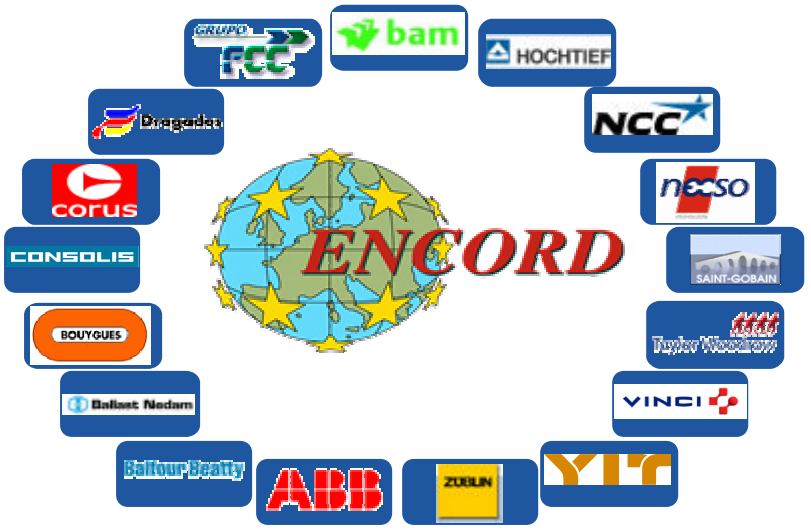
ENCORD's strategic objective:

To be Europe's forum for the promotion of industry-led research, development and innovation in the construction sector.

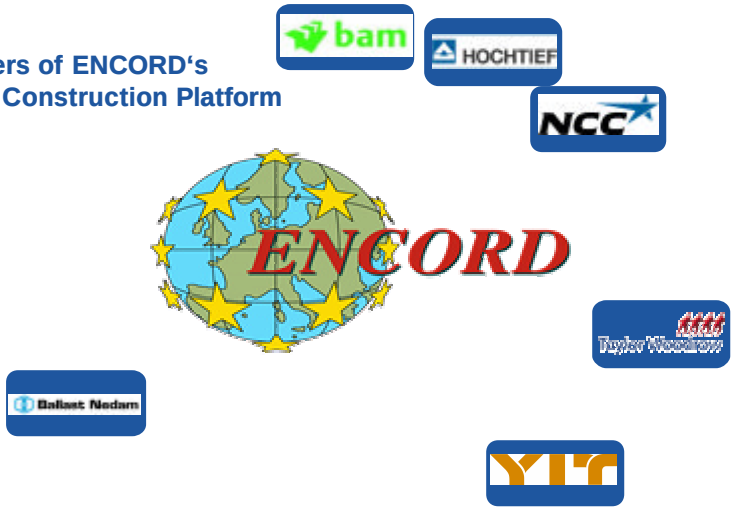
- President: Dr. Jesús Rodríguez, Dragados
- Vice-President: Dr. Michael Hirschfeld, HOCHTIEF
- General Secretary: Mr. Stefan Lindsköld, NCC

www.encord.org





Members of ENCORD's Virtual Construction Platform



HOCHTIEF

Virtual Construction means building digitally first!

- Building model, product model
- Visualization, Virtual Reality, walk through
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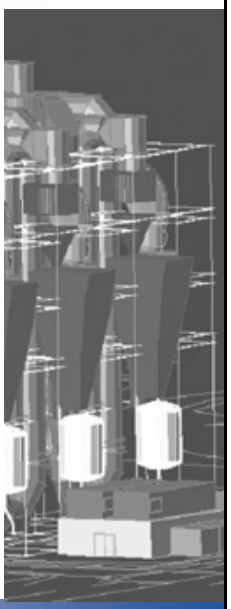
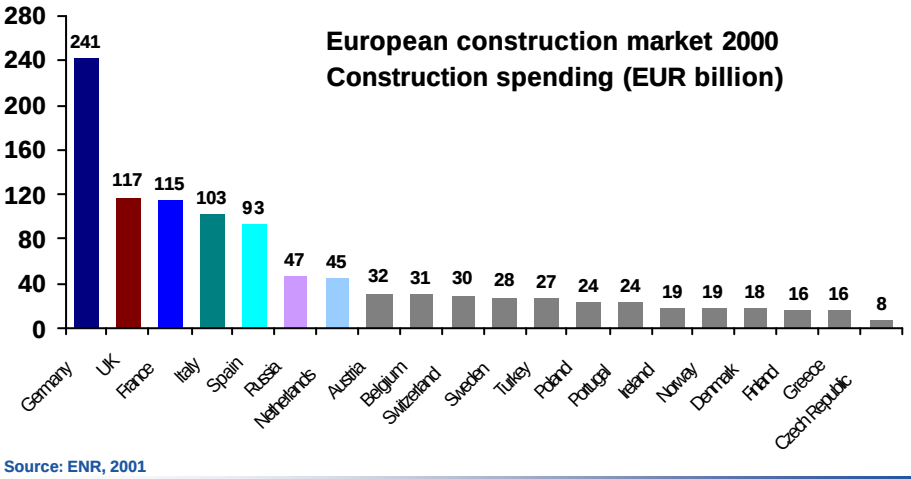


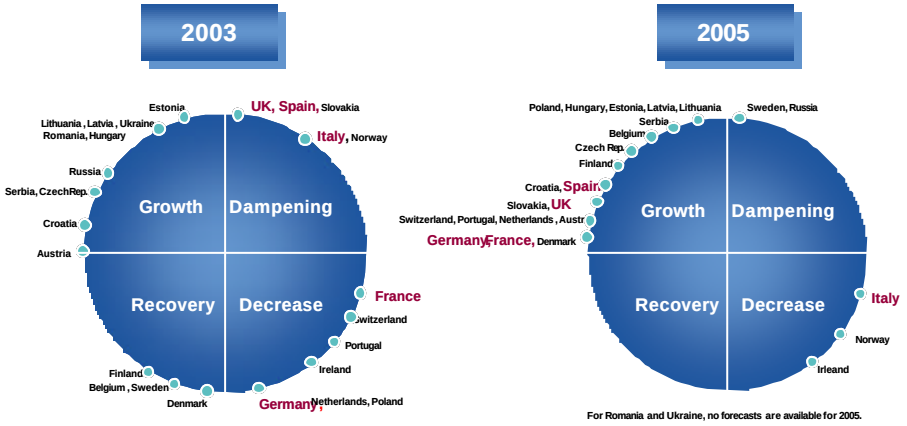
HOCHTIEF

Today's market situation – some key facts



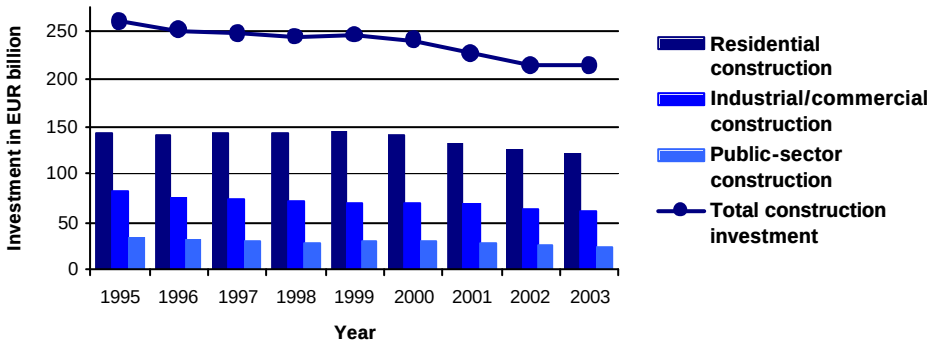
Source: ENR, 2001

Market development "investment metres"



Source: Euroconstruct

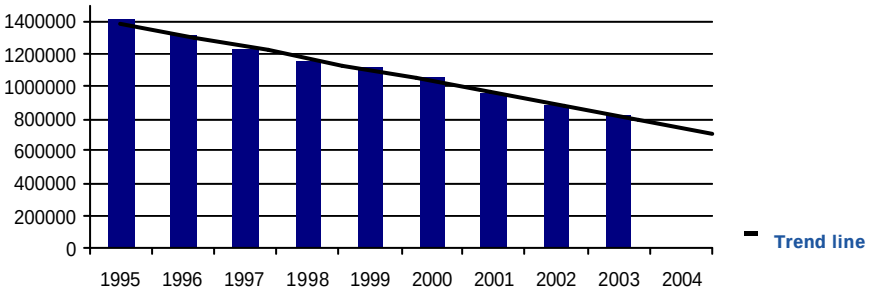
Construction investment - Germany



Source: Central Federation of the German Construction Industry

HOCHTIEF

Workforce in the construction industry - Germany



Source: Central Federation of the German Construction Industry

HOCHTIEF

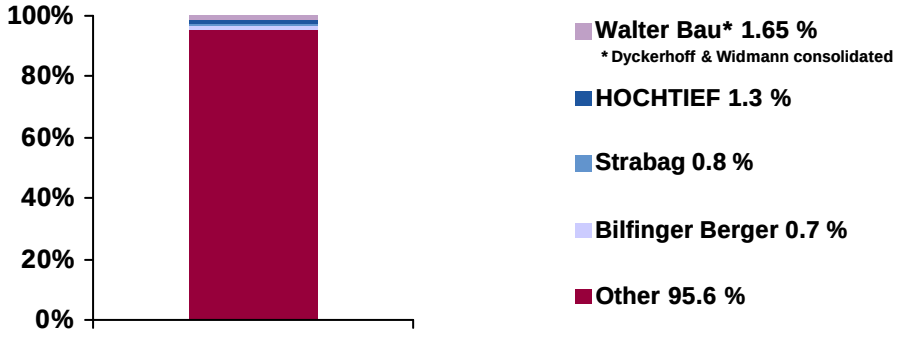
General situation in the construction industry (2000-2003)

- Sales ↘
- Hours worked ↘
- Workforce number ↘
- New orders ↘
- Order backlog ↘
- Number of companies ↘
- Gross value added ↘
- Insolvencies ↗

HOCHTIEF

Market shares of major construction companies in the home market (1)

Construction investment in Germany 2001



Source: "Bauwirtschaftliche Informationen" magazine (BWI-Bau), ENR

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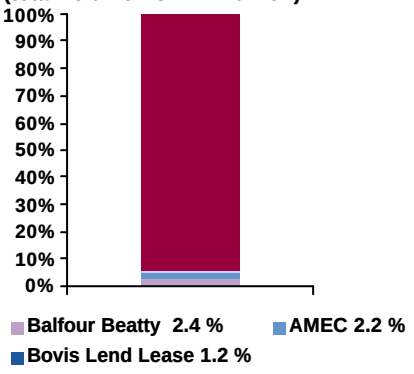
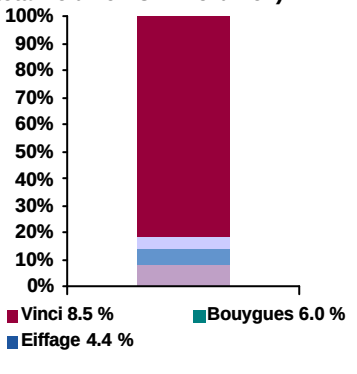
Market shares of major construction companies in the home market (2)

Construction investment UK 2000 (total volume EUR 117 billion)



Construction investment France 2000 (total volume EUR 115 billion)



Source: Central Federation of the German Construction Industry, ENR

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Structure of construction companies in Germany

Companies with ... staff	Number of companies	Share
1 - 19	67,804	85.1%
20 - 49	8,178	10.3%
50 - 99	2,332	2.9%
100 - 199	944	1.2%
200 - 499	303	0.4%
500+	79	0.1%
Total	**79,640**	**100%**

Source: Construction industry tariff collection 2001/2002, Central Federation of the German Construction Industry

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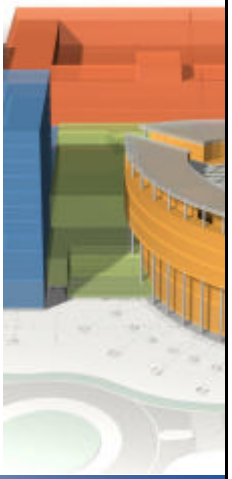
Structural change in the construction industry (1)

- **Drifting apart of corporate groups (general contractors, system vendors) and small-size companies (suppliers, subcontractors)**
- **Shift from production to provision of services**
- **Shift from traditional construction to maintenance, conversion, servicing and operation**
- **Increase in PPP and operator models (financing-expertise!)**
- **Industrialization of production**



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Structural change in the construction industry (2)

- Increasing product diversity
- Continued division-of-labour process
- Accelerated construction operations
- More stringent requirements on occupational health and work safety
- Sustainability as a major trend
- Huge documentation need
- Strong influence of information and communication technology, thereby influence on labour market and training

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Virtual Construction for our industry – an advantage now, a necessity soon (?)

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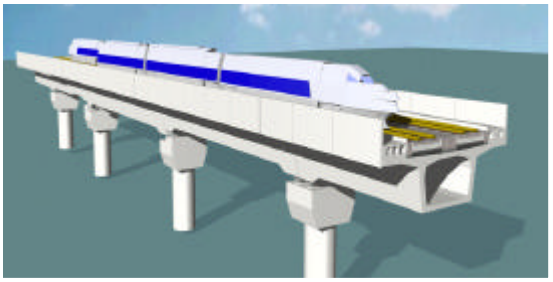
Document control at Taiwan High Speed Railway Project, Lot C250



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Taiwan High Speed Rail Project Lot C250

HOCHTIEF-Ballast Nedam-Pan Asia (HBP) Joint Venture

27 km	**Viaducts built with precast elements (box-girder)**
10 km	**In-situ concrete bridges (cast in place, movable shoring system, free cantilever construction)**
1,8 km	**Steel bridges and composite bridges**
0.7 km	**Cut and cover tunnels**
2.7 km	**Earthworks with structural elements (retaining walls, abutments, overpass etc.)**
9	**Operation buildings**

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Design units and design stages

108 Design units for planning and construction

7 Design stages
- Definitive design
- Intermediate design
- Final design
- Construction design CD1, CD2, CD3
- As-built design

48,000 Drawings (127,000 including revisions)

49,000 Check reports and documents

1,000 Structural analyses and reports (approx.)

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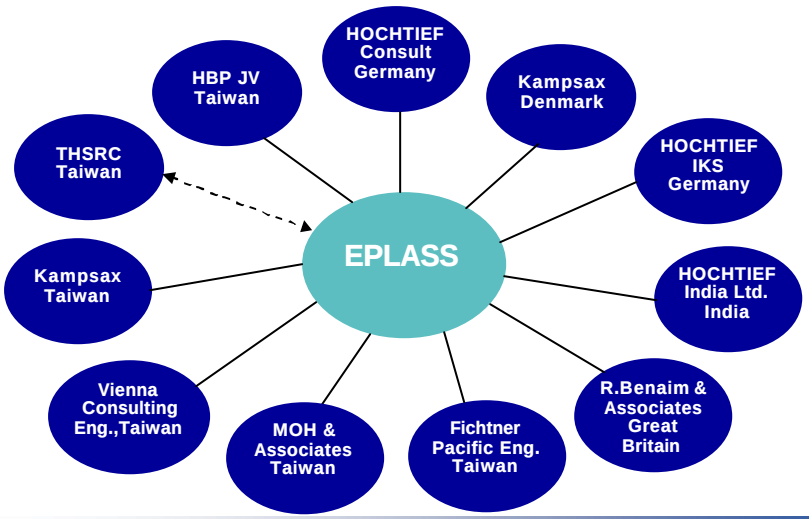
Links between the parties involved in design

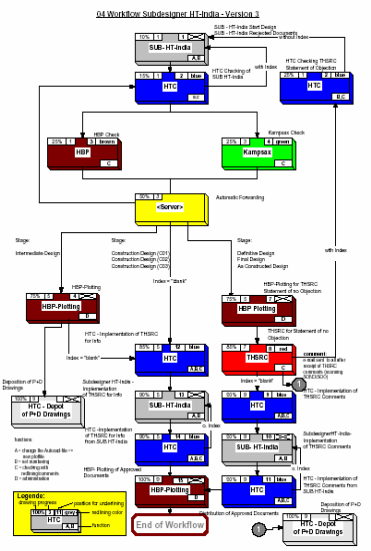


Workflows - Control of design documents

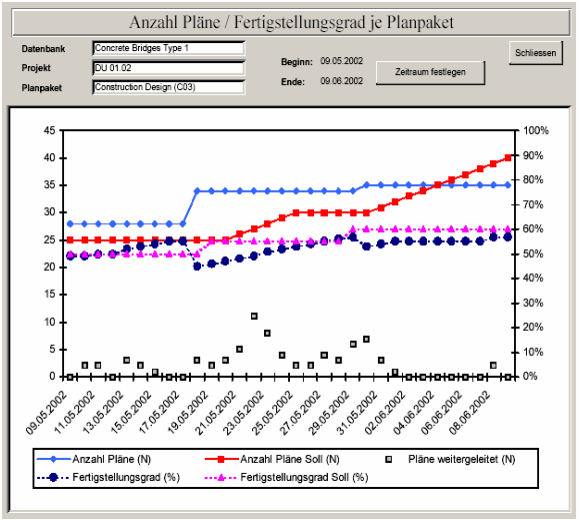
Workflows

- **Individual workflow for each designer**
- **12 different workflows implemented**
- **Visualization of steps for checking and approval**

All drawings, design analyses and reports are forwarded by EPLASS and are available for each party linked to the system.



Design progress - Controlling



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Functionality and benefits of the implemented system

- Efficient collaboration between parties carrying out their design works anywhere
- Availability of all design drawings, analyses, reports etc.
- Transparent status for each particular document
- High acceptance due to easy navigation, well-structrued views and filter options
- Use of standard IT hardware
- Savings on personnel resources
- Powerful document management system with excellent support

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Relevance to Virtual Construction

- Digital 2D is the first step to building digitally first
- Virtual construction is more than 3D modelling
- 2D, document management and workflow support will remain important in the future
- Also data exchange between 2D documents

➔ Main drivers for innovation are business needs

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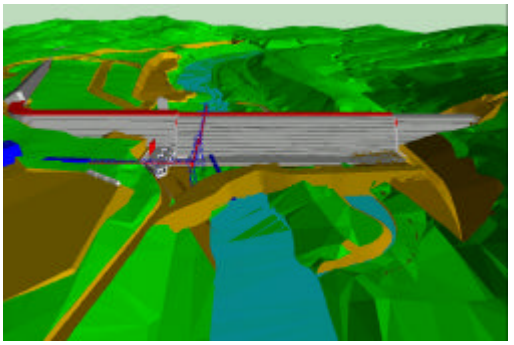
ViCon – HOCHTIEF‘s worldwide innovation programme

ViCon
VIRTUAL DESIGN AND CONSTRUCTION



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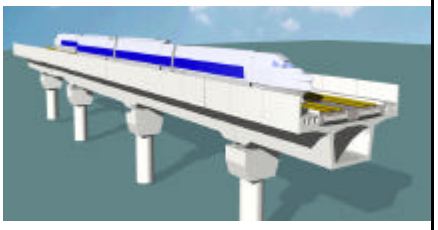
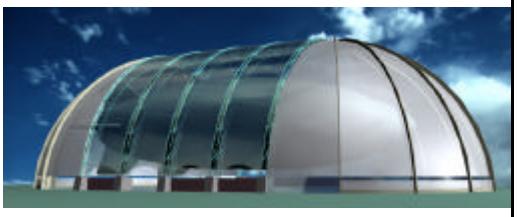
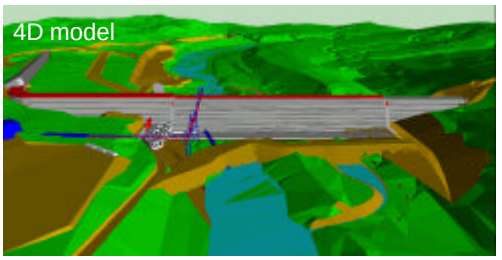
ViCon Masterplan

- Visualisation
- Cost analysis
- CAD planning and design
- Simulation
- Interoperability, Integration
- Implementation



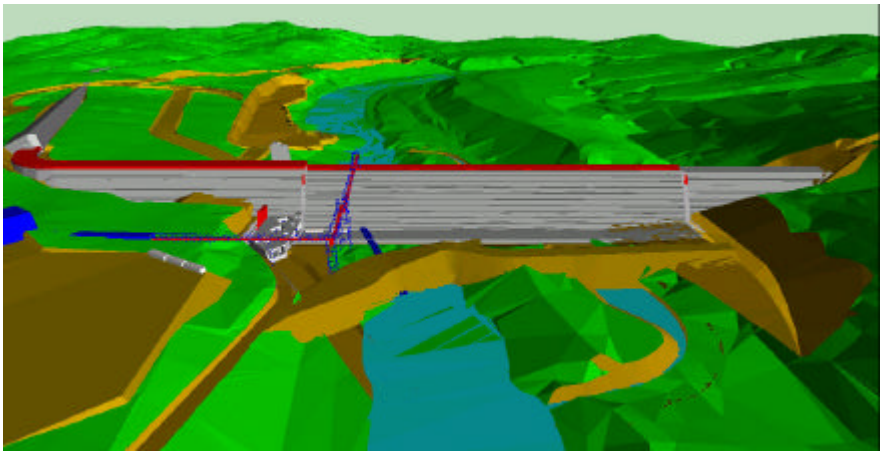


4D modelling: Simulation of construction sequence for dam project

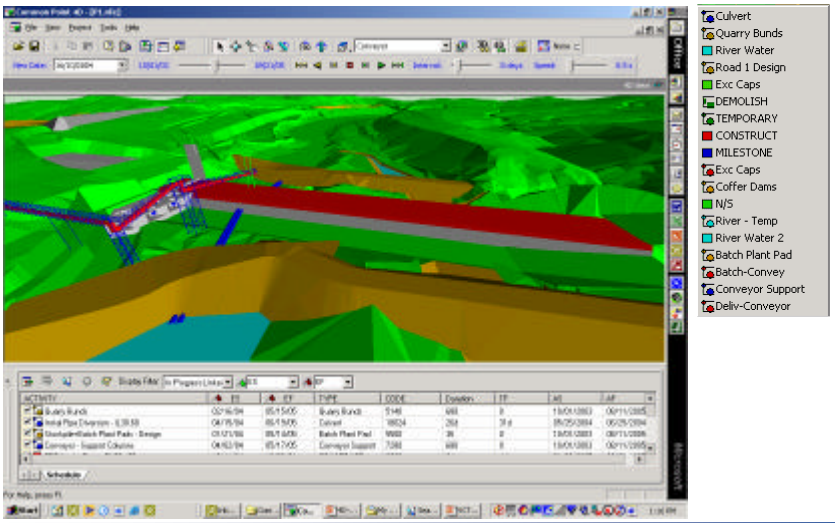


- **Burnett River Dam, Australia – May to Aug, 2003**
- **3D/4D team worked in parallel with the project team**

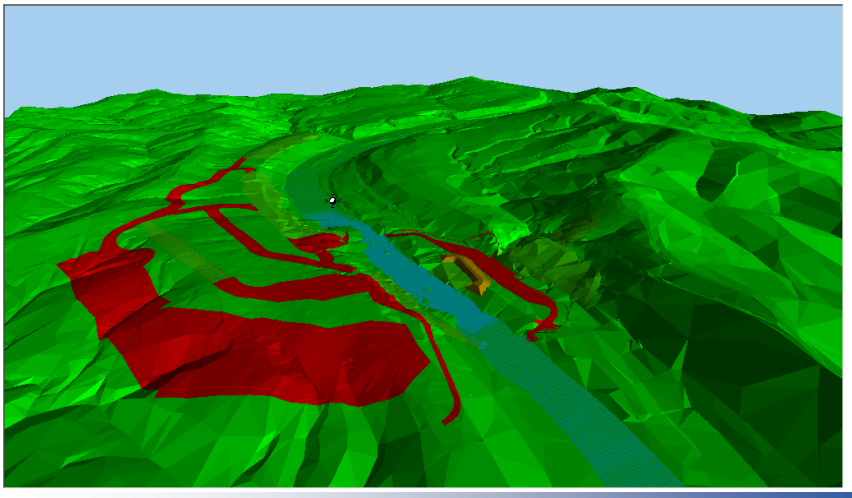
Burnett River Dam



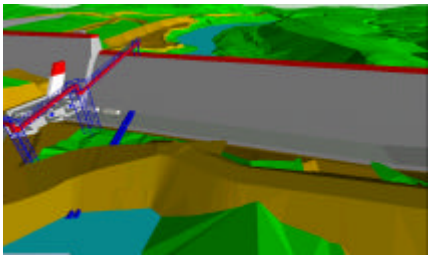
Common Point View

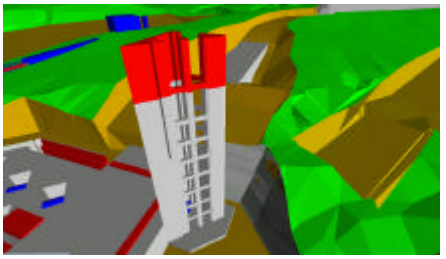


Burnett River Dam



Burnett River Dam





Client‘s and alliance team‘s comment:
"The 4D model simply and clearly demonstrated how the project is to be delivered and effectively displayed the proposed design and construction methodologies"

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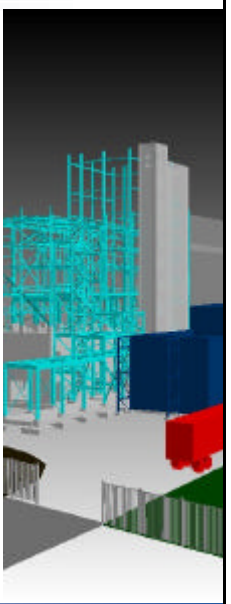
Industry trends

Vision for future ICT in construction according to ROADCON

“Construction sector is driven by total product life performance and supported by knowledge-intensive and model based ICT enabling holistic support and decision making throughout the various business processes and the whole life cycle by all stakeholders”



Source: ROADCON, Final Report, Sept. 2003
ROADCON: "Strategic Roadmap" project launched by the European Commission in 2002

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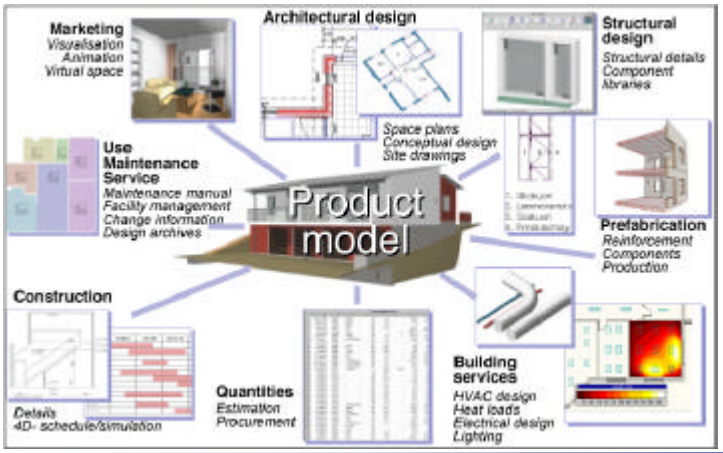
ROADCON: Building model supporting various engineering applications



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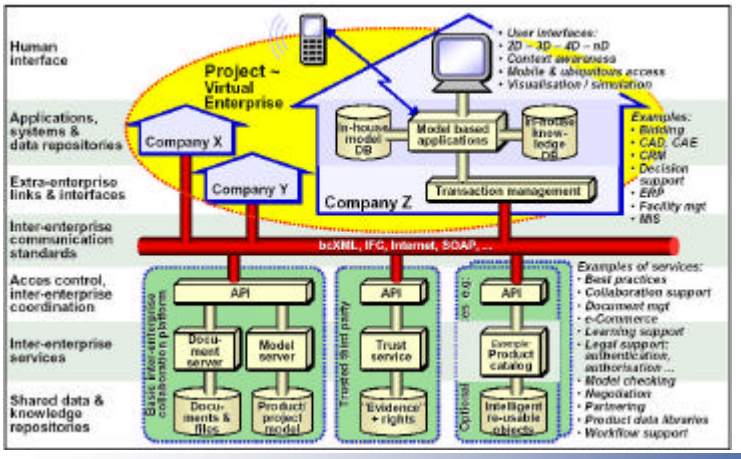
ROADCON: Target ICT system architecture



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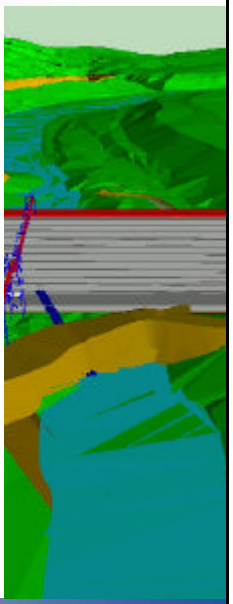
Trends in our industry: Clients demand Virtual Construction!

Owners are demanding new ways of collaboration with the help of virtual construction technologies!

E.g.:

- **US Coast Guard**
- **General Services Administration (GSA)**
- **Daimler Chrysler and other car companies**
- **Intel**
- **British Airport Authorities (BAA)**
- **Senate Properties**
- **Walt Disney Imagineering (WDI)**



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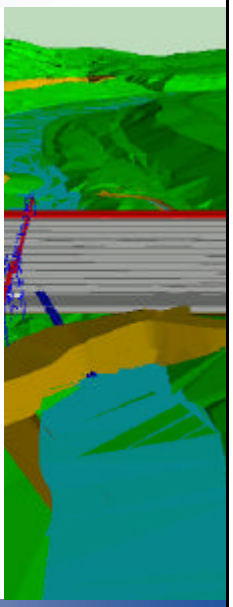
Trends in our industry ctd.



- Major CAD vendors have introduced Building Information Modelling solutions as their key startegic tool
- Many new software companies come up with new products
- Major general contractors are realizing the potential of Virtual construction for their business
- Most universities and research institutes teach and work in that area
- Young engineers coming from universities have necessary knowledge
- ……..

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Industry needs

Generic solutions

- Use of generic solutions which are not construction sector specific
- Learn from other industries, work together with them (e.g. car, manufacturing, shipbuilding, aerospace)

No greenfield approach

- We have many software tools in use and cannot afford to throw them all away
- Use of existing technologies in an intelligent way
- Interfaces between software available on the market and data exchange between them
- Solve today's implementation problems

Industry needs (ctd.)

New ways forwards

- Incremental steps
- Fast prototyping instead of long development with result at the end
- Easy to use, simple desktop applications
- Needs of users must be considered in a thorough and detailed way
- New technologies must not be introduced to industry in a premature stage
- 3D must become economically successful for engineering design

Resumé

The structural change currently taking place in the construction industry must not be an obstacle to innovation. The situation has, on the contrary, to be seen as an incentive and driving force for developing and researching new solutions. Only by permanent innovation can the new challenges be mastered and exploited in a positive way.

Innovation as the result of target-oriented R&D work is

- a tool for differentiation
- an element of technical competence
- an element of acquisition activities
- an agent for reasonably priced and quick construction
- a driving force for development
- added value for both client and contractor
- an instrument for the standardization of our processes


HOCHTIEF
Virtual Construction for our industry –
an advantage now,
a necessity soon!