BIM – Building Quality
Content 2
Dear customers and partners 4
Smarter Planning, Design, Construction and Facility Management with BIM 6
BIM in Building Projects 8
New Karolinska Solna 10
Good Samaritan Hospital 12
Barts and The Royal London Hospital 14
KBS Shopping Center 16
James B. Hunt Library 18
Manskun Rasti 20
CB Centrum 22
Nyhamn Apartment Complex 24
BIM in Civil Projects 26
M25 Widening 28
Highway 78, Brawley Bypass 30
A1 motorway, Gdańsk – Toruń 33
Bjørvika Tunnel 34
Crusell’s Bridge 36
Bim in Industrial Projects 38
Catskill and Delaware Water Treatment Ultraviolet Disinfection Facility 40
eBay Inc., Project Topaz 42
Atmospheric and Vacuum Distillation Unit 44
Every Step of the Way 46
The most recent significant improvement in our services is Building Information Modeling (BIM) technology, which offers several benefits to you. BIM is the latest building information management system, which can be used in the design, construction and even maintenance phase of the building. Using BIM, the performance of the building or infrastructure can be designed incorporating its most important features and described clearly in an illustrative three-dimensional format that includes all necessary information.

Naturally, BIM is very useful for developing projects here at Skanska. From the perspective of designers, BIM is helpful because it significantly improves their collaborations and enables optimized and flawless design. BIM fully supports Skanska’s important five zeros vision goals by improving safety, efficiency and enabling zero defects during the construction phase. BIM also ensures that we have the best future personnel who continuously raise quality and customer satisfaction.

Skanska has always been known for developing cutting-edge technology and investing in the future. The purpose of these activities is to be able to offer better solutions, quality and service to our clients and stakeholders. We have been actively developing green solutions, a better safety culture and new technical solutions, for example, in all of our main business areas.

We at Skanska have conducted extensive work in developing BIM together with all of our global business units. We are now very pleased to be able to offer this global knowledge locally to you. We have compiled our best examples into this publication, which gives you an excellent overview of the benefits you may enjoy by using BIM on your project, in whichever Skanska market area you may be operating. Take your time to read through these good examples and do not hesitate to request further information from our contact people or refer to our website: www.skanska.com/BIM.

BIM is changing the construction world, get ready to take advantage of all the benefits it offers – let’s do it together!

Kind regards,

Johan Karlström
President and CEO, Skanska AB
Smarter Planning, Design, Construction and Facility Management with BIM

The emergence of BIM-related technologies is transforming the construction industry and continues to reshape how Skanska delivers projects. BIM specifically refers to a virtual, intelligent (containing precise information about the facilities, components and materials), parametric model of the facility to be constructed that gives the project team new ways in which they can continuously improve the delivery process.

Skanska has implemented BIM on many types of projects (for example, buildings, roads, bridges, tunnels and industrial plants) and has realized a variety of benefits, including improved communication amongst project stakeholders, enhanced efficiencies, greater certainty for both schedule and cost conformance and the reduction of risk. Skanska recognizes that BIM affords us the opportunity to deliver a higher quality product in the most efficient manner to our clients.

One consequence of BIM is the creation of a collaborative atmosphere where clients, designers, material producers and construction companies work together with the goal of achieving the best possible solution. BIM is not just a technological solution; it helps enable new ways of working together in a more collaborative and informed process.

Customers and clients can visualize what kind of solutions and alternatives are available for their project. Visualization of the model, whether it be simple views or the ability to walk through or fly around the virtual project, offer new opportunities in communication and understanding, which leads to better decisions. By investing in BIM-based design and construction, satisfying our customers’ desires for their project becomes easier.

BIM offers several ways to benefit the different phases of a project: design, preconstruction, construction and finally facility management. The design can be easily understood and reviewed to help guarantee its accuracy and completeness. Alternatives can be more easily understood and evaluated in terms of cost and other project parameters. Sustainability analyses can be performed and different kinds of quantity calculations of spaces and materials can be done.

Another way BIM enhances the process is by allowing the project team to determine the best way to construct the project by linking the model to proposed project schedules and studying various sequencing concepts. These kinds of processes can shorten schedules and in aggregate lowers life cycle costs and generates more accurate information to support investment decisions. This adds mutual understanding and reduces the risks in the project.

The construction team can get the material information easily from the models and buildings can be built virtually by visualizing the schedules before starting actual work.

Safety planning becomes easier when the production team can examine the virtual building and determine hazards before they occur and plan how to handle them. Work can be more easily coordinated using clash detection techniques and field problems can be solved virtually before they actually occur. Finally, the models can be completed with as-built information and integrated with all of the operation and maintenance required of the project and delivered to the owners as part of their facility management strategy.

BIM is a major component of our future in the construction industry. At Skanska, we have readily embraces this dynamic tool, always striving to improve our overall delivery process. Skanska brings you the combined experience of our operations from around the world, committed to achieving our clients goals with the most creative and efficient means.
BIM in Building Projects

From office buildings to shopping centers, hospitals and residential development, BIM has already proven its potential across all stages of various building projects. From early design to the production phase, coordination and overall efficiency can be substantially improved all with greater control of risk. BIM enables sustainable design with energy, green and CO₂ calculations.

Good Samaritan Hospital
Puyallup, Washington, United States

James B. Hunt Library
Raleigh, North Carolina, United States

Barts and The Royal London Hospital
London, United Kingdom

Nyhavn Apartment Complex
Gävle, Sweden
Having a contractual delivery on BIM, a thorough basis for BIM usage throughout the project has been created. Even though the project has just recently got under way, BIM’s position as a common tool is already winning grounds within the organization. Intelligent 3-D design is a requirement in today’s construction business. In the NKS project, every designer is allowed to use the software of their choice as long as export formats are compatible with other designer software. Project members use a central server to exchange model files weekly and Skanska chairs bi-weekly model coordination meetings where hard and soft clashes as well as better solutions are discussed. The models are also used to simulate movement of medical equipment and to assess accessibility of facilities management services.

The intelligence of the models is used to support the work of the project team across all phases. It

The NKS Project is the first Skanska project in Sweden to have BIM requirements in the contract. This means that Skanska has been contracted to work in BIM and to deliver an object-oriented BIM model with information that is linked to the model through appendices or related databases. This BIM model will provide the client all information needed for FM services and future reconstruction.
provides functions such as procurement and planners with detailed and efficient information takeoffs, and as a result time has been freed up to optimize and evaluate options and work with value-added tasks.

Working in close collaboration with Skanska UK, the team has now started to implement production progress tracking using the model. Combining experiences from the UK with new ideas of how to work with the tool, Skanska is now able to utilize it at an earlier stage. Working this way provides everyone involved in the project with a good visual tool of how work is progressing.

Using the model as a basis for facility management requires a clever way of locating objects; therefore an asset code was developed and is continuously implemented by designers as the design progresses. The asset code specifies location, function and product and can be, for example, electronically read by service technicians in the field to enable them to register service errands and extract technical documentation and manuals on the spot.

“We will not only use BIM to do production calculations and quantity take-offs, but also when we physically mark teledata in the project. We will let the designers use a specially designed software that will allow us to save about 1,000 hours of double work. All thanks to BIM.”

Andreas Udd
Project Manager, Skanska Installation

<table>
<thead>
<tr>
<th>New Karolinska Solna</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gross area</strong></td>
</tr>
<tr>
<td><strong>Floors</strong></td>
</tr>
<tr>
<td><strong>Rooms</strong></td>
</tr>
<tr>
<td><strong>Beds</strong></td>
</tr>
<tr>
<td><strong>Operating rooms</strong></td>
</tr>
<tr>
<td><strong>Radiation bunkers</strong></td>
</tr>
<tr>
<td><strong>Reception rooms</strong></td>
</tr>
<tr>
<td><strong>Price of building</strong></td>
</tr>
<tr>
<td><strong>Price of services</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>PPP companies</strong></td>
</tr>
</tbody>
</table>
The implementation of Revit Modeling in lieu of traditional construction documents allowed the owner to better understand the intention of the design before the facility was built. At Good Samaritan Hospital the architects and engineers performed weekly design updates to a central file transfer site to give all the team members access to the most current information. Skanska downloaded that information every week and separated it by floor into 2-D and 3-D AutoCAD backgrounds for subcontractor use.

At the same time Skanska maintained an exact record of every page of every contract document throughout its lifespan and alerted the design team if a new portion of the model design was impacting anything that was already contracted in a previous document release. In addition, Skanska maintained our own Revit structural model that incorporated all the latest

On the Good Samaritan Hospital Expansion project in Puyallup, Washington, the designers used the first component of BIM, model-based design, to quickly and accurately convey the design to the owner. A memo of understanding was agreed upon by all members of the design team to use Revit 3-D modeling software.
structural RFIs (request for information) and was used for self-performed concrete lift drawings and rebar detailing as well as structural backgrounds for mechanical, electrical and plumbing (MEP) coordination.

At Good Samaritan Hospital Skanska recognized that the modeling needs for designers and contractors were different. Thus, Skanska incorporated an integrated approach to the design. Skanska and the mechanical and electrical subcontractors started their own 3-D modeling efforts very early in the process. Using Navisworks software the construction team regularly compared the current architectural model with the current as-built structural model and the current subcontractor MEP models. Collisions were detected early in the project and often before the actual designs were complete. This greatly reduced the potential for time-consuming field fixes and delays.

In addition it allowed pre-fabrication of large sections of systems that would historically have taken much longer in the field.

Timely and accurate communication of quality control issues and work to complete among all members of the team, including subcontractors, has always proven to be a challenge. This challenge becomes even greater on fast-track projects when all activities are compressed and stacked in order to meet the deadline. To assist in streamlining and providing more efficient communication, Skanska utilized notebook computers in the field to access relevant portions of this information along with shop drawings, RFIs and hard-copy documents. The team maintained “live” work-to-complete lists and performed quality control checks using the same information that was available in the model.

“In relation to the design and construction of our new 360,000sf (34,000m²) patient care tower addition to our older hospital buildings, dating back as early as the 1950’s, the facilities team has appreciated, and is learning, that the use of BIM in this project not only bridged the information loss associated with handing a project from design team to construction team, but now to the hospital. BIM allowed each group in each phase of the project to add to and reference back to all the information they acquired during their period of contribution to the BIM model. BIM is beginning to prove its influence in enhancing our ability to manage our new facilities.”

Allison M. Garr, Fache
Administrator, Campus Development, MultiCare Health System
Furthermore, the CAD objects can be interrogated to swiftly and accurately extract quantities and material lists. This was used to re-inform the cost plan, challenge trade contractor tender prices and enable the environment team to set ambitious waste targets on the basis of robust data. Another use of the data was to link design information directly to trade contractors estimating software, thus saving time on the tender program. Finally, the building services model has been a key driver in the decision to use modular services in the corridors, which led to significant program saving.

The design, construction and maintenance teams met weekly to walk through parts of the model to check for safe access, usability and maintainability. Early decisions were made on valve and rodding eye positions, trip hazards were identified and mitigation agreed, platform and access ladder requirements were confirmed. Particular weekly model walk round
meetings successes have resulted in the elimination of mansafe roof restraints and the minimization of confined spaces by identifying and rerouting services in the finished building.

The ability to move objects around the virtual world and check for clashes has been used to confirm the installation and removal strategies for all the large pieces of plant and medical equipment. For example, increasing the size of three doors and reducing the depth of a downstand beam at the design stage has saved GBP 120,000 (USD 187,000). This dynamic clash checking has been particularly important for verifying the medical equipment installations. The kit is typically delivered just in time and therefore needs to fit first time. The team were able to change door sizes and corridor widths to ensure the installation of the equipment without demolishing completed rooms.

The model has been used to provide quantities for virtually all the building elements. A particular success has been the use of these quantities by the environmental team who have used the data to set and meet an ambitious 10 percent waste target for subcontractors.

So, as far as the Barts & London project is concerned, the 3-D model started as a method of ensuring spatial coordination but turned out to be a tool to improve quality, reduce costs and waste, save time and improve health and safety for the end user.

Finally, as part of an industry leading development the combined 3-D model was taken out onto site on tablet PC’s and became the hub of the BIM system by providing a route map to other databases and data sources stored on the tablets. The system was used for monitoring the progress, compliance and completion of the delivery of some 5,000 rooms, provide access to the latest drawings and room data sheets via a link to the document management system and the recording of snags (Punch list items) at source on site.

“I don’t want pretty pictures or drawings. I may ask for them, but what I want is data I can interrogate in different ways – for quantities and room areas – and yes, maybe some drawings too! But seriously, we have learned on the Barts & London project that if the designers concentrate on getting the design data right, then a variety of views – drawings, 3-D models, spreadsheets and databases – can be generated or extracted as appropriate.”

David Throssell
BIM Technical Manager, Skanska UK
Once established as a BIM project the ambition level was initially set to collision control and quantity take off. The project team’s enthusiastic adoption of BIM soon led to an expansion of these ambitions to include visualization both to aid decision making from the client and to sell both retail and residential spaces.

At the kick off, the designers from all disciplines were called into BIM workshops. During these workshops the routines and methods for modeling, model requirements, file exchange, delivery dates and collaboration were agreed upon. A further workshop was run to check for correct coordination of each discipline’s model within the merged multidiscipline model.

Through support from the BIM coordinator, Skanska Norway ensured that all designers on the project are taken care of on all technical levels. This means they get the necessary support and training in the software they use on the project. This support and competence
is available at all times throughout the duration of the project.

Using the software competence in the BIM department, any challenges that arise are quickly addressed and solved. Skanska contributes by creating special objects missing from the standard libraries so that the architect’s design process was not delayed by creating objects.

Among other objects, escalators and ramps were modeled using internal BIM resources and delivered to the architect to speed up the process so that the structural engineer could run structural simulation on time.

As production started, members of the project team used the models for quantity take-off to order materials for production on a day-to-day basis. The models were used to create excavation plans in 3-D for import to the excavation contractor’s machine guidance system. This pioneering use of BIM models saved several weeks of work usually used to create excavation models from 2-D plans, and proved so efficient that new models from the structural engineer are used to update the excavation models in a matter of hours rather than days. The amount of additional information and 3-D models available to the project team and their subcontractors led to a highly efficient and problem free excavation phase in which all parties were better informed than what had otherwise been possible.

<table>
<thead>
<tr>
<th>KBS Shopping Center</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total area</td>
<td>72,000m² (775,000sf)</td>
</tr>
<tr>
<td>Retail area</td>
<td>36,000m² (388,000sf)</td>
</tr>
<tr>
<td>Parking area</td>
<td>28,000m² (301,000sf)</td>
</tr>
<tr>
<td>Residential area</td>
<td>81 units</td>
</tr>
</tbody>
</table>
When completed in 2012, the facility will feature an automatic book delivery system, in which a robotic arm will retrieve books from a climate-controlled underground storage vault where over 2 million volumes will be stored in bins. Underground storage will allow more room in open public spaces for perceptive pixel displays and touch screen displays.

With such a unique, innovative building, the Skanska team wanted to take an “all in” approach to BIM and technology, leveraging new tools as much as possible to mitigate risks in construction, beginning in preconstruction and continuing all the way to hand over.

One particularly significant challenge in the design of the library was the custom unitized curtainwall system, which comprised over 800 unique panels, each of which had to be installed in a precise location and perform at the highest level. In order to manage this critical path activity, Skanska developed a supply
chain management protocol that involved barcoding each curtainwall unit and tracking its status from fabrication through installation. This information was linked to the team’s BIM model, allowing for easy visualization of the real-time supply chain information and giving the team the ability to more accurately sequence work based on updated production rate. This innovative approach helped the team complete the curtainwall installation in just 13 months from award—a large improvement from the 24 months originally requested by bidders.

Another critical aspect of the way the team is building the library revolves around the use of Mobile Electronic Resource Stations (MERS) on the jobsite. While Skanska personnel has the benefit of iPads and tablet PCs for updated, marked-up plans at their fingertips in the field, the subcontractors on site would have to either rely on their own set of plans or walk the 15 minutes back to Skanska’s trailer to view marked-up drawings. With the MERS, subcontractors are able to view all the RFIs (request for information) as well as the BIM model, which provides huge benefits in visualizing the work they are preparing to install. The MERS also has the coordinated mechanical, electrical and plumbing models, allowing subs to quickly understand how their installations need to fit together in congested locations.

In order to truly learn from the various technology implementations on this project, the Skanska team applied for and received an innovation grant from Skanska USA Building, which paid for a graduate-level research project on a detailed cost benefit and return on investment analysis. The study showed not only an overall return on investment of over 30 percent to the owner in project cost savings, but also provides recommendations for technology implementations on future Skanska projects.

“I’m very impressed with how the Hunt Library team has utilized technology to improve the overall construction process, and I look forward to applying these lessons learned to challenges on other projects.”

Steve Stouthamer
General Manager, Skanska USA Building
Manskun Rasti is a flagship project for Skanska Finland and that was one driver for using BIM in an extensive way. Phase 1 includes two 8-story office buildings and a shared 3-floor underground parking garage. Skanska Finland’s new headquarters will be located in the first completed building. Once the project is finished, Manskun Rasti will comprise four office buildings.

On this project BIM models are used in many ways to achieve and support ambitious green goals. For example a CO₂ footprint was calculated based on architectural model quantities, energy simulations were made using an architectural model as the basis for an energy model and energy consumption was estimated via the BIM-based energy simulations and energy-efficient solutions.

A BIM model also provides a prototype of the building in its early stages before design decisions are locked, allowing changes and new innovative solutions to be piloted before the building is constructed. The architectural model was also used to create a virtual model, which can be used to produce fly-overs, rendered project images and videos to communicate the project’s final outcome in an illustrative way.

In practice, a multi-disciplinary model has been used for communication purposes and the visualization of design solutions. Logistics and site planning helps visu-
alize the current situation on site and it brings more accuracy to the construction management.

BIM has also been used in safety planning to prevent accidents. Site and safety modeling covers temporary structures such as site office, storage areas, roads, cranes, falling prevention, marking of dangerous areas and other safety equipments including connection points for safety harnesses.

Prefabricated modules were also modeled with a detail level and linked to the structural model. Prefabrication increases productivity, saves time, it helps to prevent accidents and improves installation ergonomics.

In 2011 Manskun Rasti was chosen as the best Finnish building information modeling project by Tekla and was also the winner of the BIM Project category of the Tekla Global BIM Awards Competition. In addition, Manskun Rasti was selected as the Site of the Year 2011 by Rakennuslehti, a Finnish trade journal.
The idea of BIM design on this project was fully supported not only by the client but also by the design subcontractor, which enabled the pilot project to be carried on.

Using BIM during the design phase and flowingly during construction has ensured higher involvement of the entire team. Strict focus on mechanical and electrical services has been applied since the early phase of the design. Respecting and designing all structures in full volume has proven to be essential for successful space and volume coordination and is expected to be used for installation works later on during construction of the building.

The design team delivered a clash-free design at the stage of building permit, which is exceptional for this early stage of a project. Clash detection was executed before and during the design meetings and the BIM model was fully utilized for solving design issues and simplifying coordination and decision-
making. This process, which was completely new to the designers, was fully appreciated by all parties participating on the design works as well as the consultants and the client. While construction has not yet begun, it’s expected that utilization of the BIM model will result in time and cost savings.

As the contractor, Skanska is anticipating a higher quality design documentation coordination, which will result in lower risk of any extra works or delays caused by mistakes in design. The BIM model should also enable better control of quantities and simplify coordination of works and work scheduling.

CB Centrum is not only a pilot project for Skanska in Czech Republic, but it’s one of the Czech Republic’s first projects fully designed in BIM and the first project of this size on the Czech market to be designed in such a level of detail.

Skanska Czech Republic continues to support and develop BIM and its utilization on construction sites as well as in cooperation with universities and nonprofit organizations throughout the Czech market.

<table>
<thead>
<tr>
<th>CB Centrum</th>
<th>Skanska Commercial Development Czech Republic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Owner &amp; developer</strong></td>
<td>Ivan Krejčí, Tengbom</td>
</tr>
<tr>
<td><strong>Author architect</strong></td>
<td>Hutní Projekt Frýdek-Místek, a.s.</td>
</tr>
<tr>
<td><strong>Responsible designer</strong></td>
<td>Recoc, spol.s.r.o.</td>
</tr>
<tr>
<td><strong>Structural engineer</strong></td>
<td>AZ Klima, a.s</td>
</tr>
<tr>
<td><strong>Heating, ventilation</strong></td>
<td>AZ Geo, s.r.o.</td>
</tr>
<tr>
<td><strong>Water &amp; sewerage</strong></td>
<td>Hutní Project Frýdek-Místek, a.s.</td>
</tr>
<tr>
<td><strong>Elektricity</strong></td>
<td>Cegelec, a.s</td>
</tr>
<tr>
<td><strong>Geotechnical</strong></td>
<td>AZ Geo, s.r.o.</td>
</tr>
<tr>
<td><strong>Gross area</strong></td>
<td>30,078m² (324,000sf), includes 223 parking spaces</td>
</tr>
<tr>
<td><strong>Gross leaseable area</strong></td>
<td>22,000m² (237,000sf)</td>
</tr>
</tbody>
</table>
Installation planners went on to design the installations in 3-D based on the architect’s model. A clash control was performed, after which the installation planners were able to correct the installation design. Even the prefabricate concrete structure was designed from BIM-based architect models. Thanks to that, no installation crashes took place during the construction. Furthermore, there were no missed holes in the concrete frame.

BIM was initially used on the project in addition to idea sketches. The architect designed the whole house in architectural modeling software and the installation spaces were taken into consideration from the start.

<table>
<thead>
<tr>
<th>Nyhamn Apartment Complex</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gross area</strong></td>
</tr>
<tr>
<td><strong>Sellable area</strong></td>
</tr>
<tr>
<td><strong>Production cost</strong></td>
</tr>
<tr>
<td><strong>Architect</strong></td>
</tr>
<tr>
<td><strong>Other designers</strong></td>
</tr>
</tbody>
</table>

BIM design was also used for sales purposes, for example 3-D images in sales brochures could be obtained at an early stage. Having exact 3-D images from different angles that paint an accurate picture of what the apartment will look like provides considerable security for potential occupants. Thanks to BIM, they could even see the view from the balcony.

3-D models of the finished building were also shown to all the construction workers on site so that they had a visualization of the finished building. Even detailed
solutions were revealed in a better way than 2-D drawings.

A carbon footprint can be embodied carbon or operational carbon. Embodied carbon covers construction materials and construction activities and equates to approximately 20 percent of building total life cycle carbon dioxide emissions. The remaining carbon dioxide emissions are produced in the operational phase (heating and electricity consumption). Both CO₂ calculations were made for the Nyhamn Apartment Complex project, which was designed to consume 35 percent less energy than the Swedish building standards. This saving turns to direct financial saving for the buildings occupants. In embodied CO₂ calculations the greatest carbon footprint was steel and concrete, which turned out to be more than half of the building’s embodied carbon. Calculations cover a 50-year operation lifespan.

A diagram of calculated carbon emissions from the Nyhamn residential project. The biggest carbon emission comes from the concrete framework.
BIM in Civil Projects

In constructing our society's infrastructure, new kinds of challenges become everyday elements on all projects. Through the adoption of BIM processes, every detail can be planned, constructed and analyzed beforehand to minimize risks. Even bridges, highways and tunnels can be built in a smart, efficient way with BIM. Modern modeling provides a link from the design through the construction planning right out to the machine control loaded on the heavy equipment in the field.

- Bjørvika Tunnel
  Oslo, Norway

- Highway 78, Brawley Bypass
  Brawley, California, United States

- M25 Widening
  Around London, United Kingdom
BIM in Civil Projects

Crusell’s Bridge
Helsinki, Finland

A1 motorway,
Gdańsk – Toruń
Rusocin to Czerniewice, Poland
The use of BIM on the M25 Widening project has delivered the efficiencies required to allow the design and construction teams to meet the demanding program and reduce risk. A coordinated, accurate, integrated 3-D design model is relied on by the design and construction teams to visualize the whole project both above and below ground. In addition to the physical aspects of the design, non-physical aspects like safety and access zones were included in the model. The software used to develop and coordinate the model enabled the team to identify and resolve clashes in advance of construction, which would have been very difficult to do accurately using traditional methods.

The BIM model files are available to view by all of the M25 project team and around 90 percent of the 120 design-related staff are regular users. Regular project review meetings use BIM model files and staff members can learn about the model and its uses. Us-

### M25 Widening

| **Length** | 117 miles (188km), 63 miles (101km) of this is being widened |
| **Project value** | GBP 6.2 billion (EUR 7.6 billion, USD 9.7 billion) |
| **Construction spend** | Average GBP 1 million (EUR 1.2 million, USD 1.6 million) per day |

The combination of working on sections of the busiest motorway in Great Britain, having to maintain three running lanes in both directions during the day and delivering the widened sections of carriageway to a very demanding program required Skanska Balfour Beatty and Atkins, the design team leader, to adopt a new way to manage the widening works. The award-winning use of BIM on the project has enabled the joint venture to reduce risk, decrease cost and deliver the widened sections of motorway.

The combination of working on sections of the busiest motorway in Great Britain, having to maintain three running lanes in both directions during the day and delivering the widened sections of carriageway to a very demanding program required Skanska Balfour Beatty and Atkins, the design team leader, to adopt a new way to manage the widening works. The award-winning use of BIM on the project has enabled the joint venture to reduce risk, decrease cost and deliver the widened sections of motorway.
ing the model prior to constructing elements of work allowed the project team to complete their work with confidence, right first time construction minimises remedial work and allows the project to comply with the programme.

While basically changing the role of the traditional land surveying function, the application of global positioning and modeling and the application of laser scanning have produced substantial secondary benefits, such as savings in traffic management fees thanks to shorter lane closures.

Using the BIM model has had a positive impact on reducing construction errors. This has allowed the project team to build elements correctly and avoid the need for costly and time-consuming remedial works.

BIM is a valuable tool that has been used by the team during the process to value engineer elements of the widening works, for example, the retaining solutions for the cuttings and embankments.

The model makes it easy to view and understand the project. Screen shots and fly-throughs from the BIM model allowed the design to be better understood so that potential problems could be resolved in the office rather than on site. This allowed the project team to prove that elements will work within the overall scheme in a virtual model before building them out on site.

Adding further aspects to BIM models for future projects will have time and cost benefits and enable project teams to make informed decisions from an earlier stage, reduce risk and save time and costs.

Experience has shown that it would have been extremely difficult for the team to deliver the design and construction of the widened section of the M25 without the use of BIM. It’s a valuable tool for large, complex and bespoke civil engineering projects, and its use on the M25 project has set a benchmark for future large highways projects.

“Here at Skanska ID we develop, invest and operate long-term building and infrastructure projects. While it is clear that the implementation of BIM on our projects has brought many immediate benefits to the design and construction phases, we also recognize the significant efficiencies and cost savings that the ongoing application of BIM allows through the operation and maintenance periods. BIM really helps us with life cycle and green optioneering, which ensures that we deliver optimum value to our clients. Therefore we strongly support BIM and are working hard to ensure we exploit the various applications as widely as possible across our portfolio.”

Julian Desai
Life Cycle Director, Skanska Infrastructure Development
The state worked very closely with the contractors, even supplying CAD’s pre-bid, which is not a typical practice for this department of transportation. So the project team saw this as a perfect opportunity to use BIM from a pre-bid level through construction. A 3-D BIM model that the takeoff department in Riverside, California, created with Agtek was used to check early quantities and design logistics. This helped in staging, balancing materials and constructing the state appointed temporary construction easements – before anyone from the management team set foot on the site.

The management team sat with CALTRANS at the pre-construction meetings to assess and review any contract specifications, tolerance and practices. This ensured both parties were in accordance and it helped minimize conflicts further down the road.

Skanska USA West Civil California District was awarded the Highway 78, Brawley Bypass CALTRANS, project on April 7, 2008, with a contract value of USD 68 million (EUR 53 million). Being a CALTRANS pilot project implementing machine guidance grading, this was a unique opportunity for both owner and contractor.
Skanska USA Civil West California District has been using machine guidance as the BIM frontline since 2005, and successes with the technology gave the team’s input validity for this particular site.

Post award the team had to make sure the client’s 3-D data was usable to create a machine guidance model. So a BIM model with higher standard was created, but kept to the information supplied in the master design that was provided by the client. The final 3-D BIM model was used to check intersections, vertical curves and grade breaks in the office before it went to the field. When the model was sufficient, the 3-D BIM model was transferred to the machine control systems with a variety of different software.

The second goal was site control. For the 3-D BIM model to work for quantities and machine guidance, the team had the site plane match the client’s with utmost accuracy. There was no margin for error here and Skanska made that very clear from the beginning.

The 3-D BIM model was used in all construction phases. The model, loaded on the motor graders, was used in prepping the road bed’s foundation treatments and roadway structural sections and finishing grading of the sub-base surfaces. CAT D9 dozers with machine guidance were used to build and complete fill-slope work and embankments, and field personnel used handheld GPS (Rover) to check quantities and set and check grades all loaded with the 3-D BIM model.

Highway 78, Brawley, was an excellent use of BIM with emphasis on 3-D modeling, quantity takeoff and machine guidance. Using the technology, the team was able to complete the job with fewer errors, greater efficiency and reduced labor costs.
A1 motorway, Gdańsk – Toruń is one of the most important transportation routes in Poland and throughout Europe. It will become part of the Trans-European Transport Route, leading from Gdańsk, Poland to Vienna, Austria via Katowice, Poland and Brno, Czech Republic. It is a project of strategic and economic importance, creating numerous new investment opportunities.

The Skanska-NDI joint venture is responsible for designing and constructing the entire 152km (95 miles) stretch linking Rusocin near Gdańsk to Czerniewice near Toruń.

In December 2007 the northern part of the first phase of the highway – 25km (16 miles) long – was handed over more than a year ahead of schedule. In October 2008 the team finished the construction of the remaining 65km (40 miles) of the first phase between Swarożyn and Nowe Marzy – this time two months ahead of schedule. In spring 2009 Skanska-NDI started the second phase of the project that covers the remain-
“Machines working with 3-D machine guidance systems increase the efficiency of construction works on the site and facilitate planning and compliance with the schedule, which is very tight on a project as big as Gdańsk – Toruń motorway. Thanks to the machines equipped with the 3-D system we are certain that irrespective of fast rate the works are completed precisely. To be literal – down to the exact millimeter.”

Torbjörn Nohrstedt
President of the Management Board, Gdańsk Transport Company
Skanska’s Dutch partners on this project (BAM and VSCE) have experience on more than 25 immersed tunnel projects, and they brought this invaluable expertise to the Bjørvika Tunnel project as well.

The models usage on this project was focused on correct and accurate geometry. The project demonstrates the innovative use of technology to ensure that the elements would fit together and achieve the levels of precision required to execute the project. Scanning technology and 3-D design were used in the production phase for trench excavation and backfilling design. It was important to gain full control of material quantities and monitor excavation progress from the outset. In particular, the contaminated mud from the sea floor required special techniques for dredging to avoid spreading material. To achieve this, a boat was equipped with a multi-beam scanner to scan the harbor. This helped to create and maintain a highly accurate terrain model of the sea floor, as well as to provide complete terrain models for machine guidance on all dredging vessels.

The tunnel was built using large concrete elements placed on the harbor floor and connected together.
These elements were prefabricated at a dry dock in Hanøytangen near Bergen, Norway. After completion, each element was laser scanned to create a precise, as-built point-cloud model of each element. Once the scan was completed the elements were sealed and prepared for floating and towing from Hanøytangen to Oslo.

The two tunnel mouths that the sunken tunnel was to join were also laser-scanned. These three sets of scanned point-cloud models were put together to enable a virtual quality control of the complete tunnel using the as-built elements and the multi-beam scans of the harbor floor. This quality check confirmed that the tunnel elements fit together correctly with both the harbor floor and adjoining tunnel mouth. The quality check was made possible by setting up the measuring system used in laser scanning at the dry dock at Hanøytangen so that the reference points on the elements could be forced into the correct coordinate system for the elements final location on the harbor floor. This simulation of as-built geometric data from the elements allowed the project team to set out the elements as if they were in their final positions in the Bjørvika basin. This same as-built data was used for volume calculation for weight control, ballast calculations for the transport leg and geometric checks.

Parallel to the prefabrication of the elements in Hanøytangen, the harbor floor in Oslo was being prepared for placing the elements. During the project, 680,000 m³ (24,000,000cf) of material was dredged up from the harbor. The dredged trench was then filled with gravel on which the tunnel would finally rest. The dredging and subsequent backfilling processes were monitored continually using the machine guidance software while the multi-beam scan data was updated on a weekly basis. Once the elements were in place and joined, the seals were removed and Skanska began building the roads inside the immersed tunnels.
The model of Crusell’s Bridge is one of the most detailed ones currently available. Details were crucial in this relatively small but complex project where BIM was used on site comprehensively. On this project, the entire bridge, including all the rebar and details, was designed using BIM.

The various benefits of BIM became clear as soon as the project got underway. The model synchronization feature provided fast information exchange that ensured the continuous availability of updated design data on the jobsite. Bridge-building logistics were easier to understand when designed in 3-D format. In addition, problem solving, communication and work planning became faster and easier. Schedule reliability was enhanced because the foreman of the steel fixing group was able to use the model to plan the team’s work more precisely. The decision making in the design and project meetings was streamlined as less time was needed to explain the issues that could now be understood simply by viewing the model.

The 4-D construction simulation provided the client with a comprehensive view of how the bridge was to be constructed. At the same time, it produced accurate understanding of the task sequencing by dem-
“Utilizing BIM provided us with plenty of benefits and a clear view on the essence of modeling. In designing and building versatile infrastructural entities, anything can happen during the process, so seeing the big picture at all times is necessary. BIM makes simulation, resourcing and decision-making a lot more efficient. It certainly proved the point of adding value at all stages, and should be included in future projects on a regular basis.”

Ville Alajoki & Peter Henny
Project Directors, Public Works Department, City of Helsinki

The model was also used between the contractor and subcontractors to ensure that every party shared the same understanding of what should be built, which further improved the reliability of the entire project schedule. Model data was used to prefabricate steel beams and rebar to minimize human errors in interpreting the design solutions to the machinery. The client’s supervisors could use the model to verify the quality of rebar installations. Furthermore, prior to the casting of concrete, laser scans were produced to document how the rebar inside the concrete structures were placed and to verify that the excavation and filling work of the seabed was executed as planned.

At completion the whole bridge was laser scanned, and in addition to traditional as-built drawings, a dimensionally accurate, easy to use, lightweight version of the point cloud data was handed over to the client. This lightweight viewer version of the point cloud data can be used to review the as-built information, take measurements and check coordinates, whereas the full-blown point cloud can be used as initial data for designing renovation or reparation work.

<table>
<thead>
<tr>
<th>Crusell’s Bridge</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total length</strong></td>
</tr>
<tr>
<td><strong>Width</strong></td>
</tr>
<tr>
<td><strong>Client</strong></td>
</tr>
<tr>
<td><strong>Designer</strong></td>
</tr>
<tr>
<td><strong>Project value</strong></td>
</tr>
</tbody>
</table>
BIM in Industrial Projects

Complex industrial projects include several stages, usually with different setups and different kinds of objectives. Here, the ability to see the big picture even before the first phase has begun is essential. With BIM, every link of the long chain can link seamlessly together for the benefit of the customer. BIM is the only way to efficiently manage these complex projects.
BIM in Industrial Projects

- Atmospheric and Vacuum Distillation Unit
  Rio de Janeiro, Brazil

- Catskill and Delaware Water Treatment Ultraviolet Disinfection Facility
  Westchester County, New York, United States

BIM – Building Quality
The project consists of nine major structures: the UV building, ED building, North forebay, South forebay, Catskill valve chamber, Catskill flow meter chamber, Catskill connection chamber and the generator building. The UV building will host 56 48-inch UV treatment units, each with a capacity of 40 million gallons per day and holding 210 UV bulbs.

At Cat-Del the team has been using BIM applications such as 4-D scheduling and 3-D coordination. The project was originally designed in 2-D and all contract documentation, including design, was provided in 2-D. In order to facilitate and enhance certain project processes such as drawing coordination, change order processes and conflict resolutions, the NYDEP provided the contractors with a 3-D model. The model was an interpretation of the 2-D design and was very detailed.

The project is a high-capacity water treatment facility, treating drinking water from the upstate Catskill and Delaware Catchments areas, providing around 90 percent of the needs for New York City. The maximum capacity of the facility will be approximately 2 billion gallons per day (approximately 7.6 million m³). The water treatment is by means of ultraviolet light disinfection only and the Cat-Del facility will be the world’s largest UV disinfection plant when taken into operation in 2012.
Using BIM applications at the project has been instrumental in scheduling and progress updating as well as prime and drawing coordination.

The model was initially used to virtually navigate the facility and all of its structures. It helped the project team understand the design early on so that alternate means and methods could be studied and the construction sequences could be visualized. By connecting the model to the baseline schedule the project team, the construction manager and the client could easily understand the sequence of construction activities for this very complex water treatment project.

The logistical planning was a great challenge due to the project site’s limited access. Crane access and transportation of material had to be planned carefully and the model provided great help to understand these challenges.

The drawing coordination was started as a 2-D process but once the 3-D model was introduced and made available, the team got up to speed with the technology and the drawing coordination, gradually changing from 2-D to 3-D. This drawing coordination evolution has proved very beneficial and overall a great asset to the stakeholders.

“The improved quality of the drawing coordination as well as the new means of communicating schedule and progress through these BIM applications has brought new standards to the jobsite.”

Christian Sandberg
Commercial Manager, Skanska USA Civil Northeast

Catskill and Delaware Water Treatment Facility
Westchester County, New York, USA

<table>
<thead>
<tr>
<th>Location</th>
<th>Westchester County, New York, USA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum capacity</td>
<td>2 billion gallons per day, equals approx. 7.6 million m³ per day</td>
</tr>
<tr>
<td>Client</td>
<td>NYCDEP (New York City Department of Environmental Protection)</td>
</tr>
<tr>
<td>Contract value</td>
<td>USD 1.109 million (EUR 860,000)</td>
</tr>
</tbody>
</table>
Because the energy and carbon footprint of data centers has been increasing rapidly, sustainability and energy efficiency has become ever more important. Energy efficiency requirements are met for example by continuously measuring equipment performance, performing analytics and most importantly keeping that data for future correlation and cross-referencing. BIM can be used as a connective element to map equipment performance to a larger context – the facility.

Skanska extensively utilized virtual design and construction (VDC) methods and employed a lean delivery approach to construct and commission the project in only 14 months. Successful BIM coordination between project team members allowed efficient design and construction that was essentially free of change orders and coordination conflicts. In addition, it supplied the client with a detailed 3-D model that represents the as-built conditions in the operational facility.

The project team leveraged the virtual 3-D model further by integrating it with the plant’s building main-
As a result, it is now used as a comprehensive portal to obtain information and statistics for every piece of equipment in the facility. The integrated model can be accessed from remote workstations or from hand-held devices. When in use tablets allow facility and maintenance staff to access various documents, such as commissioning reports, and operation and maintenance manuals in the immediate vicinity of the plant’s equipment.

As an early adopter, eBay’s facility utilizes a multidisciplinary monitoring and archiving system that continuously observes most of the electrical, mechanical and IT systems. Current and historic metrics of hundreds of thousands of equipment properties can be obtained directly through the virtual model, including temperatures, flux and pressures for mechanical systems, as well as power consumption and utilization for electrical and IT equipment. Such granular data is crucial to continuous improvement of the plant’s performance and efficiency.

Through a variety of illustration techniques used on the web, in print and media, one has become accustomed to color-coded maps that display weather data, home prices or population statistics. The exact same mash-up techniques are used at Topaz to visualize highly complex data sets very clearly through the virtual model. For instance, temperature readings of a server room or power draw of IT cabinets are displayed in real time. Piping systems are colored dependent on pressures measured inside them.

It is fundamentally important to address efficiency, operations and maintenance strategies during design and preconstruction. This provides a project delivery system that integrates both construction and operational aspects. Skanska recognizes that the construction industry must develop beyond the physical build. Today Skanska has the ability to deliver equipment databases, knowledge libraries and integration of real-time monitoring solutions, providing a streamlined transition from construction to operation.

**eBay, Inc., Project Topaz**

<table>
<thead>
<tr>
<th>Client</th>
<th>eBay, Inc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>South Jordan, Utah</td>
</tr>
<tr>
<td>Architect</td>
<td>RTKL</td>
</tr>
<tr>
<td>Total size</td>
<td>245,000sf (23,000m²)</td>
</tr>
<tr>
<td>Raised floor area</td>
<td>50,000sf (4,600m²)</td>
</tr>
<tr>
<td>Delivery method</td>
<td>Design-build</td>
</tr>
<tr>
<td>Start date</td>
<td>December 2008</td>
</tr>
<tr>
<td>Completion date</td>
<td>April 2010</td>
</tr>
<tr>
<td>LEED® certification</td>
<td>LEED Gold</td>
</tr>
<tr>
<td>Tier level</td>
<td>Tier IV</td>
</tr>
</tbody>
</table>

**Image: Dave Whitcomb / RTKL**

**BIM in Industrial Projects**

**eBay Inc., Project Topaz**
With this type of project, one of the client’s main concerns regarding design is to ensure the consistency of the engineering work of the different units in order to enable the use of the design products to manage the life cycle of the complex. Therefore, a comprehensive set of standard practices was issued to which contractors adhere, which specify what to include in 3-D models and how these models should be structured.

Skanska took part in this project as a member of a team that shared the design, procurement and construction effort. As a result of the project set up, the design work of the six disciplines involved was distributed across two countries, three cities and two languages.

The use of BIM tools in process projects is no longer a choice, since it is largely recognized as the protocol.

Three engineering groups worked in a single virtual...
office, on a single database, which was constantly synchronized. Although different parties may have been aware of each other’s work, eventual clashes were detected almost in real time, giving the designers the opportunity to resolve them before proceeding with the work, saving time and resources.

Just like in traditional design, the actual construction and procurement documents are lists and 2-D drawings, but with BIM tools these documents are the children of a parent 3-D model, ensuring full consistency with each other. This is also a much faster way to produce such documents and allows for quicker response to design changes.

The benefits of BIM application in process plants design go beyond the quality and cost of engineering deliverables. It’s more about the construction cost and time savings as results of the reduction of rework and materials surpluses. Shorter procurement time is another consequence of the quicker generation of bill of materials.

Skanska Latin America has been in the process plants engineering, procurement and construction business for over half a century. Skanska has pioneered the use of CAD tools since the early 80’s. On this project, the team reached the highest level of interdisciplinary integration. The design work was carried out in a full scope, geographically distributed and multi-company virtual office.

Skanska Latin America’s ability to handle complex projects in a collaborative environment is achieved through personnel training, procedures development and the experience gathered on projects along the way. Clients can count on this ability to make Skanska their first choice.

### Atmospheric and Vacuum Distillation Unit

<table>
<thead>
<tr>
<th>Project type</th>
<th>Oil refinery unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete</td>
<td>16,000m³ (565,000cf)</td>
</tr>
<tr>
<td>Steel Structure</td>
<td>1,600 tons</td>
</tr>
<tr>
<td>Piping</td>
<td>3,000 tons</td>
</tr>
<tr>
<td>Process equipment</td>
<td>250 units, 7,500 tons</td>
</tr>
</tbody>
</table>
Every Step of the Way

BIM keeps your project on the right track from start to finish.

BIM is Skanska’s way of adding value to its customers and taking the entire construction business forward. The illustrative 3-D model contains all phases, angles and details of the project, thus presenting a clear, straightforward route for everyone involved.

Thanks to BIM, your project’s schedules and costs can be accurately estimated. Furthermore, it enables smooth operations with increased operational safety and without unexpected interruptions. Every pile, floor, wall and pipe is now visible and in the right place. Just one look at the model and you know precisely where to go next.

Find out how BIM can enable your next project to become a true success story – contact your nearest Skanska representative now!
From more information about BIM and Skanska, visit www.skanska.com/BIM