In this case study, we will show how we used Autodesk® Revit®, Autodesk Navisworks®, and Autodesk 3ds Max® to develop a complete model of the existing airport along with modeling a proposed expansion of over 180,000 square meters. The class will cover the process since we started implementing Revit at NSW AP, what helped us and what problems we encountered on the way. We will discuss how we interacted with consultants that use different software applications, how we implemented and used Navisworks, and how we created glossy images with 3ds Max. This project involved a team of over 70 people from more than 4 different companies all sitting together. Finally, we will show where we are and where we expect to be in the next few years in the project and in our office.

Learning Objectives

At the end of this class, you will be able to:

- Combine tools to get the best possible results
- Obtain realistic expectations of the software and transmit this to the client
- Handle people and teach them the correct use of Revit and Navisworks
- Describe how we have managed effective communications between both consultants and software applications
About the Speakers

**Alfonso Rengifo** started with AutoCAD® V10 while in university, and worked for several companies during this time helping them setup the system and start the use of AutoCAD. He has worked with renovation, conservation, new build housing, apartment, offices, airports, and hospitals as an architect, CAD coordinator, and now as BIM manager. He started using Revit® in 2008 alongside Navisworks® and 3ds Max®. Alfonso manages the use of Revit and other software in the office, in addition to giving internal courses in Revit and Navis® for the different teams for the different projects. ar@nswap.no

**Morten Ræder** currently works as project BIM manager for the Oslo Airport T2-project at NSW-AP in Oslo, Norway. He graduated as an architect from the Academy of Fine Arts School of Architecture in Copenhagen, and has been working professionally since 2006. Besides working as a regular architect, he has had the responsibility of implementing Autocad® Architectural Desktop and Revit® Architecture in various projects such as housing, museums, and large-scale office buildings. mr@nswap.no

**Bjørnar Markussen** has been participating in the A/E business for 27 years, the first 14 years as an old school “pen and ink” drafter at an architectural office in Lofoten, Norway. He did his bachelor's degree in Structural Engineering in 2002, specializing in heavy concrete and steel constructions. Among several other projects, he has participated as CAD manager at Tjuvholmen, an underwater floating parking house, and at Icon Complex—an art center at the downtown seaside of Oslo City, drawn by famous Architect Renzo Piano of Italy. He is currently working as BIM manager, at Gardermoen Airport, Terminal 2. In his very first presentation at AU, he will speak about BIM and collaboration in large and complex building projects. Bjornar.Markussen@aas-jakobsen.no

**Bridget White** currently works as BIM manager and Architect at the Norwegian company Narud Stokke Wiig based in Oslo. She holds an honors degree in Architecture from Victoria University in Wellington New Zealand. She spent 3 years prior to moving to Oslo working as an architect in Wanaka NZ and has been using Revit Architecture professionally for 5 years. In addition to her role as BIM manager and Architect she also creates the parametric families for many other large scale projects within the office and is responsible for creating the family database library. bw@nswap.no
**Innhold**

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NSW Architects and Planners
We are an office located in Oslo, Norway. We currently employ 82 people, of which 67 are architects, with a multi-national staff from over 20 nations. The international staff provides a valuable professional and cultural diversity in the creative process and working atmosphere. The numerous clients and project portfolio also reflect the international profile.

Sample Projects:
Bergen Airport, Flesland, Norway. 60.000 m² (645.835 ft²)

Trondheim Airport, Værnes, Norway. 30.000 m² (322.917 ft²)

Rajiv Gandhi International Airport, India. 117.000 m² (1’259.378 ft²). 2010 number 1 airport in 5-15 million traffic category by Airport council international.

New Molde Hospital, Norway. 45.000 m² (484.376 ft²)

St Olav Hospital complex, Trondheim, Norway. 153.500 m² (1’652.260 ft²)

From CAD to BIM
We started our move towards BIM compatibility in October 2008. We downloaded and tested different software, to see which one will fit best the way we work and will give us the easiest transition from the software used until then. Mainly we been using for years AutoCAD and Microstation with their different versions.
After a couple of months of testing we decide to move to Revit. The 2 CAD managers went to a beginner and then advance courses in Revit and after 2 months testing the first project started. A 28000 sq. meters (300.000 sq. feet) Shopping center. A couple of months after this, we find out we have won the competition for the Gardermoen Airport expansion with a total area between old and new of 170000 sq. meters (1’829.865 sq. feet). Since then 90% of our projects are developed in Revit.

At the start we were only two people handling the responsibilities for the new Software, Setting up new projects, giving support for the teams, advance internal courses, etc. When more and more projects made the move towards Revit and one of the BIM managers move abroad, I saw the necessity for restructuring the until then CAD/BIM group. Now the BIM group, new positions were created to facilitate the use of the software and so each project received the support needed. For this the following positions were created following the guidelines learned in the AU 2010 conference

_BIM Manager_: General overview of the software, testing, courses, R&D and purchasing.

_BIM Project coordinator_: In charge of one or two projects, setup the files, give daily support and is part of the teams.

_BIM specialist_: In charge of creating the tailor made families for each project.

_CAD manager_: In charge of continuing support for projects developed before the move towards Revit.

As for the architects, we started to send each team to the beginners' course, and then after they have been using the software and are familiar with it, we created advance courses, in house, depending on the necessities of the project.
OSLO AIRPORT GARDERMOEN

Part I. 140.000 m²

2010 most punctual airport in Europe.

The original design of Oslo Airport Gardermoen was won by competition in 1990, this included the general Master plan and the terminal building. The overall objective of the master plan for Gardermoen was to create a simple and clear solution that was cost effective, flexible, and adapted to the environment and the landscape.

The utility buildings, parking facilities, and the terminal building are located between the runways on the landside. This ensures short transport distance both for cars on the landside and for planes in the airside. All areas were positioned so they can be extended without affecting the neighboring area.

The overall objective in the design of the original terminal building was to create a simple and clearly laid out building in which travellers would feel comfortable and staff would have a good workplace, while transport companies could operate efficiently.

The most fundamental requirement for an airport is that it is functional in all respects. It represents a "process plant" where all systems must function optimally.

The primary challenge lies in blending this complexity of systems into one simple, clear, rational and economical whole that in addition to being effective must have a human dimension, an architecture that travellers experience in a positive manner. It is also important that the many thousands who work in the building have good working conditions in pleasant surroundings.

The terminal is based on a central building containing most of the joint functions linked by a pier that mainly accommodates passageways and waiting areas. The ground floor level is used for arriving passengers while the departures hall is on the upper level. Two independent four-storey buildings that contain passenger services, commercial premises and offices are sited under the roof canopy.

The pier is the transport route between the central building and the planes. The wings of the pier constitute large, light, airy spaces. It has a passenger flow zone for departing passengers in the middle, with waiting areas by the gates at each side. Arriving passengers proceed from their planes along a series of galleries positioned above the departure hall. The 4 meters wide galleries are located along the outside wall. The central area of the pier is approximately 18 meters wide. This was finished by 1998 with a capacity of 16-17 million passengers per year.
Since its opening, NSWAP has carried a number of extension projects to increase the capacity to just over 20 million ppy.
Part II. 130.000 m2.

T2 project. The project for Terminal 2 was won following an international architecture competition with five competing pre-qualified teams.

The growth in air traffic now demands a large-scale expansion, the first stage of which will provide a capacity of 28 million passengers, rising to 35 million after the second stage.

The winning concept preserves and strengthens the current centralized terminal both functionally and architecturally. The central building is to be extended to the west, giving a large check-in hall with the railway station centrally located in the complex. The roof structure will be timber – the same as in the existing terminal – while diagonally crossing wooden beams span the railway station, allowing strong daylight penetration to accentuate the design concept.

A new pier will be built northwards from the central building and a large triangular-shaped area containing shops, restaurants and cafes will be located in the connecting area between the pier and the central building. Architecturally the new pier will be subordinate to the main building. Its outer form and use of material will optimize energy consumption. The project also encompasses rebuilding and extending the road system and the airport taxing areas.
**Transition from AutoCAD to Revit**

The winning competition entry was done in AutoCAD 2D with parts modeled in 3DS Max for visuals. This was quickly proved not to be an option for the subsequent phases, as the complexity and scale of the project kept growing. The ambition for the project to become a BIM spearhead, was decided upon soon after starting on the sketch phase. A few of the users were well trained in advance, however, for most this was their first time with Revit and they just had to plunge into it.

We first needed a detailed underlay model of the existing 140,000m² terminal building and piers. This was modeled in Revit based on AutoCAD and Microstation references.

At the same time as the existing BIM-model was started, work on the 130,000m² addition began. At this stage there were 12 users working in the single model file. Worksets were set up dividing the building into geographical areas, and subdivided by General, Structural and Architectural worksets. Rather than basing these on building parts general to the entire terminal, like roofs, ceilings etc, this proved a wise decision later in the process.

**Existing BIM**

Precise modeling of the existing terminal is crucial to the progress of the project. We need quality assured underlays to position the new building precisely and this information must be available in the Revit model.

Modeling the existing terminal turned out to be a very good starting point for welcoming newcomers into the project structure, giving them a controlled sphere to work within. The 2D underlays help decide where objects are to be placed, but the result in 3D makes the users aware of the paradigm shift in modeling and drawing that Revit vs. AutoCAD is.

Due to the massive amount of drawings, details etc. this work is still ongoing and will probably not be finished before the buildings are handed over in 2017. The existing BIM model will also be a vital part in future use of the IFC model for Building Management Services.
Time to split...
After 10 months time of modeling the number of architects grew to 30, and the file size was peaking over 1.000mb! The network, machines and graphic cards was kneeling under the workload and synchronizing could take 30 minutes or more. This called for some radical cleanup in the project, and the file size was cut down to around 550mb by e.g. removing all dwg references. The Revittools add-in proved a valuable resource for purging these elements.

Still, detailing had not yet properly begun and it was painfully clear that we would need to split the model into three major parts to achieve manageable sizes of both data and user groups. Even if file sizes would be even lower and number of user fewer, further splitting would be very impractical to administer and would not be very logical in terms of building construction. The geographical worksets proved an efficient way of achieving clean cuts in the model, even though the buildings were growing into each other in several areas.

The split was a difficult decision, as a lot of views, official drawings and schedules were based on the entire project being loaded. It would be a time-consuming and perhaps risky job to clean up the files after the split, but it was decided that the workflow benefits would be substantial. We managed to pull through with few errors, but in the end had to do a lot of work cleaning up annotation and optimizing sheets and views. The file sizes came down to 250-400MB with 4-12 users per model file. Lately, these numbers have grown some, but we are fairly confident that our current setup will do for the rest of the detailing phase.
The experience from the split is that we should have decided to split at a much earlier stage. Still, it wouldn't have changed the current workflow where information for the entire project is spread over three separate files. To have one file for calculating quantities, keeping track of sheets and general scheduling was a great benefit in the beginning of the project (and would still prove the best) but this perhaps made the earlier stages more efficient.

In addition to the original project, there are several auxiliary buildings throughout the airport being modeled in separate files. This includes a new Ground Radar Tower and additions to the Central Heating Facilities and Water Cleanage Facilities.
Case Study: Oslo, Norway, Gardermoen Airport

Addition to existing Central Heating Facility

Ground Radar Tower
Collaboration
We closely work together with four other companies for the Structural and MEP disciplines. At the startup of T2, it was decided that each discipline should choose their preferred software tools for optimum control over workflow and output. This resulted in all of us making different decisions, as it at the time was impossible for one software package to meet the demands of each discipline. Because of the differences in the native file-formats, a live link between the models was not possible. Instead we use an agreed set of export views from the models, based on a shared co-ordinate system for easy import.

Imports and Exports
We have decided that all 2D underlays are to be exported weekly, while the 3D are done every second week. About 100 views are exported each week to various formats - IFC, DWG and Navisworks. The IFC format was chosen as the main collaborative model format for all disciplines, and DWGs were mainly used for MEP drawings.

To check modeling in areas defined by a give contract number, we have adopted a system of using Revit Links based on 3D DWGs or IFC imports from the engineers. In order to avoid accidental insertion or exploding of DWGs in the main model files - that would create a nightmare of unwanted linetypes and geometry - we are enforcing a rule that no DWG links are allowed in the model. The method is rather to insert a DWG export into a blank, Generic
Family that is loaded into a blank Revit file. This file is then linked into the main Revit file placed on a workset set to "not visible by all views"

Collaboration based on the Revit IFC exports is challenging. The geometry is not correct for many of the objects, the export routines are time-consuming and file sizes are massive. This seems to be mainly a Revit issue, as the other disciplines have been able to overcome most of their obstacles successfully. Still, when IFC is going to work properly in Revit, it will be of great benefit to the project. Not only for collaboration and cross-disciplinary quality assurance, but the utility of the IFC model is much more versatile the native model. It will be linked to anything from room databases, calculation programs, building management services etc.

The hopes are high for the IFC format, but sadly the experience for us has been rather frustrating. IFC exports from Revit are unstable, and there still is no option to link IFC-files - that would ease the export-import workflow substantially. We are left with export results that we barely trust, and our experience is that once a problem finally is fixed, two new ones tend to appear. Hopefully Autodesk's open invitation to the IFC community will result in faster, better and broader support of this format!
BIM-managing the project
With nearly 40 architects working in the three main model files and the four auxiliary building models, there's an incredible amount of information to keep track of and make consistent across the project.

To efficiently handle room and door schedules these are handled by 3rd part add-ins like dRofus for room schedules and area planning, and Microbuild for the door database. The add-ins work by extracting parameter sets for specific objects from the Revit database and linking this to either IFC objects or entries in an external database. Example screenshot shows dRofus room database where all rooms in the project are created and then placed in Revit. The add-in then reports back room parameters like area, perimeter and geographical roomnumber. An IFC model would further help to visualize room placement and organization.

Screenshot from dRofus with rooms for baggage handling highlighted
Naming conventions need to be kept consistent for all model files, and with architects generally opting for their own "logic" in naming objects we enforcing a strict naming convention for all objects. To easily compare naming and effectively change Revit Family properties across the models we are using Ideate BIMLink. This is a very practical add-in that links Revit parameters to an Excel-file for quick and easy editing. The file is read back into the model after editing, updating immediately.

![Ideate BIMLink keeping track of doors...](image-url)
A system of tagging objects by their contract number, phase and status enables us to keep track of how the project is progressing in various areas. This comes in handy for sorting out door schedules based on delivery, filtering out as-built objects for certain contracts and of course quality assurance per tender delivery.

**Quality**

Quality assurance is vital in succeeding, and we are currently adopting procedures for this in regards to the BIM model. The process is a simple yet effective way to check that the model is without modeling errors, and that the most basic information always is included.

The QA for BIM is set to be checked at given milestones for each delivery. Repeated controls of this will hopefully will leave us as close to error free as possible. The QA is carried out by using 3D views vs. Floor plans, and view filters to sort out tagging, worksets etc. Screenshots are used to document the process, and is archived together with the QA report.

The workload for QA is spread between the architects. The BIM manager only checks that the procedures have been correctly been followed.
BIM-experiences and the way forward

We currently are two BIM-coordinators on the project and this seems sufficient. We have divided our workflow so that we have individual responsibilities in regards to developing and maintaining exports, workflow procedures, take-offs etc, while sharing support tasks.

With the team consisting of everything from Revit super-users to complete novices, there is naturally a huge difference in support tasks. In addition to the mandatory introductory classes, in-house training is crucial to spread knowledge and awareness to everyone involved. Also, many people have the same questions and it's important that information is kept easily ready for everyone. We have a series of manuals and walk-throughs of common tasks, like setting up schedules, naming conventions, tagging procedures etc. It is a core task to keep constantly updated.

With so many users working at the same time, there are also great challenges in regards to object control. Accidental deletion or moving of objects are unfortunately common errors that require a lot of time to fix and generates new levels of stress for everyone with a deadline coming up.

The new Revit 2012 features for workset visualization is a great tool for control, but we'd really wish for even more tools for BIM-managing. This should include a way of keeping all common settings, filters and naming consistent across the entire project. Today, this is time-consuming and not very rewarding work and tools to assist in this would be much appreciated.
Wishlist
We'll be happy to present a small wishlist for some of the feature that's missing in Revit in order to ease our workflow.

- Greater control over objects. There should be an option for a real pindown of controlled and checked objects—possibly even password protected!—in order to avoid accidental deletion or moving. Today, it is possible to edit objects, delete or move them even if they are pinned. It just is so impractical when the roof of the entire terminal disappears two hours before a delivery!
- There should be a better way of controlling project standards across several models. It would be great with a mother file where all families, types and system settings where set and spread to the children models.
- An automated way of copying crop regions and sheet placement for a quicker, easier way to achieve consistent sheet layouts. The guide grid is too time-consuming.
- There should be an option to add depth fading to sections and elevations. A lot time is being spent on cleaning up and creating graphic overrides for background objects for these views.
- And of course, it goes without saying, reliable and consistent IFC exports!
BIM process and collaboration in T2

Introduction
In this part of the presentation we will explain how the T2 project is organized in terms of BIM. Which software we use and how we push our software to its limit. As all disciplines uses different BIM applications, for that reason file exchange is a vital component in the collaboration process.

The quality assurance is also an important part of the design, and with the introduction of BIM, the need for new ways of thinking and resources to quality assurance increases.

Further we will say some words about how our BIM is used in the construction phase and some thoughts about operation phase.

Organization
Team_T consist of a consortium of five of the largest companies in their industry or discipline. And under each company there is a forest of smaller firms that delivers services in different ways. In Team_T there is a total of 100 + full time employees at the terminal building and 20 + at the airside, far more at peaks.

Since the start of preliminary project, back in 2009, the architects and engineering team was located at Majorstuen, Oslo. Later it was decided to merge Team_T together with the project management, and relocate near the building site at Gardermoen.

For optimal collaboration processes the client has built a new office building at site, with all facilities. And from 7th of November Team_T merged together with the project management and the entire team now consists of near 200 employees.
BIM organization Team_T

In terms of BIM, the project attempted to spread the responsibility down to the user level by dividing up the tasks in a natural way. Since there is a marked difference between how we use BIM at air side and terminal building, we also divided the responsibility here, with an overall BIM management of the entire project on top. There is also a BIM coordinator at client side.
Software in use
As a part of requirements for delivery of BIM, the client made a BIM specification describing what to deliver. And as a part of those requirements open BIM and IFC has a clear focus. Further, all disciplines where free to choose what BIM application that suites their need best.

As a part of the project kick off the project team arrange a deep dive into the market and had a look at and tested witch programs that was able to fill each disciplines needs. And as a part of this process we did initial testing to see how our program choices were able to do what they supposed to do – regarding BIM and collaboration.

This process ended up choosing following programs:

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<th>Architect</th>
<th>Revit Architecture</th>
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<td>Structural engineer</td>
<td>Tekla Structures</td>
</tr>
<tr>
<td>Electro engineer</td>
<td>AutoCAD with MagiCAD Electro</td>
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<tr>
<td>HVAC engineer</td>
<td>AutoCAD with MagiCAD HVAC</td>
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<tr>
<td>Air side (all dis.)</td>
<td>MicroStation v8i</td>
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<td>and Autodesk Civil 3D</td>
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To fill other needs the projects BIM team also looked at, and choose:
- dRofus - Room planner
- ISY Calcus – Calculations
- Navisworks Manage / Simulate/ Freedom
- Solibri Model Checker / Model Viewer
- DDS Cadviewer - IFC viewer

We also use programming tools like MS Visual Studio (.Net, Visual Basic, C#, C++…) and file tools like Robocopy, Powershell, VBS script etc.

Products from software
As our main product from our BIM models of course drawing has an important place. There is no way, as we see it, that we are able to let go of drawings in the foreseeable future. Every discipline is delivering drawings as a product of their own BIM.

When that is said, the weekly collaboration model does play a central role in doing QA before producing drawings.

Collaboration model is a Navisworks NWD file, based on mainly NWC, NWD, DWG, IFC and some files in VRLM format. As part of illustration there is also some files done in SketchUp.

This file represents a “as is” snapshot of what are inside each discipline native model files.
Keywords collaboration model:
- Approximately 30-40 exported input files from disciplines, merged together in Navisworks
- All files located in same coordination system (x, y, z), except main map at airside.
- Files from discipline exported minimum once a week and result in an updated collaboration model
- Distributed thru ProjectWise Server at client side and local server at Team_T
- Size of NWD file is pr. today approx. 280 Mb – growing….

Information exchange between disciplines
Information exchange between each discipline’s BIM is based on two main principles, exported files from one BIM linked into another BIM and direct link of native files into each other’s BIMs.

- From ARK and RIB to other disciplines – file export DWG and IFC
- From RIE and RIV – based on IFC and native DWG

IFC is preferred mainly because the ability to exchange information in a proper way. But our experience is that not all BIM software is capable to link IFC and for that reason, we often do need the good old DWG.
The importance of open BIM and IFC

Gardermoen Airport is designed and built for lasting 53-100 years, with continuing redesign and rebuild. For that reason, it is extremely important to have the opportunity to manage the BIM thru the whole life cycle, from design to demolishing.

For those reasons our client demand open BIM and deliverance in IFC format, supporting and following BuildingSmart advices and demands. This opens for several important opportunities in the future:

- Connection against software for Facility Management services
- Free BIM software choice
- Ability to switch software
- Future reuse of objects and information (roundtrip)
- Stimulant for competition

Because this open format mostly is human readable we believe that as a spinoff effect we will see a competition between software vendors, which will give both software users and their clients a better product.
QA processes
The project structure brakes down our project into 150 + contract, driven as a BIM in BIM project. Main reason for this is a extremely high grade of complexity when implementing the construction phase into a ongoing operational phase. And one of the main demands is that their customers should not be affected of the construction in any negative way, when running the building process.

As a effect of this splitting of contracts, together with a long construction period, we will continuously have a BIM that is finished As Build in some areas when conceptual at other. Running a ordinary clash check, for instance, is not possible because these differences in level of detailing.

We are therefore dependent on splitting BIM split into smaller pieces and run collision check area by area. Splitting mainly done by exporting to IFC and running clash check in Solibri Model Checker

When moving forward, we get a BIM with different level of detailing or finishing.

Principal sketch of level of detailing vs QA
(Milepel = Milestone, Entreprise = Contract, Framdrift = Progression, Område = Area)

Quality assurance process in BIM is based on milestone delivery of tenders and drawings. In this cycle of delivery, all interfaces against other contracts, other disciplines etc are very important. When using BIM as a toolbox in this process, we believe that we have all opportunities to deliver a 0-error project when construction starts.
One of our main tools in this QA process is use of Solibri Model Checker, checking files based on exported IFC.

Because of differences in level of detailing we are highly depending on human resources and their ability to think forward, and avoiding “painting us into a corner”. This competence together with tools running checks like:

- Automated collision check
- Revision and change history
- Information tags
- Information takeoff
- Quantity takeoff

We are pretty sure that this gives us great advantages.

The QA process in BIM is run by:
- Each discipline – at their own BIM
- By all disciplines in Team_T together
- Inter discipline together with client, against other contracts, e.g. BHS

Main control is done in design phase before submission of tenders to contractors, and repeated when change in design.
BIM in construction phase

From BIM to construction phase is a upcoming and exciting process that has just started. Because of security reasons and a demand from client not provide any benefits for “first incoming” entrepreneurs, there have being a kind of missing link between BIM and contractors.

Only drawings, schedules etc. from BIM are, until now, distributed. And as a “in between stage” we have provided drawings with high grade of 3D detailing.

But after some time of persuasion we were able to convince our client that distributing smaller pieces of the BIM, primary per contract, we are able to limiting each entrepreneur to
their own contract and smaller parts of interfaces. For this reason we do not compromise the security and benefits are limited.

The immediate effect is providing BIM files with reinforced concrete structures directly to contractor and his workmen at site.

Next challenge is to provide parts of the BIM as native files to be designed in detail by concrete and steel contractors. And in next turn, achieve files back from the contractor, and implement into main discipline BIM.

**BIM in operation phase**
In this project this is a nearly unwritten page. Our client, together with Team_T, is running processes to see which possibilities that are possible in near and far future. So far there is only a decision on using dRofus and Tida (Technical Information Database) as main tools for harvesting information related to operational phase.

And as far as we can see, in a huge project like T2, there will be a need of a kind of model server, based on storing BIM files mainly in IFC format.
T2 and the importance of parametric family components

The airport

The use of parametric design with in family creation is extremely crucial to modeling efficiency and adaptability of large scale design such as T2 Gardemoen.

The processes of development in an aesthetic, functional and structural sense are complex and by creating components which can flex, adapt and record calculated information we can improve the ongoing level of accuracy within the model.

An overview - Their place in the project

The parametric design of components allows the model to grow and develop through each phase of design. Unknown variables can be tested, trialed and recorded using the flexibility of parametric components. Beginning from a conceptual parametric and there for flexible family, as important project decisions are made, the components can be edited, updated, and locked in types to allow the same family to become part of both the conceptual design and construction drawings. This is beneficial in both time efficiency and keeping accurate placement of the elements within the model.

A developing column from conceptual design to tender documentation

The airport structure encompasses many repeating elements, similar types of working elements and a continually adapting technicality of repeated detailing. For this reason many components created were designed to parametrically adapt to different circumstances within the T2 model, size, calculation, materiality and many other component options allow the same family to be repeated but its type to reflect the desired geometry. This also enables a smaller file size.
Case Study: Oslo, Norway, Gardermoen Airport

Below a flexible frame family which can be used in a range of spatial circumstances.

Additional file size from many components is also an issue in such a project because of the variety of components needed, in particularly specialty equipment, airport specifics, and complex structure. In tackling this issue, the importance on parametric design is highlighted.

Our office as a case study, the use of parametric families between projects.

In NSW, our expertise center around hospitals and airports which forms a dominant part of our project base. In this sense we have the ability to increase the modelling efficiency between projects by using a collective family database which groups parametric families and provides workable templates for families that need to operate similarly. Such examples include airport specialty equipment such as baggage conveyors, security check, main structural elements (in the sense of calculations needed), skins, adaptive components, furniture and masses. By creating parametrically we can cover a wide range of options within one family – and as the project develops we refine the design specific to the project and resave as a different file, so all files are kept in the database for further use.

The above example shows a simple parametric design that we use its geometry and calculated values throughout many airport projects.

Our database is an interactive PDF browser located on the central network and which is constantly updated by users as new families are produced. In locating a file we have grouped all collected material into revit library groups and also special folders which isolate airport, hospital and other families for ease of navigation. From this all of the families parametric information and catalogs are available so base families can be sourced and adapted easily to suit new situations. A direct link to the family is included so all can be loaded from the interactive pdf.
T2 and the limits of parametric design.....

Here's a little something to lose sleep over!

Parametric family 1 – adaptive components

Parametric family 2 – column and beam frame structure

Parametric family 3 – roof structure

And finally.... The combination. To create a 3 part nested parametric family which operates to allow the entire structure to flex and adapt to ongoing T2 development.