

## Navigating ATP towards a better BIM

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## Navigating ATP towards a better BIM

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Company assignment ADMS, January 2013



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Navigating ATP towards a better BIM

A.F.S. (Aury) van Beers  
Company assignment ADMS, January 2013





## **Navigating ATP towards a better BIM**

*Guidance on how to improve the BIM competence within the Design Process at ATP Innsbruck*



# Navigating ATP towards a better BIM

Guidance on how to improve the BIM competence within the Design Process at ATP Innsbruck

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## Foreword

In the context of completing the postgraduate technological designers program Architectural Design Management Systems (ADMS) a nine months assignment, from May 2012 until January 2013, with ATP was completed to investigate the most efficient way of implementing BIM into practice. The postgraduate training consists of a two year program at the Technical University of Eindhoven for graduates who wish to develop their competences in the field of process design and Design Management in the construction industry.

The aim of the in-company assignment was to develop a tool for ATP which will navigate ATP towards a better BIM.

In front of you is the report concerning the outcomes of this in-company assignment research project. This Report describes the results from the Analysis of how ATP can improve its BIM competence, and which process aspects will need to be followed.

I would like to take this opportunity to thank ATP for making this In company assignment possible, in particular I would like to thank Andreas Rieser, Alois Salzburger and Magdalena Obermair, for their time, Enthusiasm and Support. In addition I would like to thank my academic committee at the Technical University of Eindhoven: Bauke de Vries, Ad den Otter, Henk Jan Pels for the enlightening conversations and highly valued feedback. Finally, I would like to thank all interviewees for the time they took out of their busy agenda's to speak with me. The inspirational conversations I had with each of them resulted in valuable contribution to the research.

Aury van Beers  
Innsbruck, 2013

## Summary

ATP, a multidisciplinary architectural and engineering organization originated in Innsbruck Austria, is implementing BIM. ATP wants to increase and further develop its BIM capabilities on organizational and interpersonal level to exploit the BIM benefits. BIM requires a different working process approach, traditionally parties work on separate information pools, but in a BIM process they work on the same information pool. Therefore, the design team and all disciplines, involved in the project, must work in an integrated and concurrent manner. BIM implementation can provide the organization and projects with a faster design process and a reduction in construction errors during the execution phase, which consequents in a reduction of design and construction costs. So, ATP can produce its designs more efficient and effectively with less production costs and lower failures. This might positively affect the final quality of delivering products to its clients and stimulates ATP to become an innovative leader in the use of BIM.

For these reasons a research project was defined to gain insight and understanding in the adaption of BIM, and how they can further develop its implementation, in order to reach the benefits described. As main research question was defined:

How can ATP improve their BIM competence, while enhancing an effective and efficient integral working process?

The introduction of a new technology into a design and engineering organization is far more complex than simply purchasing the software package as, for instance, in the past the introduction of 2 and 3D CAD showed. This is especially so with BIM, because it involves a paradigm shift towards a representation of physical and functional characteristics of a facility.

The research period took nine months and was mainly executed within ATP's Innsbruck office, as well as brief reviews at the other offices of ATP. The project consisted of an orientation phase, analysis phase and the Design of a management tool to support the use of BIM in ATP Innsbruck.

The orientation phase is used to define the problem statement more clearly. During the Analysis phase, the definition of BIM and the important aspects regarding its implementation were explored, and the current organizational capabilities. The outcomes were compared to the relevant literature. Based on these findings the design of a management tool for the design and engineering process and its communication was developed in the next phase.

Based on the outcomes of the analysis it was also concluded that new management positions need to be created. First of all, BIM Managers need to be positioned in the organization to stimulate the performance of BIM. The positioning of a BIM Officer is a valuable addition to the organization to be able to manage the group of the BIM Managers. In that way the quality of the Building information Models produced by design teams can be controlled effectively. Based on the outcomes from the interviews, expert meetings and project investigation, the selection criteria for the design model were developed.

During this part of the research, it was also found that the most important aspects for a more advanced BIM capability were: 1) the communication in the project teams, collaborative and 2) the integral design ability and finally 3) the working process. Each aspect was investigated how it need to be improved, and how this would affect the internal BIM process.

The findings have been translated into specific aspects of the design model developed for the advancement of ATP's BIM adaptation. Currently the BIM capability level is still AD hoc and in a trial and error phase. It need to be further developed to support the organization's mission statement fully and an integral work process using BIM.

The design model developed concerns a BIM workflow Guide. This is a supportive tool to create a repeatable and qualitative BIM process, which will allow ATP to obtain the benefits of BIM, while supporting an Integral working process. The guide will bring transparency to the team and the organization regarding the deliverables, task division roles and responsibilities, whilst allowing ATP to improve its internal BIM process in a consistent structure.

The guide contains a tool called the ATP Radar. The ATP Radar is a method to stimulate the communications at ATP in an informal and unstrained fashion. Providing the organization with a solution towards an improved communication, which will ultimately benefit the design processes. The ATP Radar stimulates communication, by illustrating all employees, in the design disciplines, and there current availability as well as the projects they are involved in.

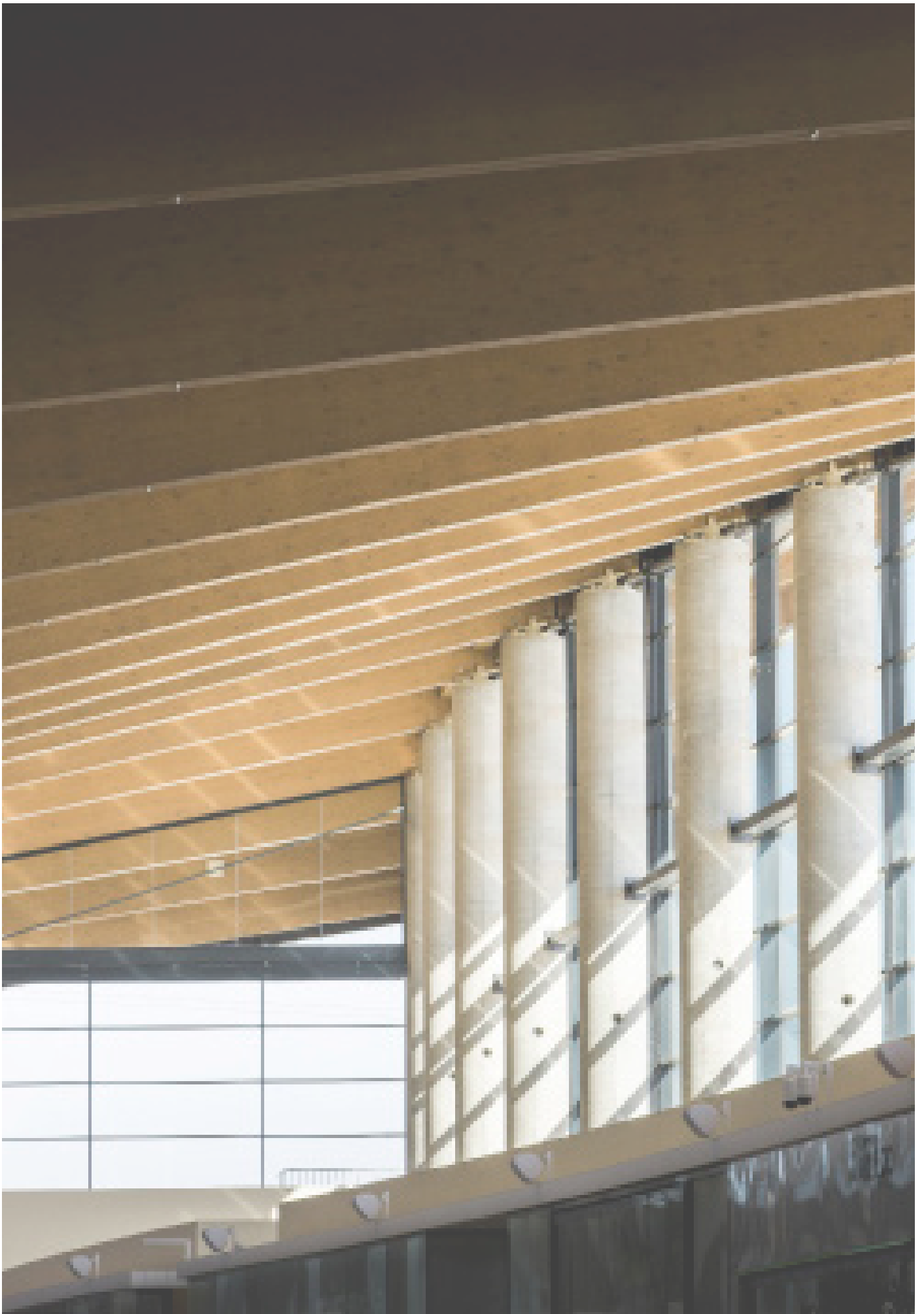
The guide is intended to benefit the entire design and engineering team. It will stimulate the communication and transparency within the organization. It needs to be mostly used by the General Project Leader's and/ or Project Leaders of ATP. It is recommended to install the guide with the existing network of ATP so that the information, assembled from the instrument, could be made visible to all ATP employees. The knowledge of external experts in the field of BIM was used to reflect the design on its usefulness in the organization and its implementation.

In this way the BIM work process of ATP Innsbruck can be enhanced, as was aimed by ATP at the start. It will contribute to insight and understanding into how ATP can improve their internal BIM competence and will support the further adaptation of BIM within ATP.



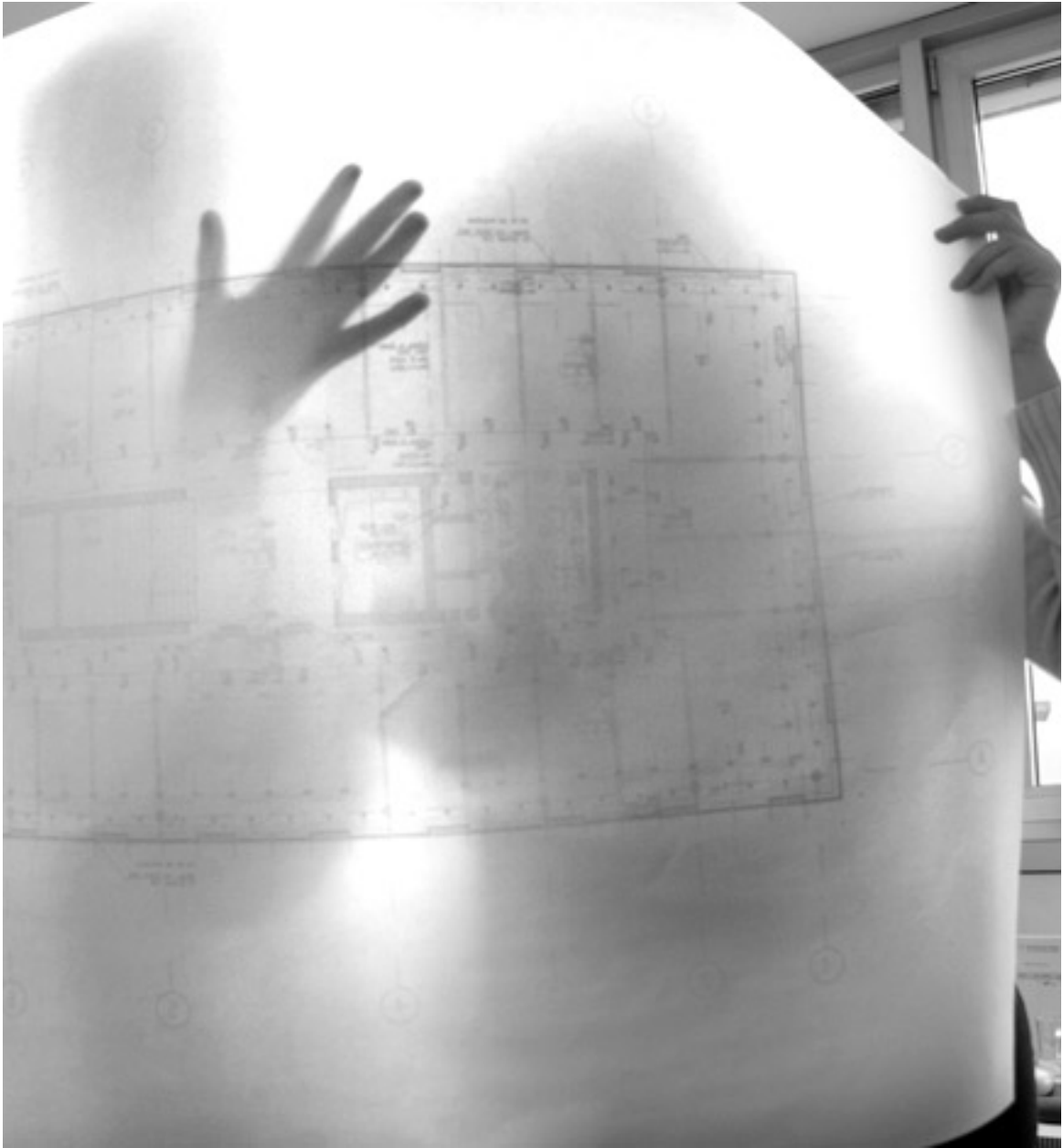
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# 1. Introduction





## 1.1 Preface

This research could be performed in accordance with the Architectural Design Managements Systems (ADMS) program at the Technical University of Eindhoven (TU/e) for ATP Innsbruck. ATP is a multidisciplinary, Adhocracy organization (Mintzberg, 1994) interested in the best way to implement a new Technological based System into their organization. And to define what the best way is to implement new technology in their procedures, and how this affects the distribution of role's and the design- and engineering process of each project. The scope of this research is to provide the organization with a suitable prototype for a method how a new software system needs to be implemented turned to this organization, and to define and explain what characteristics and functions are needed in each project for a smooth working process.

ATP elates itself at being sustainable, innovative and focusing at an integrated design process within its organization and with the external partners in the Austrian and German building construction industry. To further strength itself, ATP is currently attempting to implement BIM. BIM is a set of technologies and group of processes; it is a catalyst for change poised to reduce industry's fragmentation, improve efficiency and effectiveness of the building design and construction processes. BIM is a multidimensional (nD) model that makes it possible to visualize the design and carry out clash control. The result should be a smoother and faster design process and a reduction in construction errors during the execution phase, consequently resulting in a reduction of design and construction costs.

## 1.2 ATP Description

*In this chapter the tasks and responsibilities of ATP are described and explained. The multidisciplinary organization as well as the mission and vision of ATP Innsbruck will be briefly described as well as the organogram and the network of employees.*

### *ATP Deliverables*

ATP is a multidisciplinary organization, which prides itself as being sustainable, innovative and at leading in integrated design within the European building construction industry. The organization is driven towards creating innovative solutions and accommodating users and clients throughout the entire building development process. ATP is able to deliver the entire building development process to its clients, as all disciplines involved during an entire building process can be found in house.



Figure 1. ATP Integrated Design offices model from the ATP website

ATP is the second largest Architectural and Engineering firm in Continental Europe and the largest in Austria, with circa 400 employees and offices in Frankfurt, Innsbruck, Moscow, München, Vienna, Zagreb and Zürich as illustrated in Figure 1. ATP Innsbruck is the largest office, and the original ATP location. This office is able to take on complex building projects and enter into European market because of their excellent market strategy and wide spread of in house knowledge. ATP only recently opened their Moscow Office.

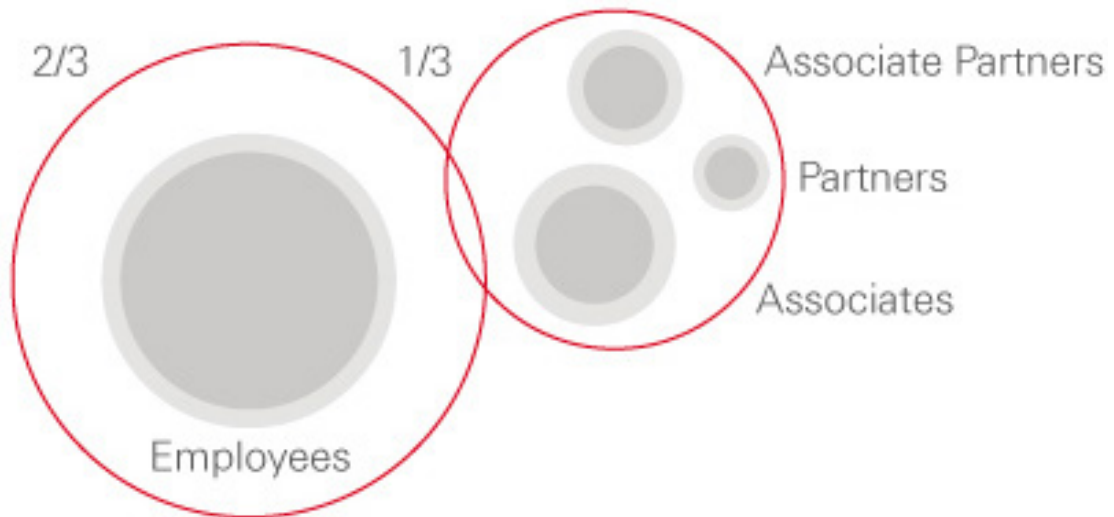


Figure 2. ATP Partnership model from the ATP website

*“ATP architects and Engineers develop innovative solutions along the entire length of the real estate value chain in order to support- faster, better and more sustainably- the key processes of our clients. Our way of working, based on simultaneous cooperation, aims to find the perfect balance between aesthetic, functional and constructional considerations as well as the best possible solution in environmental, human and economic terms.”* from the ATP website

#### Mission and Vision

ATP architects take the lead in this integrated design process in intensive cooperation with the client. All creative contributions to meeting the challenge in question are dealt with simultaneously and treated as of equal importance as they are integrated by ATP’s architects and engineers into the design process with the aim of contributing to the sustainable quality of our buildings and, hence, to the core processes of our clients.

#### Organization

The organization is more top down organizational form (Mintzberg, 1994). A top down organizational form implies the organization has a very tight vertical structure. Functional lines go all the way to the top, allowing top managers to maintain centralized control. Work is very formalized, there are many routines and procedures, decision-making is centralized, and tasks are grouped by functional departments.

ATP Innsbruck has all the disciplines in-house, compared to some of the offices that do not have all the disciplines in-house. In the Innsbruck office the disciplines in-house are: Architects, Structural Engineers, Mechanical Engineers, Electrical Engineers, Tender, Site supervisors, Accountancy, and Administration.

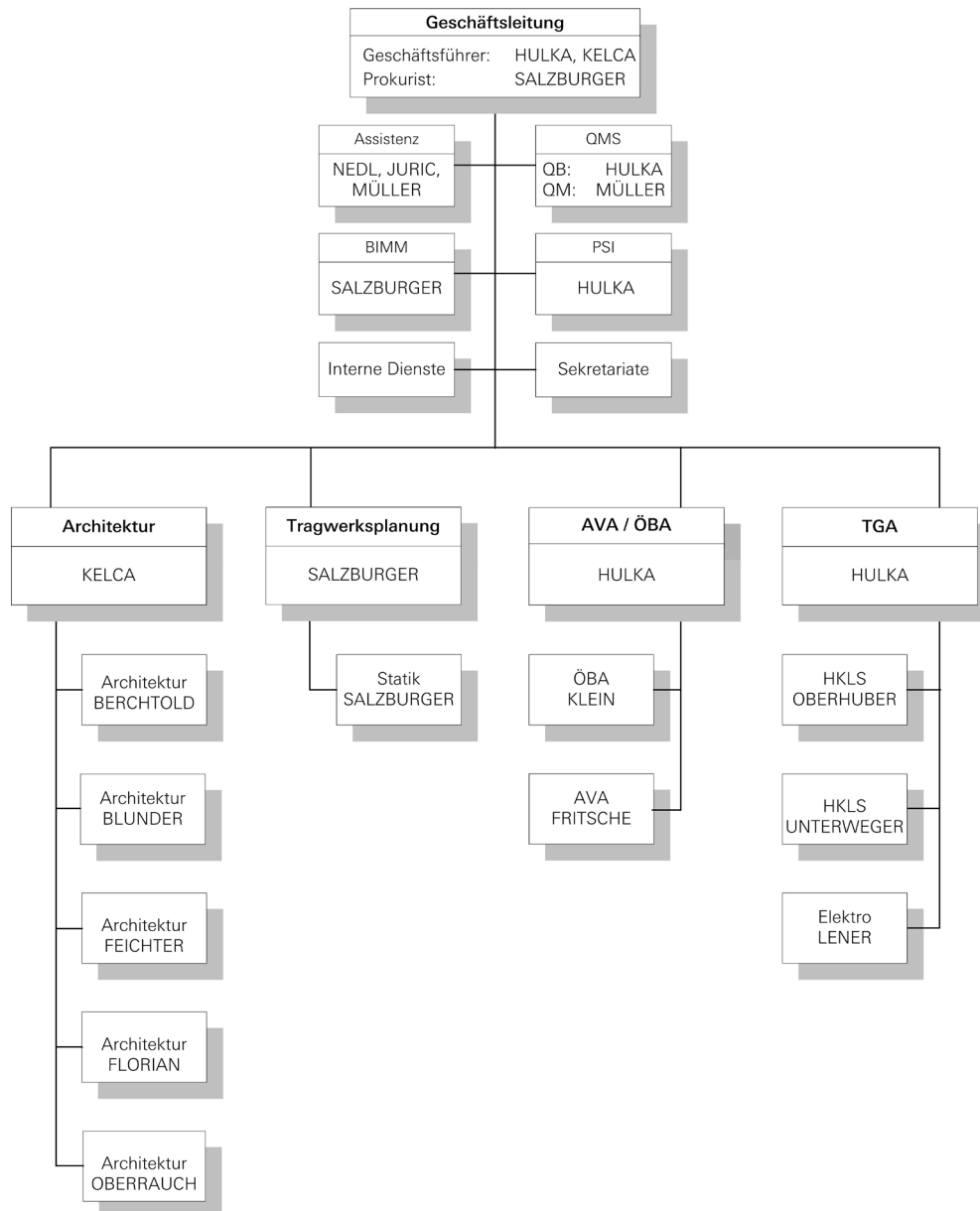


Figure 3. Organogram of ATP Innsbruck

*“ATP Architects and Engineers is engaged in Networks and working groups covering its areas of operation and state-of-art technical issues as a means of sharing knowledge and experience. Communication and cooperation projects with universities, corporations and other organizations are means of actively supporting interactive and innovative processes and gaining even more benefits from the available potential.” ATP website*



### 1.3 Motive

The core drive of ATP is to deliver the best quality product to their clients. This entails an efficient and optimized working process. To achieve an efficient working method ATP has chosen to implement a new technology system. The technology system implemented into the organization will benefit ATP in a number of ways:

1. all in-house disciplines will be able to work using the same software system.
2. any misunderstandings in communication between the stakeholders will be minimized as all the information is contained in a nD building model, communicating all the necessary information in a clear manner (see figure 4)

Building Information Modelling has recently attained widespread attention in the Architectural, Engineering and Construction (AEC) industry. There are lot of indications supporting it will be the future working method in the industry, making ATP a forth runner in working in a BIM process in Europe. A necessity for an organization which prides itself on being innovative.

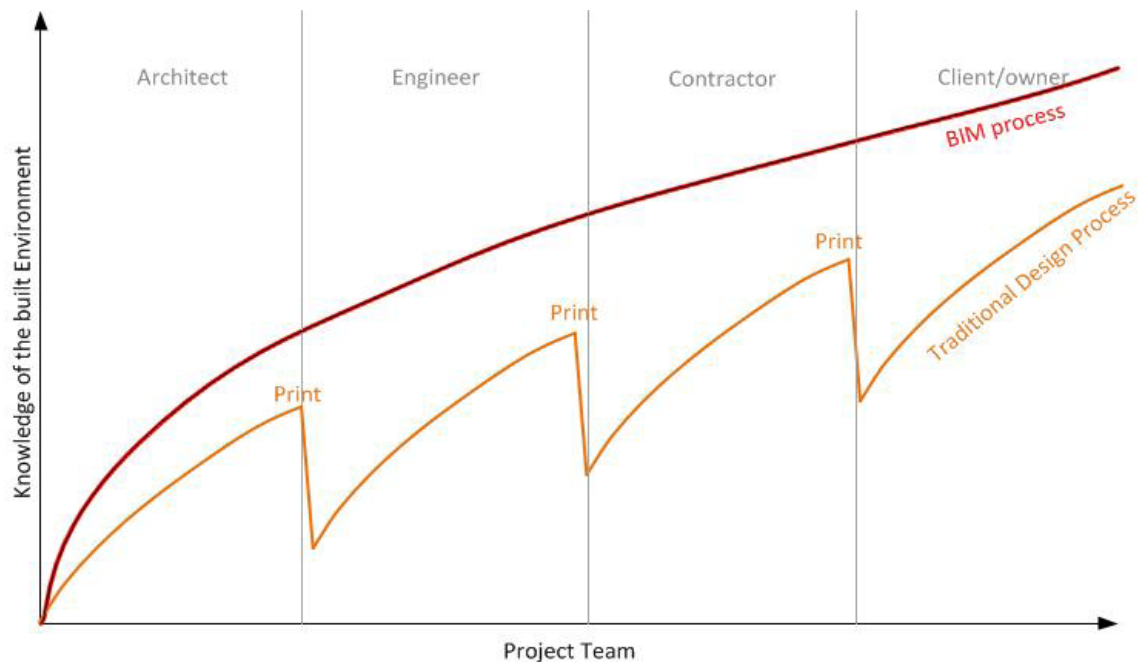


Figure 4- The BIM curve

*“The added value of a BIM-based delivery and operation process is spread throughout all its phases and can, therefore bring benefits to all actors involved in each stage. A particular aspect of the added value a BIM product can bring to the project is enabling optimized activities of analyzing, testing and validating the design before the project execution, thus saving a significant share of failure costs later in the building lifecycle”. (Eastman, 2008)*

*However in order for ATP to refine the implementation of this new working method more information needs to be obtain on the organizational change and work process in order to adopt the most beneficial and efficient process suitable to working with BIM.*

## 1.4 Problem statement

The current organization needs to advance their internal BIM process and it expects to do so by gaining benefit from the adoption of a BIM software package.

The building industry is under pressure to provide value for money, sustainable design and construction etc. and this has propelled the adoption of BIM. Construction companies are facing barriers and challenges in BIM adoption as there is no clear guidance or best practice studies from which they can learn and build up their capacity for BIM use in order to increase productivity, efficiency, quality, and to attain competitive advantages in the global market and to achieve the targets in environmental sustainability.

Regardless of the benefits BIM brings to the company, introducing a new technology into an organization is always more complex than simply purchasing the software package. When implementing a new technology this requires an adaptation period

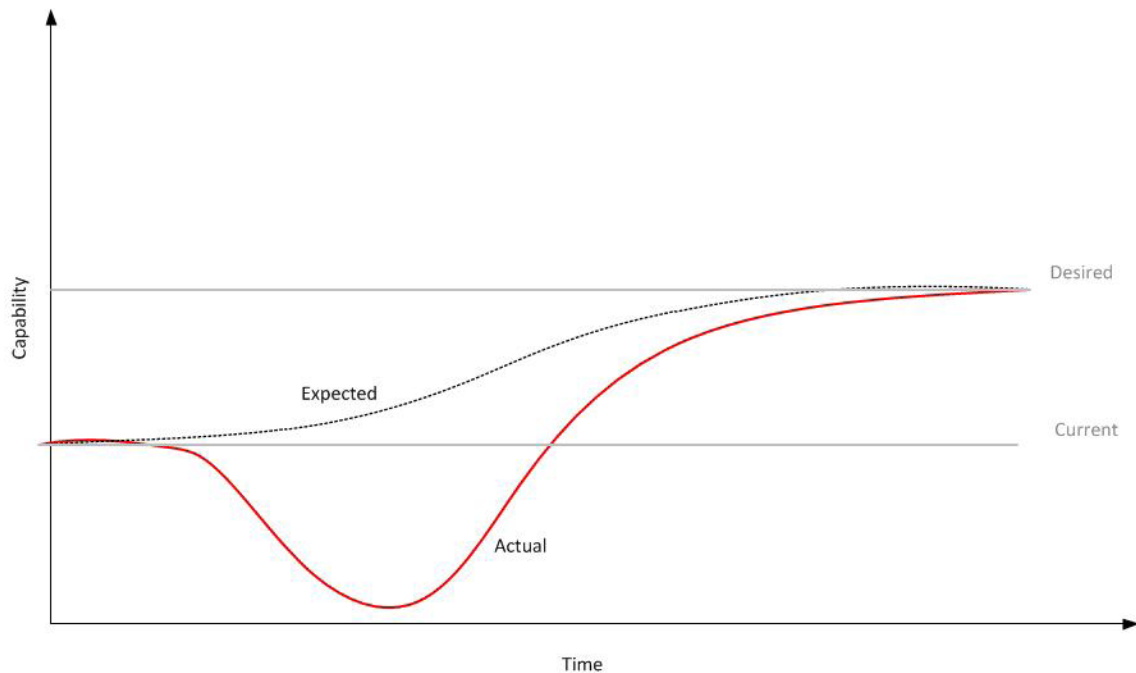


Figure 5- ANGL curve (2011)

from the employees and a managerial and process change in the organization. Figure 5 describes how that a technological change is always a more strenuous process than is expected.

*“The transition to BIM however is not a natural progression from computer-aided drafting (CAD). It involves a paradigm shift from drawing to modelling, and it facilitates- and is facilitated by- a concurrent shift from traditional competitive project delivery models to more collaborative practices in design and construction.” (Eastman, 2008)*

*“The transition from the traditional paper-based projects towards a digitized*



*3Dimensional comprehensive building prototype is not to be underestimated. The enthusiasm and curiosity demonstrated within the building industry provides good indication that BIM as a design technology is gaining popularity. More and more BIM-related events, such as workshops and demonstrations are crowding agendas nationwide.”- (Illiescu, 2010)*

*“Globally only a few companies are technically and organizationally advanced enough to satisfy the needs for fully digital product development. Most companies are at the evolutionary stage changing from 2-D drawings to 3-D CAD”. (Korbijn, 1999)*

*Eliminating the traditional 2D CAD paper-based workflow enables a higher degree of parallelism by removing sequential steps. This should be apparent in the working process. Therefore the organization should not only learn how to work using a new software tool, to communicate the project to the involved stakeholders, but the organization should also adapt their working process to be more suited to an nD workflow. Using a BIM workflow allows the project team to make instant and concurrent decisions through collaboration with other entities and minimizes misunderstandings between the stakeholders.*

*It is the complexity of the BIM work process that led to a difference of interpretation on the BIM working process and levels of engagement with BIM, in current practice. It is in this context that the different disciplines have provided the need for this research to see what is needed for all parties to come to a satisfied and agreeable working method.*

*“simply purchasing a package of CAD-software will not do. To reach full digital definition and use of a companies’ products, four crucial functions of the enterprise must be satisfactorily developed, i.e. product- and process definition, product data management, computer and communication facilities and organizational and process improvements”. (Korbijn, 1999)*

*An efficient and effective BIM working process has the potential to enhance performance, optimize solutions and enrich design collaborations, within the building and construction industry. To guarantee a smooth transition to an efficient BIM process, in the current design practices of ATP, the communication during such a BIM working process needs to be further established. The value of enhancing the communication and flow of interaction between co-workers will benefit such a BIM process.*

## 1.5 Purpose

The purpose of this research is to navigate ATP to a more efficient BIM working method. Essentially driving ATP from its current working maturity; as defined according to the Succar BIM maturity theory (See appendix 8 for further explanation), towards a developed working process. An optimized working process would entail a BIM strategy that is frequently revisited on ATP's organizational model and realigned with other strategies.

The ATP employees all have a different level of ambition and innovative behaviors as indicated in the Life Cycle graph (see figure 6). Ranging from individual employees ambitioning to be Innovators to Laggards (Rogers, 2003). This is an organization, which is functioning by a Top down approach. Therefore it is essential to stimulate drive and motivation with the employees for a successful implementation of the software. This can be achieved by moving the ATP employees forward in the Technology adaptation Cycle.

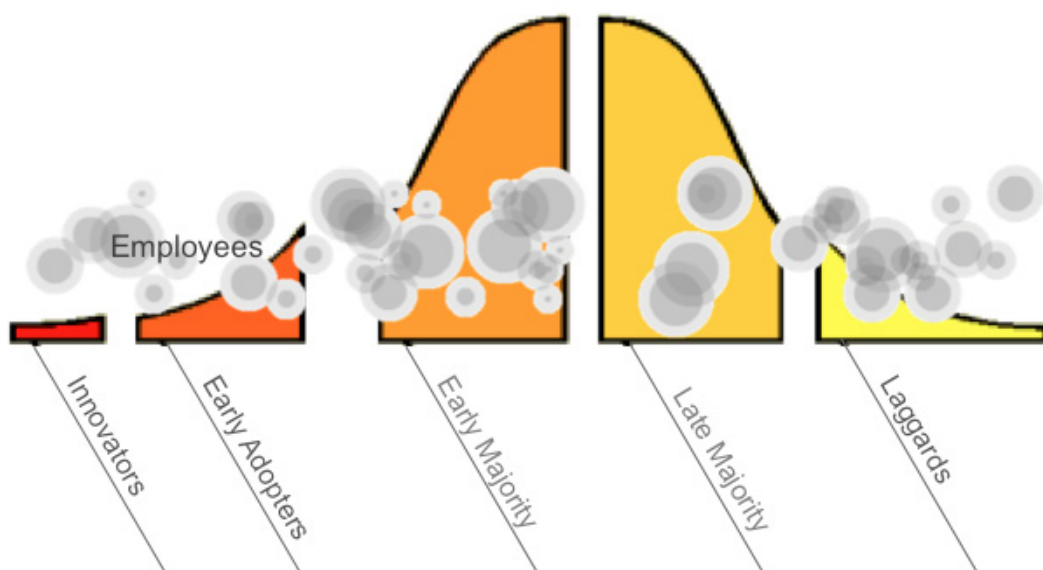


Figure 6- The revised Technology Adoption Cycle (Rogers, 2003)

## 1.6 Research question

The described and explained Motive and Problem statements of the research lead to a general re-search question.

**How can ATP improve their BIM competence, while enhancing an effective and efficient integral working process?**

In order to successfully answer this research question, it is devised into three sub-questions. The acknowledgement of the sub-questions will consequently lead to the main answer. The main re-search Question is broken down into the following three relevant notions:

1. *What are the positions and duties needed for an improved BIM process at ATP?*
2. *What level of BIM competence should ATP strive to achieve to improve their BIM competence?*
3. *What are the most crucial aspects, within the internal working process, for an im-proved BIM process for ATP?*

The above sub-questions have determined the analysis and design framework throughout this project, as it will be shown in the following sections of the report.

### 1.6.1 Aim

The aim of the research is to enhance the BIM work process of ATP Innsbruck. This is done while supporting one of the main strengths of ATP, which is Integral design (see appendix 4). The outcome of this research is to support and stimulate the existing integral working method of ATP, and the adoption of BIM technology at ATP. This transforms the paradigm of the construction industry from 2D based drawing information systems to 3D object based design information systems (Mihindu and Arayici, 2008). The framework that will be designed needs to assist ATP and their employees in improving their capability and to achieve process improvement benefits.

Therefore the overall aim of this research is to develop a tool for the BIM adoption and implementation. The overall BIM implementation approach uses a socio-technical view, which considers the implementation of technology as well as the socio-cultural environment that provides the context for its implementation.

## 1.7 Scope

*A successful BIM adoption needs an implementation strategy. However, at operational level it is imperative that professional guidelines are required as part of the implementation strategy.*

### *Focus with ATP Innsbruck*

*From the diagnoses made during the first phase of the research it has been discovered that it is important for ATP to gain a certain BIM competence level. It was also made clear, during discussions with the ATP supervisors and interviews with the other ATP offices that ATP Innsbruck is the front runner in the organization to adapt this new technology system. Therefore the scope of this research is to look at how ATP Innsbruck can develop its BIM competence and establish an efficient working method. This should finally result in spreading the knowledge and the framework to the other offices of ATP and the adaption of the Innsbruck learning process.*

### *Focus on internal communication and Integral Design*

*The biggest bottle neck for ATP is to establish an efficient working method which seems to be mainly concerning communication i.e. when changes are made-, in the design or in the software technology, the way they are articulated and communicated to the necessary employees. This makes the communication aspects very relevant to achieve an efficient BIM process. As a multidisciplinary office the strength of ATP lies within an integral working method. As BIM is a tool which stimulates integral designing it is an important aspect to include communicational aspects in the research, essentially strengthening ATP even more.*

### *Technology*

*When implementing a new software technology into an organization the following three aspects should always be taken under careful consideration;*

- 1) Technology,*
- 2) Process and*
- 3) Organization.*

*Plandata, a daughter company of ATP, whom supports ATP with any technologically based issues and educates the technological aspect of BIM to the employees at ATP Innsbruck. Plandata is situated within the same building; this research will exclude the technology aspect out of the scope of my research, as indicated in Figure 7.*

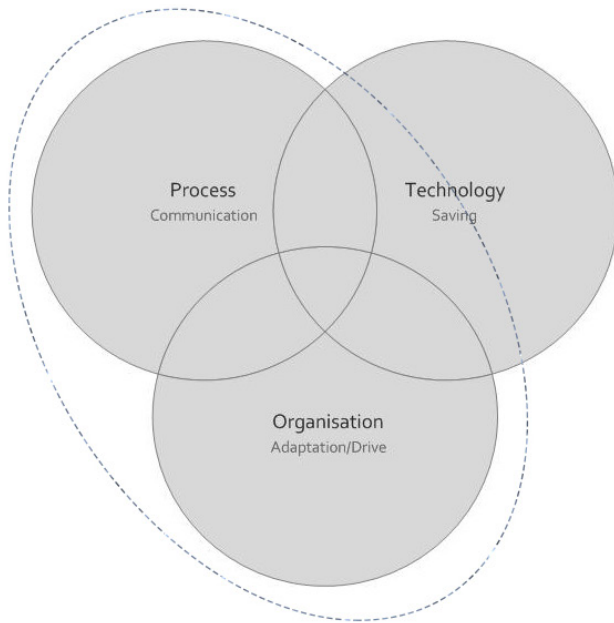


Figure 7- Illustrating the focus of this Research

#### *Cost management*

Currently research has been carried out regarding the cost management with support of BIM at ATP. „Evaluierung Kostenmanagement mittels iTWO durch Verknüpfung mit REVIT-Modell“ iTWO is a tendering- and for cost-management-program able to import and analyze information of 3-D-data-Models. Because this research already touches upon the cost management analysis it is delineated of the scope of the research. However, regular meetings will take place to allow this research to include their findings and allow for an output that will be suitable for all aspects of BIM use.

#### *Out-house optimization*

Before ATP starts communicating via BIM to stakeholders outside ATP, it must first implement the efficient BIM communication internally. Therefore this research will focus on implementing the efficient use of BIM successfully internally.

#### *Facility management*

The ideal situation is reached when the life cycle information is incorporated into the ATP service concerning Facility Management (FM). However, because the organization has yet to provide this service, it was not included into the research as there are no in-house examples to draw from.

Even though this subject matters, Technology, Cost management, Out-house optimization and Facility Management, fall out of the scope of this research, it was taken into account and left open during the development of the Design to allow for ATP to include these aspects in the future.

#### *BIM software*

A Building Information Model can be created from a series of different software packages. Before this Research was initiated, ATP had already chosen for the use of Revit. This AutoDesk software package was exclusively chosen by ATP because of its modelling compatibility for all disciplines. Therefore research to the most applicable BIM software was excluded from this research.

## 1.8 Approach

Displayed in figure 8 is the Research model. This model is a schematic representation of the steps globally taken to execute the research in a focused manner.

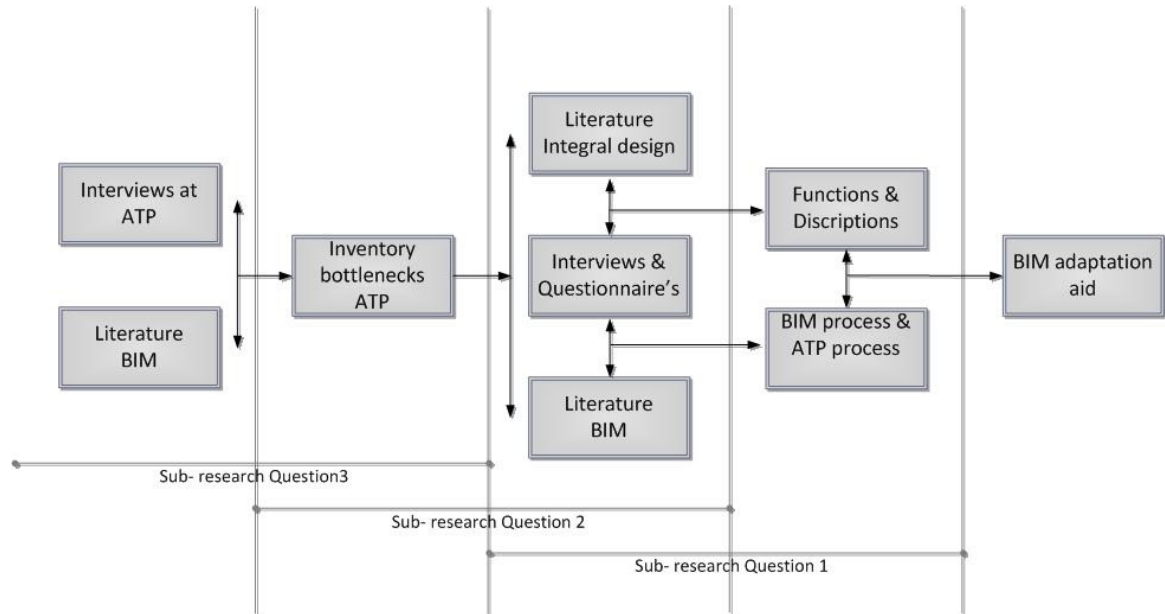


Figure 8- Research model

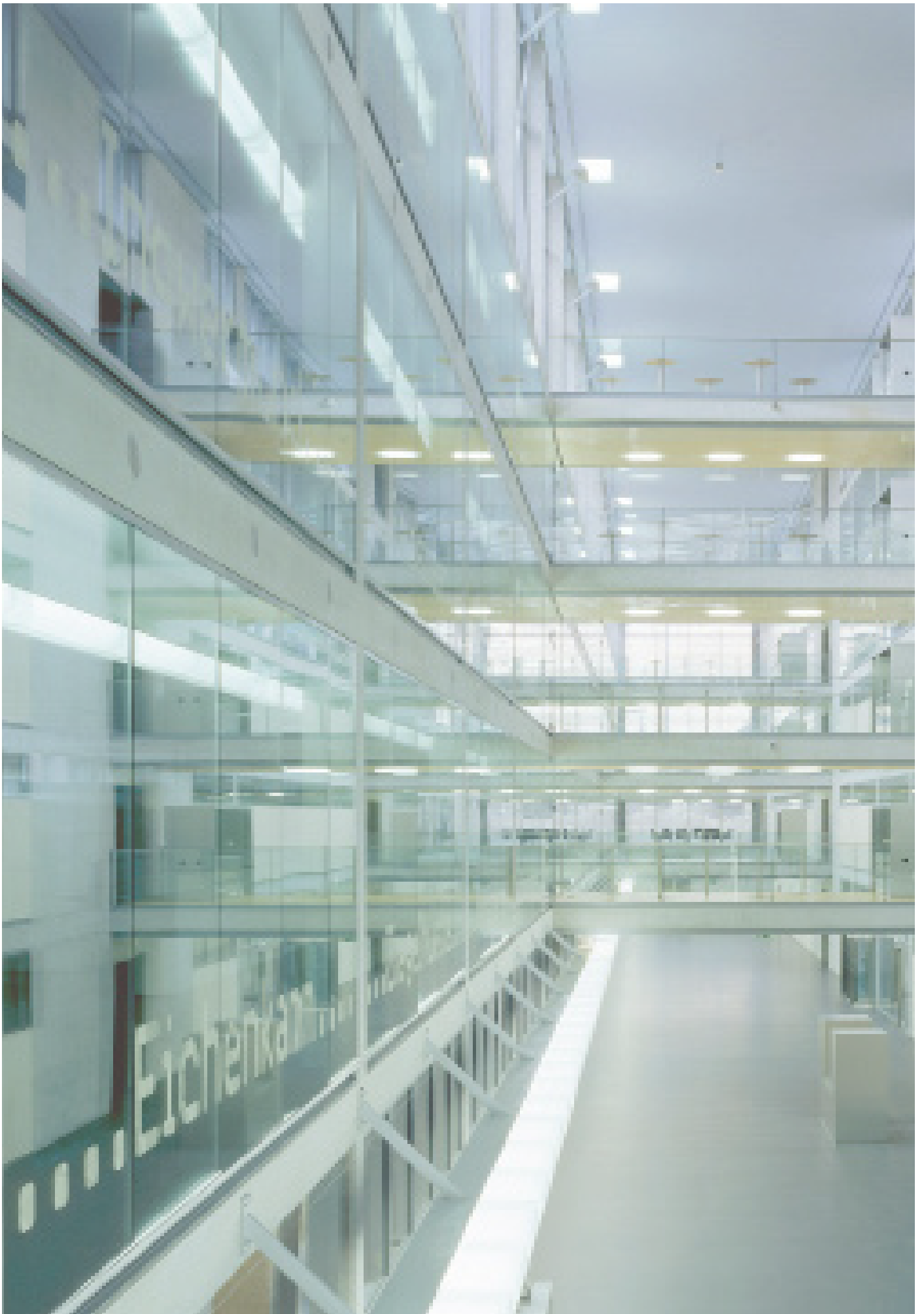
### 1.8.1 Design Method

The design Methodology consists of 3 phases, which are briefly described below:

- The first phase of this research concerns the Orientation phase. It consists of the problem statement and an initial evaluation. The aim of this phase is to gain insight into the problem at hand. This will be conducted from a number of interviews and a literature study. The problem statement will be evaluated to through a series of meetings with ATP supervisors.
- The second stage, the analysis phase consists of a comparison between the findings from the practice and literature.
- The third phase is the Design phase: the development of an instrument specific for the BIM Process at ATP Innsbruck. The characteristics of the instrument should correspond to the bottlenecks found during the analysis phase of the research. The initial Design will then be evaluated and iterated to improve the initial design.







# 2. Analyse

## 2.1 Analysis Framework

The analysis phase of the research aims to provide a definition based on the results of the literature study to gather better understanding of BIM in practice. The notion and current understanding of BIM is distinguished. In addition, the literature results concerning the answers to the three sub questions will be answered individually. Furthermore, attention is paid to the attitude of employees at ATP of how they handle the adoption of BIM within the internal working processes.

The Analysis chapter aims to articulate the Building Information Modeling in practice, at ATP Innsbruck. The analysis intends to compare the current practice with Literature available on the subject matter. To get a complete overview of the current Practice situation, and to enable an in-depth analysis, a questionnaire was developed to interview employees at ATP. A series of comprehensive interviews were held in-house as well as external interviews with leading experts in the field. Next to that, five projects carried out by ATP were studied. (See Table 1 for the names of the projects). The employed literature was selected because of its relevance to the aim and the sub-research questions.

To complete the Analysis phase, the sub-research questions were individually investigated and acknowledged to provide a solution. Consequently the main research question can be answered to solve the formulated problem statement.

## 2.2 Definition of BIM

There are several definitions available to describe what the term BIM actually means. As conceptual BIM boundaries are ever changing, and the technologies surrounding BIM are constantly developing, it is difficult to define what is understood by the meaning of BIM.

Within several studies numerous definitions of BIM are drawn. Some are very general; others bring the concept in connection with several specific discriminatory aspects. Within this study, the following two criteria for a working definition of BIM were used:

- 1) The definition does not radically differ from the general understanding of the word.
- 2) The definition is described in its own quality, and where each property is necessary and sufficient, with minimal defining qualities while retaining completeness.

A Building Information Model (BIM) is a digital representation of physical and functional characteristics of a facility. A BIM is a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle. BIM technology facilitates simultaneous work by multiple design disciplines. (Succar, 2009)

BIM asks for a different working process, therefore it involves more than merely implementing a new software package. It requires a move away from the traditional working method, to a more concurrent process. The design team and all the disciplines involved in the project must work in a more integrated manner. This is a substantial shift from the traditional conventional working method, where parties often work on separate Information pools, to a new method working on the same information pool. BIM is a nD model that makes it possible to visualize the design and carry out clash control. Using an online nD, model generates a series of benefits for ATP, as it encourages a more integrated approach, including all the disciplines from the initial phase of the design process. Also it is easier to monitor the design evolution as well as recognize conflicts through clash control. Making the appropriate corrections in earlier phases of the design project, leading to a shorter design time, as the design choices can be made faster and more accurately, reducing uncertainty and increasing the quality of the design. The result is a faster design process and a reduction in construction errors during the execution phase, consequent in a reduction of design and construction costs.

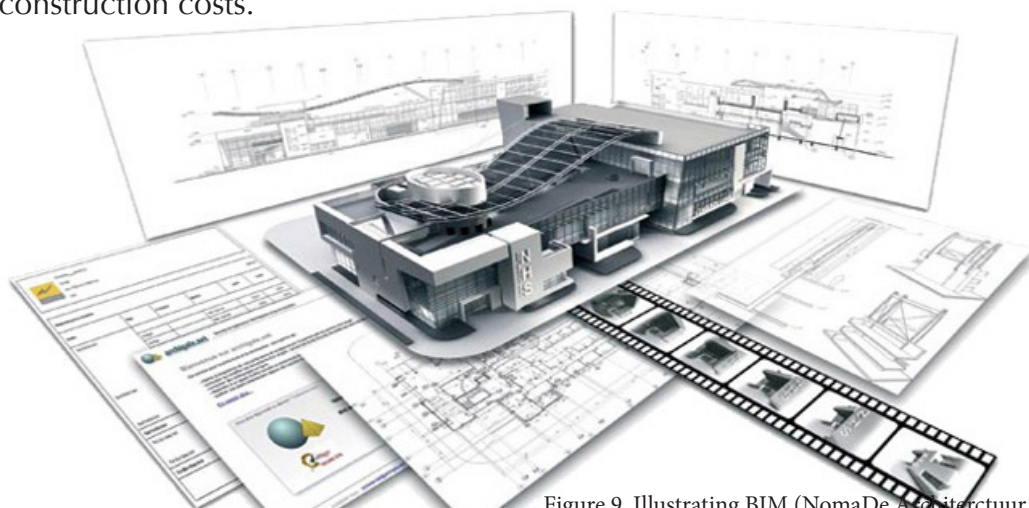


Figure 9. Illustrating BIM (NomaDe Architectuur, 2013)

## 2.3 Positions and Duties

During the research the positions affected by the implementation of BIM, where inquired by analyzing how these positions influence the internal working process of BIM. The current positions are initially described and analyzed before being compared to the positions described in the BIM Literature.

### 2.3.1 Current Positions and Duties at ATP

The current BIM functions at ATP Innsbruck are that of the; ‘CAD Verantwortlicher’ (CADv); the BIM Manager (BIM.M); the Modeller, the Super Users and the Drafts Person. These Positions and the position of the “Gesamptprojektleiter” are all important and relevant to the implementation of BIM, as they are effected by, or arose from the implementation of BIM. This chapter will briefly cover the important attributes of these functions. Figure 10 aims to describe how these positions relate to each other in the apparent hierarchy of the current organization, to indicate the relationship between the current BIM functions during the course of the research.

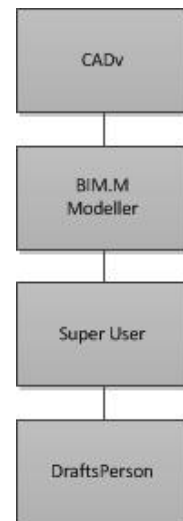


Figure 10.

#### ‘CAD Verantwortlicher’

The function of the ‘CAD verantwortlicher’, briefly summarized, is to keep apprehending what is currently happening within the organization, with regards to the Computer Aided Design Software Systems or other computer aided tools, for the design aspects. The duty, of the ‘CADv’ is, to keep track of how the organization and the employees adapt and perceive any of the Design software. The CADv should also be approachable for commendations or objections by any of the employees.

Below is a SWOT diagram, to create a clearer idea of what this job function attributes. \*A SWOT diagram is a useful technique to help identify the Strengths Weaknesses Opportunities and Threats for this particular situation. The SWOT diagram has been used on the majority of the functions elucidated in this research.

SWOT Diagram representing the ‘CADv’:

<p><b>Strengths</b></p> <ul style="list-style-type: none"> <li>- Overall overview of Computer Aided Design(CAD) Software Implementations</li> <li>- Knowledgeable about the technological field, and the current market</li> <li>- Knowledge about the perception of the CAD of the employees</li> </ul>	<p><b>Weaknesses</b></p> <ul style="list-style-type: none"> <li>-Position of the CADv is more of a conceptual and overall position; it is not into the specifics of making the software feasible.</li> <li>-Making it difficult to retain a Micro understanding of what are the processes in the organization</li> </ul>
<p><b>Opportunities</b></p> <ul style="list-style-type: none"> <li>- Ability to implement or recommend new Software, after standard scrutiny</li> <li>- to have an understand what packages are needed for ATP</li> <li>- to maintain a network of people in different practices to perpetuate knowledge of other software tools for the building and construction industry.</li> </ul>	<p><b>Threats</b></p> <ul style="list-style-type: none"> <li>-If not receiving accurate information from the employees, regarding CAD software, would minimize an effective output of this position.</li> <li>- inability to create and stimulate motivation with colleagues, regarding software implementations</li> </ul>

\*A SWOT diagram is a useful technique to help identify the Strengths Weaknesses Opportunities and Threats for this particular situation.

### *BIM manager/Modeller*

The position of the Modeller is one that is transitioning to a BIM Manager, during the development of this research. Thus the function of the Modeler is initially described and then compared to the function of the BIM Manager. This function is developing and changing according to what is now needed within ATP, compared to what was needed during the commencement of the software system.

### *Modeller*

The most important position at ATP, with regard to the use of the initial implementation of BIM, is that Modeller. This function has however developed because the organization is acclimatizing to working with BIM. During the early phase of this research the function of the Modeler was to:

- Help their co-workers to understand and educate how to work with Revit, after their introductory workshop.
- Assist the design teams by establishing and setting up the BIModels, and often during the course of the design phase implement the progress into the model.
- Create and make families for the Projects.
- Draw complex building aspects.
- To develop and maintain a certain drawing standard.

The function of the modeler and its effect in the current internal working process of ATP Innsbruck were analyzed by using, a SWOT Diagram. This method ambition to illustrates the full scope of benefits and obstacles of the Modeller.

SWOT Diagram of the Modeller:

<b>Strengths</b> <ul style="list-style-type: none"><li>- Super user</li><li>- Early adapter</li><li>- High level of knowledge on modeling with Revit</li></ul>	<b>Weaknesses</b> <ul style="list-style-type: none"><li>-Has to spend a lot of time educating other employees</li><li>- Too much demanded from one function</li><li>- Too busy with "Revit families" to foresee upcoming conflicts between disciplines</li><li>- No drawing standard was set at the commencement of this function, therefore, drawing standards had to be put into effect</li></ul>
<b>Opportunities</b> <ul style="list-style-type: none"><li>-To adapt to Revit as one of the first in the organization</li><li>-To create or have an input into building/modelling families</li><li>- Help co-workers adapt to Revit</li><li>- Foresee conflicts between disciplines</li><li>- Help the setup of BIM in Innsbruck</li></ul>	<b>Threats</b> <ul style="list-style-type: none"><li>-A job function that will become less useful to the company as more employees learn how to adapt to Revit</li><li>-The modellers seem to have no managerial overview of the running projects</li><li>- Easily Side tracked from its Modelling function to help teach co-workers, or visa versa</li><li>- In absence, the project team could severely lose time during the project process</li></ul>

## BIM manager

The outcomes of the SWOT diagram shows that, as the individual employees within ATP improve their BIM capabilities, there would be less need for the function of the modeler, but rather that of a proprietor regarding the technological aspects of the model. This development leads to the need of a BIM manager, rather than that of a Modeller, the function of the BIM manager is taken into effect during the course of this research. Despite the fact that the function of the BIM M still remains to hold a lot of the same properties and duties as the Modeller, it is the first transparent shift towards a more adapted BIM process. The duties and function of the BIM manager currently entail some of the following:

- Monitoring standards throughout the project, and making certain standards get met by the appropriate team member(s).
- Help co-worker to understand and educate how to work with Revit, or assist them, or recommend them to Plan data for additional workshops.
- Update and maintain families for the Projects, also in the archiving
- Setup BIM model
- Draw complex building aspects
- Continuous monitoring of the qualitative performance
- Participate in necessary project meetings

(For a complete job description of the BIM Manager please see Appendix 8)

SWOT Diagram representing the BIM manager:

<p><b>Strengths</b></p> <ul style="list-style-type: none"> <li>- Super user</li> <li>- Monitoring of the overall project</li> <li>- Understanding of the entire BIM process</li> </ul>	<p><b>Weaknesses</b></p> <ul style="list-style-type: none"> <li>- The BIM process is not yet understood by all ATP employees</li> <li>- Too many employees still need to adapt for this function to be carried out as described</li> </ul>
<p><b>Opportunities</b></p> <ul style="list-style-type: none"> <li>-To pilot the BIM process in a project and within the organization</li> <li>- To advance the existing "Revit families"</li> <li>- Domain over the Modeling qualities.</li> </ul>	<p><b>Threats</b></p> <ul style="list-style-type: none"> <li>-To administer the collaboration between disciplines</li> <li>- Too much demanded from one function, as the firm is starting their BIM competence</li> </ul>

The BIM manager's function is evidence of the adaptation and the learning curve, towards a BIM process within ATP, as briefly stated above. According to 'De Geus, 1988' (van Aken, 1993) The inherent uncertainty in any strategy can be controlled by a recent strategy to implement at once, therefore piloting what works and what does not work. The strategy should be open to any readjusted strategies, and constantly occupied with 'future mapping', of the aspired outcome. Illustrated in Figure 11. This aims to explain what is currently happening in the organization, with gauge on the function of the BIMM, and what the outcome of this research should offer aid to advance.

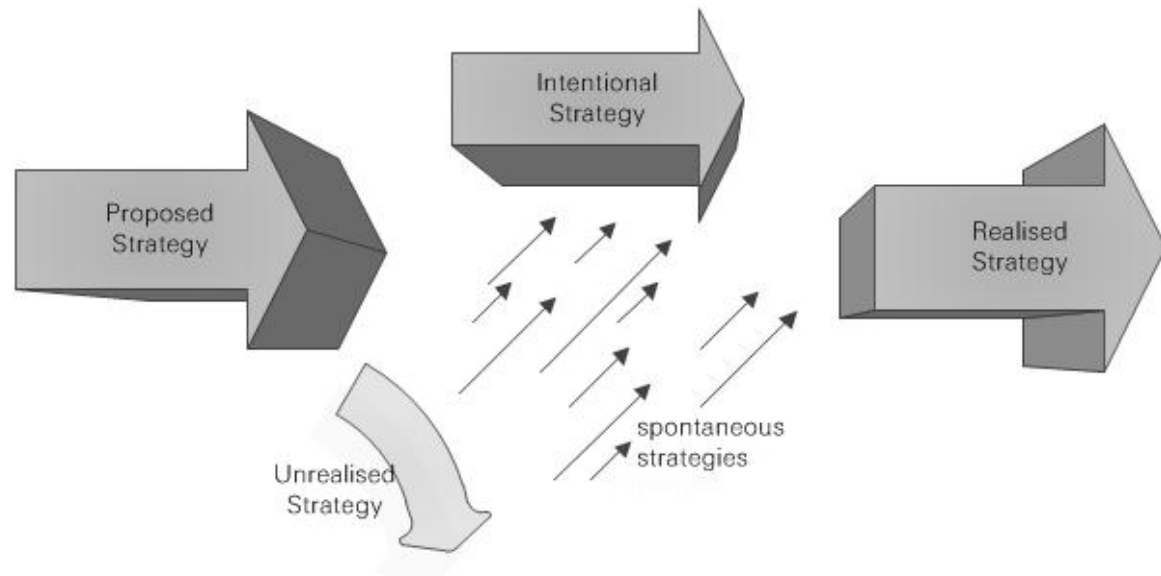


Figure 11. Spontaneous strategies. De Geus. 1988

The Illustration of De Geus theory in Figure 11, aims to describe that a strategy or an implementation is a dynamic aspect within any organization. As the Initial Proposed strategy is actualized, the reality will always take a different form from the Theory prior to the strategy execution. Therefore, the unrealized strategy should be acknowledged as a spontaneous strategy, which would to steer the dynamic organization back to the initial strategic aim.

This is what is currently happening with the implementation of BIM and its BIM positions. The initial response to the Modeler function has shifted to the function of the BIM manager.

To fully understand the Macro influence of this transitioning function on the work flow in the organization, an investigation was made, surveying the number of hours the Modelers worked, compared to the total number of hours spend on the entire project. See table 1. This was tested on 5 projects, because during this phase of the analysis at ATP Innsbruck, it had completed only 5 Revit projects. According to this we can gather that on average the Modellers time consisted of 10 % of the entire projects. This calculation is based on the BIM projects completed thus far, and as the BIM adaptation within the organization develops this percentile is predicted to vary. Ergo these calculations should be considered as an indication and revised with more BIM experience.



	Maximarkt Anif	Maximarkt Anif	Mpreis Backerei	Miratorg Briansk	AEG MIS	Bauerngut Konnern
Project number	3378	1294	1292	1298	1257	
Total Hours	12088.2	27506.5	39309.5	27126.1	17269.2	
Hours Modeller(s)	2016.5	2294.4	3204.3	2900.5	948.2	
% of hours of the modeller	17	8	8	11	5	
Average %						10

Table 1\*

\*Please note that these calculations are based on the function described as the modeler, and not of the function described as the BIM manager, as the projects realized at this date of observation was done before the transition between these two functions.

### *Super User*

A Revit Super User is an employee at ATP, who is highly proficient, obtains specific knowledge, and is very skilled in the use of the Revit software package. He or she should be able to work in Revit with minimum uncertainties, regarding the use of the software during the project, and even be able to create 'Revit families'. As the prior design tool was AutoCAD the employees have to adapt to become more proficient in using Revit; currently there are very few Super Users.

### *Draftsperson*

The position of the draftsperson is to implement and update any design changes into the Revit model. In order to complete this task, he or she should be able to acquire a reasonable proficiency in his or her individual Revit capabilities. The draftsperson should be able to layout and prepare the Revit Model before the team starts working in the Model. Currently the 'Modeller' is doing this work, but it should be the draftsperson who makes these preparations.

### *"Gesamptprojektleiter"*

The position of the "Gesamptprojektleiter" (GPL) is very much affected by the implementation of BIM. The interviewed Project Leaders seemed to be divided between Innovators and Laggards as Rogers (2003) identifies (see Figure 6). For the adaption and motivation within the organization and the employees, it is important to obtain a united force into the response of BIM implementation.

The GPL is not only responsible for the attitude towards BIM but, as it is the position of the GPL to manage and control the building process, a thorough understanding of the effects and changes, the BIM process holds over the traditional working process, is necessary.

### 2.3.2 BIM Literature

*“An effective multidisciplinary collaboration supported by an optimal use of BIM requires changing roles of the client, architects, and contractors; new contractual relationships; and re-organized collaborative processes”.* (Sebastian, 2010)

Currently there are a limited number of publications about management functions and organizational issues compared to ATP’s management concerning BIM. Most publications regarding Positions surrounding BIM are more applicable to companies providing the services of a singular discipline. Whereas ATP is a multidisciplinary company where all disciplines needed for the project can be found in house. Therefore, the recommendations indicated by this literature are not directly applicable. However, most of the Literature found on the subject matter stems from the BIM manager website, theorist Bilal Succar and a prior ADMS report; Let’s BIM. (Detailed overviews of the BIM functions, according to these sources, are represented in Appendix 7.)

#### *BIM Officer*

In the literature a position called the BIM officer is discussed and described as the following:

*The role is mainly of executive nature, with its main responsibilities in the overall organization of the BIM process. The BIM officer will ensure and maintain the links between various project parties and across the various phases of the project lifecycle. The role of BIM officer can be assumed continuously throughout the project, or limited to the main phases of the project.*

This role differs from the BIM manager’s role in the sense that he or she should have a greater understanding of all the running projects in the organization. A brief description of the BIM Managers role:

While protocols for version control and managing releases are well developed and understood within the drawing document based world (whether paper or virtual), options are different and more open-ended with BIM. There may be a single master model or a set of federated ones. Since models are accessible 24/7, releases can potentially be made multiple times a day. As a result, the potential for model corruption exists. Because a project model is a high-value corporate product, maintaining its data integrity justifies explicit management. The model manager determines the policies to be followed for establishing read-and-update privileges, for merging consultants work and other data into a master model, and for managing model consistency across versions.

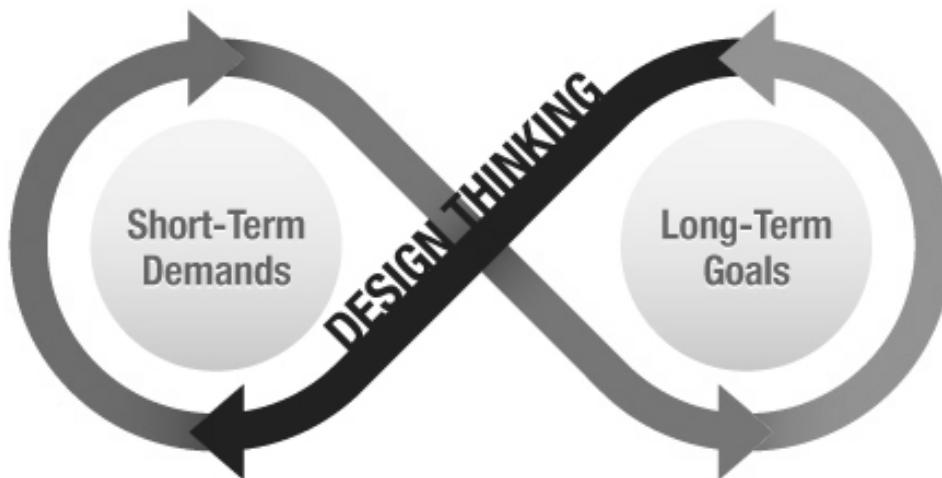
Dealing with model review and releases and managing the consistency of models will require special attention until a set of conventions becomes standard. The model manager role must be assigned for each project.

Within a BIM run project the division of roles and responsibilities differ from those within a traditional work process.

*“Though there are few real world examples of BIM usage (Khemlani 2007b, 2007c), in general the adoption rate has been lethargic. The Primary reasons according to literature include lack of initiative and training, varied market readiness across geographies, and reluctance to change the existing work-practice. In an industry where most projects are handled in multi organizational teams the lack of clarity on the responsibilities, roles and benefits in using a BIM approach is an important inhibiting factor.” (Ning et al.,2009)*

The transit that ATP has already witnessed within the position of the Modeler to that of the BIM Manager, indicates the different roles from the short-term, to long term BIM implementation. The functions differ, making it important for the BIM described functions at ATP to include a transit in the duties of some of the functions, as the employees at ATP become more sufficient in the software Revit and the working method of BIM. Illustrated in Figure 12.

Figure 12



Herzberger describes what job characteristics satisfy and dissatisfies employees (Robbins, 2010). These aspects were taken into consideration when developing a tool for ATP to achieve an improved BIM implementation in the organization. The largest satisfier, according to the two factor theory of Herzberger illustrated in figure 14, are achievement and recognition. As ATP has a very clearly stipulated career plan, this is already considered within the organization, gathered from the interviews. However, as the satisfier: responsibility is also a top4 satisfier, this was taken into consideration during for the development of the tool. From the interviews carried out it appeared that the handover of responsibility is an important aspect that is currently missing from there work. As the organization is mostly run by a Top down (also covered in chapter: ATP Description in the introduction), it seems that the responsibility is held mostly with the GPL, which demotivates the drive for the adaptation of using Revit.

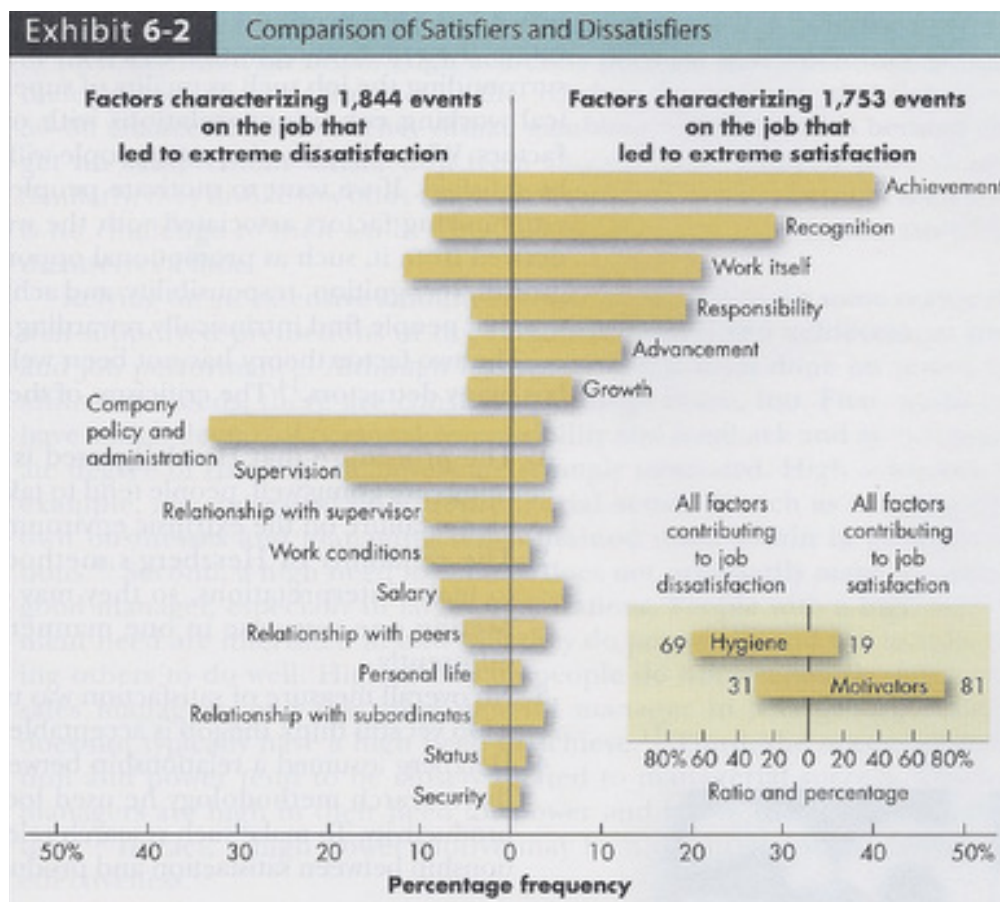


Figure 13- the two factor theory of Herzberger illustrated

In an industry where most projects are handled in multi-organizational teams the lack of clarity on the responsibilities, roles and benefits in using a BIM approach is an important inhibiting factor. (Ning, et al. 2009) This is articulated in the function definitions described by Succar, but assembled during interviews with experts in the field of BIM, it is made apparent that the clarity is not yet evident in most practices attempting to perform with BIM.

### 2.3.3 Positions and Duties Conclusions and Recommendations

Revit does entail that the employees take full responsibility for the changes that they make, however currently in the organization the employees do the work, but are shifting the preponderance of their responsibilities, and of their work to their supervisor or superior in the hierarchy levels of the organization. As ATP adjusts towards a more plane organizational (team) structure, it becomes more imperative that the employee takes more responsibilities for his/her work within the project teams.

“One scope of BIM is the seamless integration of information through a standardized format.” (Holzer, 2010) This expresses the necessity and importance of creating a standardized format and the responsibility to draw accordingly by co-workers. This is however not yet methodized within the organization, as they are too early in the adaption process, and the individual capabilities are not yet advanced enough. It would be a high recommendation for the BIM M to assemble and fabricate a set of standards, this will also be encouraged in through the outcome of this research.

From the calculation of a Modeller using 10% of the projects time is spent during a project; we can estimate the need of seven Modellers. This amount is dependable on the amount of Architects and Engineers within the organization (At time of date from this calculation 72 architects and engineers were employed within the organization. Therefore 10% of 72 = 7.2 Modellers needed). However, with the Modeller position changing to the BIM manager, and as the individual capabilities increase of co-workers, and the organization generates more Revit projects, this would imply the number of needed Modellers should decrease. Based on this premise, 4 Modellers or BIM Managers would be advised.

Several literature sources recommend having the function of a BIM officer within a BIM organization. For the reasons of keeping a general overview of all projects within the organization, and to guard that the Revit Standards stay uniform and advanced, as well as managing the distribution of the BIM M within the organization. The literature also indicates that to administer the employees with responsibilities should motivate and promote BIM. To retain efficiency, the recommendation would be to create this function as a double function within the organization, combining it with the role of the BIM manager. This function should officially fit in the hierarchy indicated in figure 15, however it is found from the extensive interviews carried out during the course of this research, that the organization would benefit from a notional approach regarding the BIM officer within the organization. Effectively releasing a considerable amount of strain the CADv currently takes on regarding BIM.

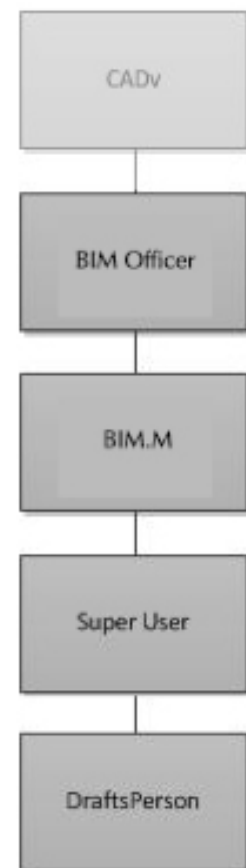


Figure 14



## 2.4 ATP BIM Diagnoses

*This chapter discusses the current BIM capabilities of ATP Innsbruck, as inquired through extensive interviews and a survey. The results are then measured alongside a benchmarking tool and compared to the BIM capabilities definitions of a theorist in the field. The outcome to this chapter should result in the answering of sub research question 2.*

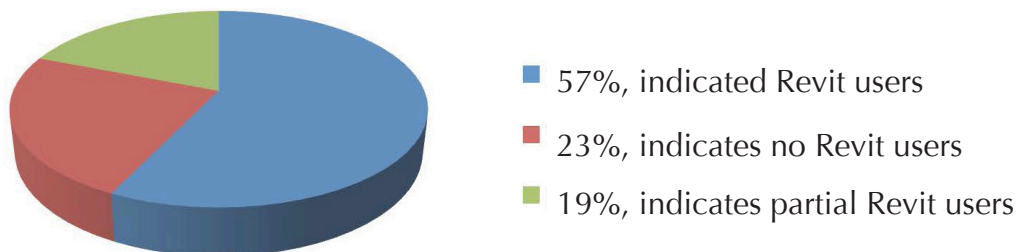
### 2.4.1 Current

#### Survey

In order to establish a general overview of the BIM capabilities of the organization, a survey in the form of a questionnaire was sent out within ATP Innsbruck. This was sent out within the disciplines of Architecture and Structure, as more projects using Revit have started up within these disciplines. The survey was realized in September 2012. (Appendix 9 is a collection of answers assembled from the open ended questions in the survey, as in this chapter only the closed ended questions are shown.)

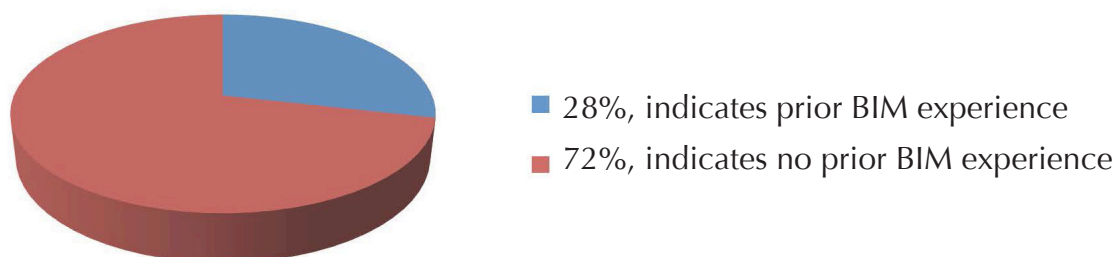
The survey questions and answers read as follows:

1. Are you currently working using a BIM software package?



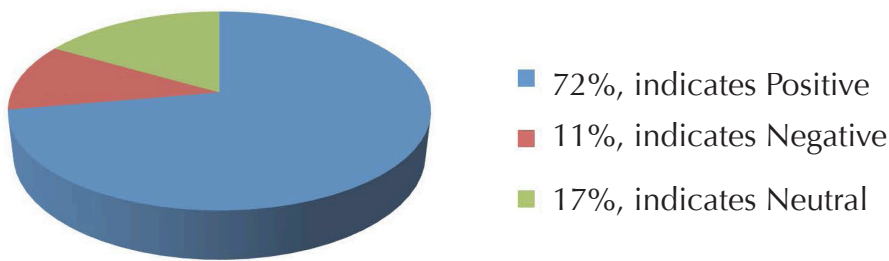
From the survey the respondents indicated that 57% are currently working with the BIM software Revit. 23% are not working with Revit and 19% are using BIM software alongside other drawing or design software.

2. Have you had any Prior BIM software work experience?



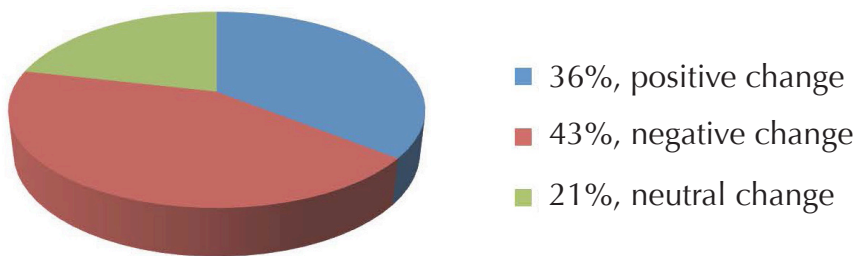
From this we can gather that the majority of the employees had no prior Revit or other BIM software experience.

3. *What is your opinion on the BIM software package?*



Although the organization can be described as top down, the majority of the employees indicated that they could see the benefits that BIM software can provide them.

4. *How has Revit changed the work process within the Organization?*



Even though we can state from the manifestation of the prior question, that employees at ATP Innsbruck can see the benefits of BIM, most have indicated, that thus far they interpret the change in their daily work process as negative. (For the responses to the open Example Question following Question 4 See Appendix 9)

*Survey Conclusions*

From the survey we can conclude that the majority of the employees are now attempting to work in a BIM process, even though the most employees did not have prior Revit working experience. We can also gather that, although the majority indicates they can see the benefits this software could provide, the outcome of the last question clearly indicates, that the BIM benefits are not yet transparent in the individuals work. Therefore, they are not yet getting the benefits of working with Revit.



## 2.4.2 Literature

There are several tools available to establish the organizational BIM competences in the AEC industry. To benchmark BIM competence level at ATP Innsbruck, the TNO tool; QuickScan was used, as it combines a lot of aspects, covered by the majority of these tools. TNO is a Research Centre based in The Netherlands, for more information regarding the QuickScan See Appendix 5. The QuickScan is a Dutch instrument based on Dutch legislation, which is more compatible to the Austrian and German law than the instruments based on American legislations.

### *Benchmarking*

This benchmarking was carried out based on a series of observations drawn from the interviews, conducted during the orientation and analysis phases.

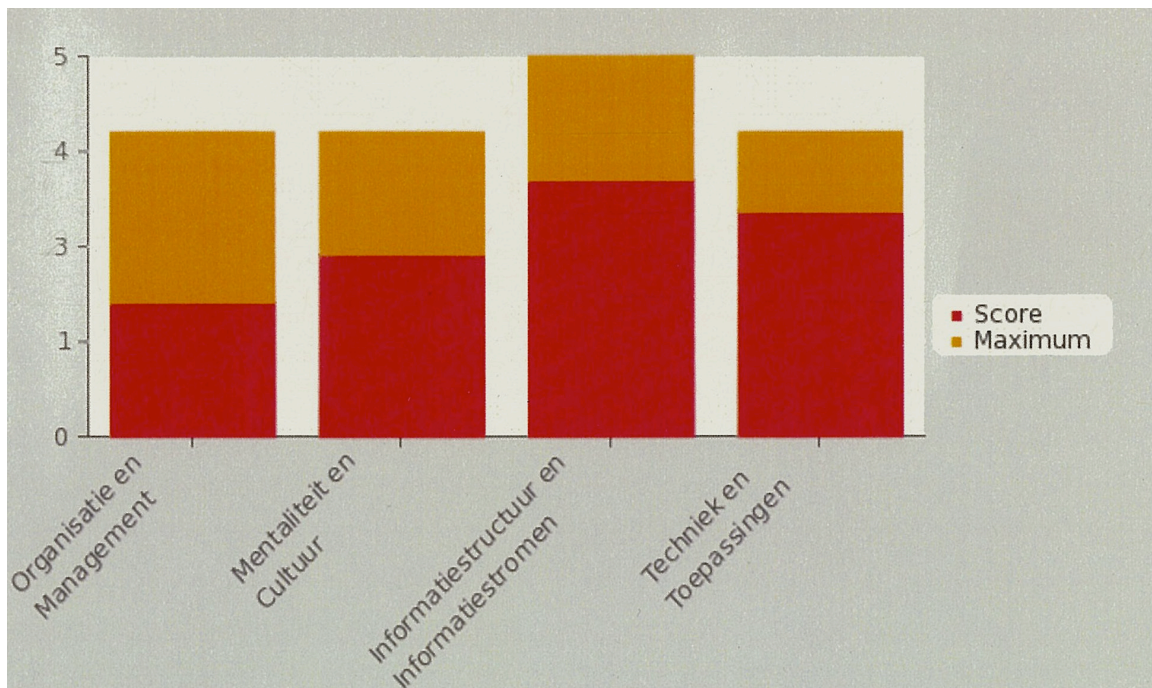


Figure 15- a graphical representation of the results from the TNO Quick scan

From the benchmarking outcome, illustrated in Figure 15, created from the information gathered during interviews, we can conclude that the Information structure and the Information flows are most accomplished within the current BIM competences. Most emphases should therefore be placed on the organization and management. This will be regarded during the development of the researches end result, i.e. the emphasis of the outcome is to focus the intentional strategy on these aspects in order to achieve the desired BIM implementation and organizational capability.

### BIM Competence

Accompanying the TNO Quick scan, the current organizational BIM competence was simultaneously measured according to BIM capabilities as defined by Billal Succar, an expert in the field of BIM. (For full list of BIM Maturity Index see Appendix 8)

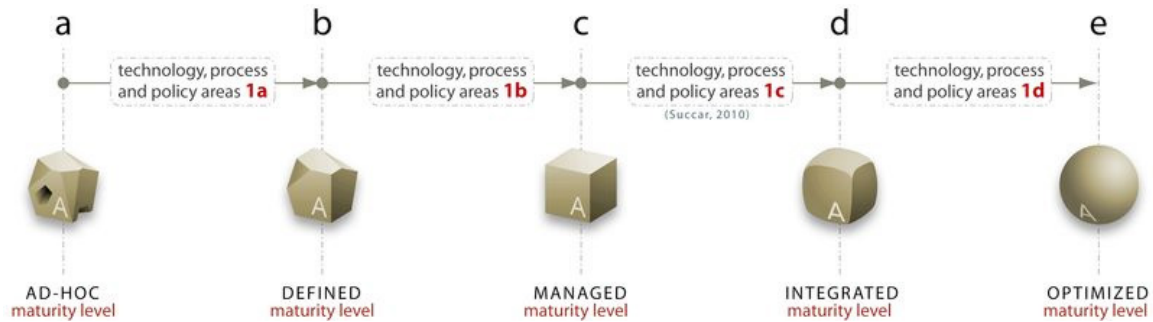


Figure 15- An Illustration describing the BIM maturity levels by Billal Succar (see Reference)

According to the BIM maturities, illustrated in Figure 16, the organization can be described as an Ad-hoc or Defined BIM maturity level. This is concluded from the extensive number of interviews held during the course of the research, with employees from different hierarchical levels in the organization, and then verified with the current CADv. As the BIM implementation is currently absent of an overall BIM strategy and a significant shortage of defined process and policies. The BIM implementation is driven by senior managers' overall vision, and however the process innovations are recognized and business opportunities arising from BIM are identified, they are yet to be exploited. For a complete overview of the definition of each BIM Maturity level see Appendix 11.

Parallel to the literature research, information was obtained through extensive interviews within the organization, in order to make the above stated estimation. The interviewees were chosen because of their diversity in discipline and levels within the organization. Efforts have been made to gather as much insight into the current BIM perspective from within the organization. A list of names and background information of all the interviewee's can be found in Appendix 2. These Interviews led to an estimation of the current BIM capabilities. It has proved to be difficult to capture the capabilities of the organization, as there is a wide span of capability levels within ATP. From early adapters who are very sufficient in their individual Revit capabilities, to laggards who find it difficult to use Revit in there daily working process. However, the majority of the employees are in the early stages of their adaption to BIM.

BIM Wash is a term from theorist Succar, describing a deception in the BIM adaptation; it can be used if a practice falsely disguises their BIM deliverables. An unintentional example of a BIM Wash is, when a practice produces a BIM output, however, treats

the process similar to that of a CAD process. A BIM wash can be promoting the use or deliverable of a BIM product or service, when it does not exist, or when it is still in a premature stage. So, a "BIM Wash exists when an individual, organization or project team's BIM claim is significantly higher than its actual BIM Competency to deliver on these claims". (Succar, 2011)

Revit is one of the BIM software systems available on the market. ATP has chosen to use BIM as it was the most applicable software source, according to their in-house research. Revit was chosen because it considered most usable by all disciplines, essentially allowing the organization to use one software system, collectively between all team members. However, the statement of Succar, evident above, indicates that the use of a BIM software does not necessarily imply a BIM working method.

### **2.4.3 BIM Competence Recommendation**

Comparing the current BIM capability of the ATP organization to the described stages, according to Succar's theory, we can gather, that currently the organization is at an ad hoc/ defined level within their BIM adaption. However, for ATP to achieve a BIM competence level that matches their mission statement, therefore they should sustain to achieve an integrated or optimized BIM capabilities level.

To develop ATP towards a BIM Maturity - the extent, depth, quality, predictability and repeatability of the BIM deliverables and services, not a BIM capability- the ability to generate BIM deliverables and services. (Succar, 2011) For this a company needs: an overall BIM strategy, tailored training plans, modeling standards and workflow protocols. The recommendation would be to aim for a BIM maturity, as it would be more beneficial to the BIM working process to achieve a predictable and achievable BIM service, rather than a BIM wash. This would also correspond to the organizations mission statement.

## 2.5 Crucial aspects for a sufficient BIM process at ATP

*This chapter aims to describe Communication, Integral Design, and Process development within the organization in its current form, by following a Description to that specific problem as it is in literature. These elements discourse importantly within a cultivated BIM process, and can form a fundamental obstruction to an advanced BIM process.*

### 2.5.1 Communication

Definition of Communication according to the Oxford Dictionary:

*The imparting or exchanging of information by speaking, writing, or using some other medium.*

#### *Current communication in the organization*

Currently the communication culture is encouraged by a top down, hierarchical organization. This implies that employees don't always communicate directly with their colleagues, to enquire after or regarding a certain design matter. This information has become apparent during the series of interviews (see appendix 2). This occurs, as the individual tasks are not always made apparent to all team members, therefore the current communication approach happens, as illustrated in Figure 17, appears more often than advantageous, in the design teams as well as the overall organization.

The interviewees have announced that a lot of conflicts with the other departments within ATP are administered through the PL-P, instead of directly approaching the employee, to whom the Design conflicts belong, or the person, who is able to make changes directly, during the course of design team conflicts. According to these sources, indirect communication occurs as a result of the following:

- When the end goals and brief of the project are unclear to all the members in the team.
- When the exact Roles and Duties of each of the team members are undefined or unclear for that particular project. I.e. who does what within the other disciplines. This is a drawback in both the working methodology of the individual project teams, as well as overall within the organization.
- The frequency and amount of project meetings are unclear to the team members of the project; issues regarding the design can often be left unannounced.

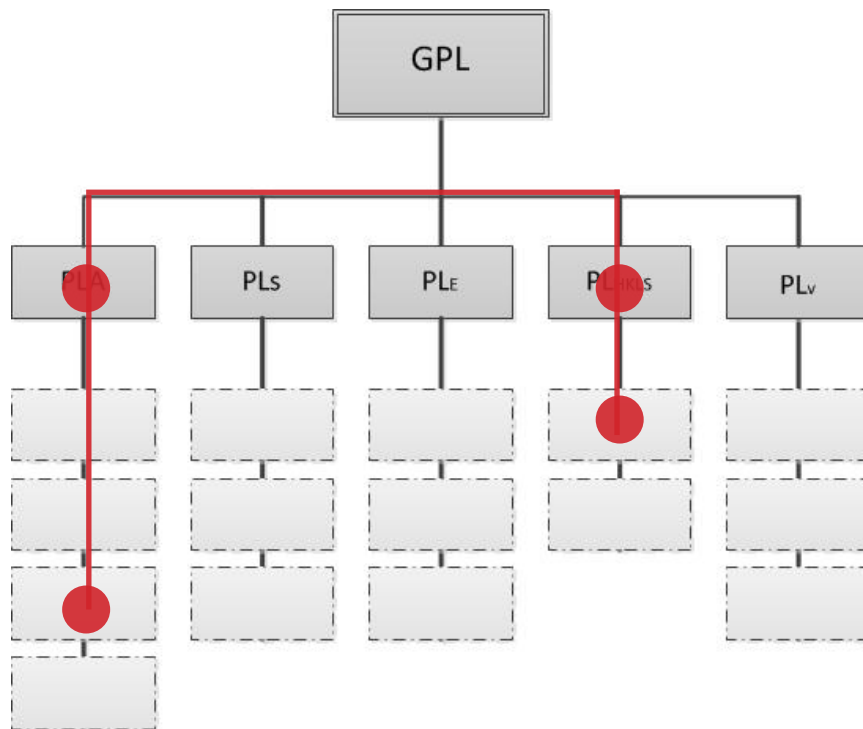


Figure 17- representation of the communication lines, interchangeable between the individual project teams besides that of the overall organizational approach.

### Literature

*“Effectiveness of team communication for the design of buildings is becoming increasingly important due to the growing technical and organizational complexity of construction projects.” (Otter, et al. 2007)*

Two types of communication can be discriminated within an organization:

- Formal communication
- In-formal communication

Formal Communications are those that take place through well-known channels, they also include paper-based and electronic communications as well as the meetings that take place. i.e. all the communication forms that take place in a formal fashion within the organization. In this type of communication the hierarchy and position levels plays a large contributing factor.

Informal communications are those that are not based upon any set of rules. It is the communication that allows employees in an organization to take initiatives into their own hands. Informal communication can often be found in unorganized settings,

such as in the office kitchen, coffee machine, or during an ad-hoc crossing in the corridors.

Both forms of communication are important mechanisms to help achieve both the production goals and the social goals of the groups project. If communicational partners have the ability to communicate with each other multiple times a day, they need not stand on ceremony in their communication, and communication moves from a formal to an informal style (Brown, et al. 1979) Proving that both forms are a valid form of communicating between the times, and that the nature of the communication setting also influences the formality of communication in it.

“Complex communication processes between numerous project participants involving large amounts of information often cause errors and omissions during design and construction” (Eastman et al., 2008) This indicates the increased importance of strong collaboration and integral working method between the different disciplines during the BIM process. As it is a complex aspect within the process, it is relevant to define tasks and roles to yield the aspects of communication within projects. The communication system, for the projects should be kept uncomplicated, for a user-friendly approach within the organization.

“BIM comprises collaboration frameworks between and technologies for integrating process- and object-orientated information throughout the life cycle of the building in a multi-dimensional model. BIM information sharing among project participants can be centralized and coordinated effectively.” (Sebastian et al., 2010)

According Caluwé and Vermaak (1999), a change in dialogue between stakeholders, in which narrow and broad approaches can be perceived. The narrow approach focuses on communication about the change process. According to this approach, the communication is the tool, used alongside the actual change process. The broad approach focuses on communication within the change process. Under this approach the change in communication is carried out. According Caluwé and Vermaak(1999), both communication, and communication within the change, are an integral element of any intervention plan. Communication about the change is also very important prior to the actual change; in this case, the change in strategy towards ATP’s BIM implementation should be voiced and communicated clearly within the individual design projects, or the organization. Therefore, it is important that a frequency of meetings, in which formal communication mechanisms can take place, during the start of a set of deliverables and after the tasks have been carried out. The completing communication is to adhere to the initial tasks and deliverables, which have been communicated and performed by all project stakeholders. The focus within the outcome of this research will be with the formal communication method, as it is the tangible communication form, to which a change in strategy can appear, but also where it is important to articulate the change from the pre-BIM working process.

“Motivations for creating a collaborative framework are to enhance communication, trust and cooperation. Means and Methods to accomplish this come from innovative development of existing possibilities together with the development of shared guidelines”. (Inpro, 2010)

*“The communication between different stakeholders becomes critical, as each stakeholder possesses different set of skills”.* (Sebastian, 2010)

Both quotations indicate the importance of the communicative aspect within a project.

In order to come to a communal goal, the collaborative framework can be achieved by the communication between the project stakeholders. Additionally, in order to achieve that goal as well as possible, collaboration, in the form of communication, must take place. As this would be organized form of communication, it would be classified as Formal communication.

### *Recommendations*

As communication is essential to the BIM process, as explained above, the recommended way of communicating, regarding the design BIM design projects at ATP is best represented in Figure 18. Illustrating a 3D Icosahedron, which embodies the concept of network communication within a project, keeping the GPL informed of all design decisions. By doing so, the communication lines are curtailed to stimulate clarity and Integral Design, and essentially solving or reducing the solutions stated in the 'current' communication chapter. This recommended communication method could improve some of the conflicts the employees have raised during the interviews.

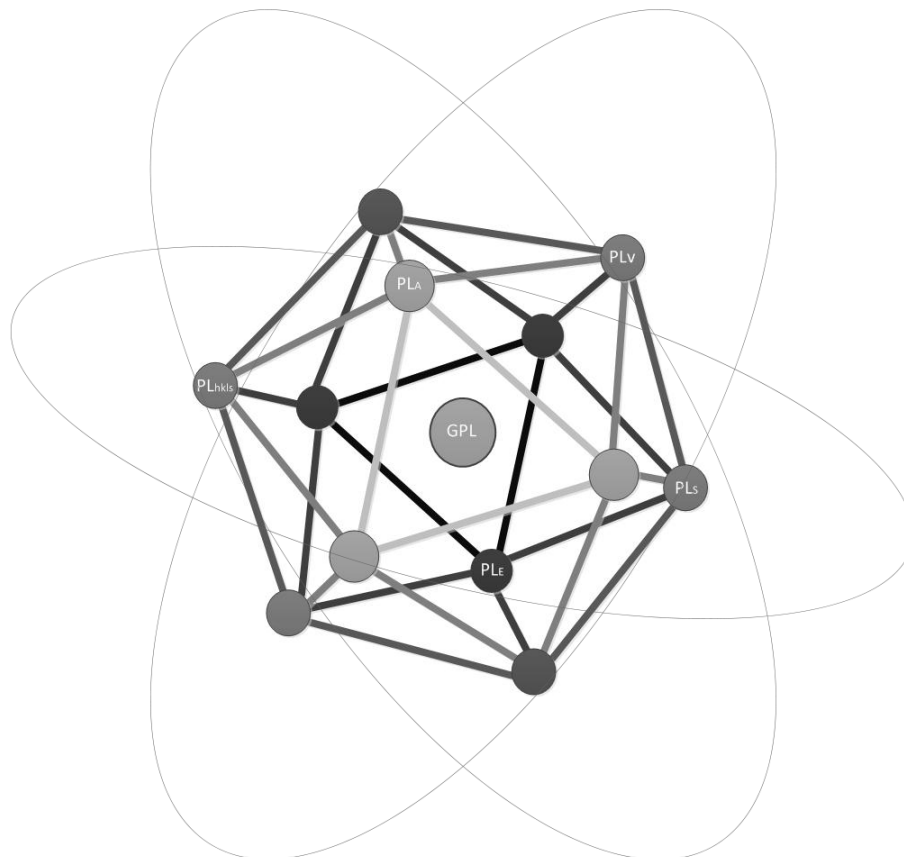


Figure 18- Icosahedron representing communication lines within a Revit project

“The imprecision of the building object as it is being designed remains a characteristic of design work and it was apparent that changing the design tool did not resolve all the design coordination issues.” (Luck, 2011) This indicates that the process is not singularly dependent on the tool, or system that the team uses to work in, but the soft criteria of communication and overall team collaboration between the team members is a relevant aspect to the project outcome. Signaling the importance of communicating within a BIM process. As BIM stimulates an integrated process it is important to maintain the communication. Communicating in a BIM process will support decision making and comparing alternatives during the duration of any design process, alternatively leading to better design results.



## 2.5.2 Integral Design

Definition of Integral according to the Cambridge Dictionary:

Necessary and important as a part of, or containing within, a whole

Definition of Design according to the Oxford Dictionary:

*purpose or planning that exists behind an action, fact or object:  
The appearance of design in the universe.*

### Current

Indicated in the introduction, ATP endeavors itself on being a company delivering a full integral design service. However, in current practice it occurs less frequent than intended by the management staff. Momentarily some disciplines are not as involved yet with the earlier phases of the process as the accomplishment of an integrated design project needs. Figure 19 displays a traditional design process in the AEC industry. The traditional process is a when the design takes place in a sequential manner. For a more efficient working process, and in order to deal with complex design briefs AEC companies are looking to work more in an integral working process.

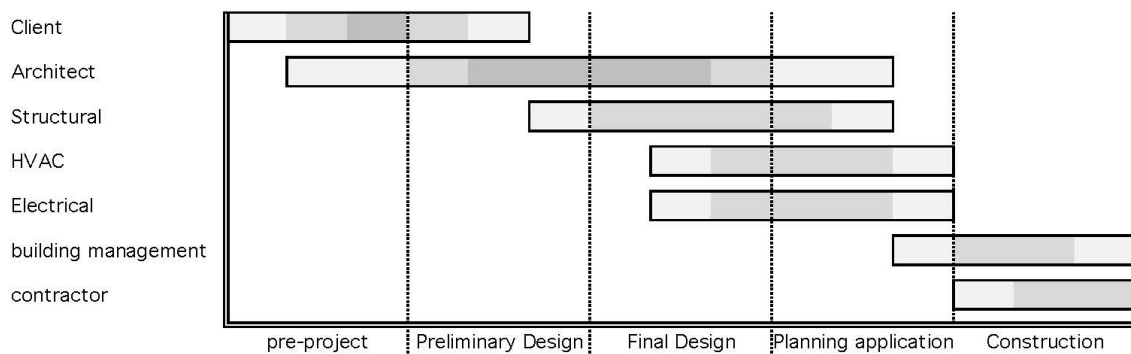


Figure 19

ATP is one of the leading companies when it comes to an integral design approach. In order to provide their clients with excellent design results, for the complex design briefs, ATP responds to this demand by providing an integral design service. As all disciplines needed, can be found in-house at ATP, it is a natural progression for ATP to provide such a service to their clients.

However, as briefly stated above, and gathered from the review of the 5 Revit project cases completed within the company, illustrated in Table 1, and the interviews with all in-house disciplines, the current method is not as integral, as indicated in the organizational mission statement. As some of the disciplines, are not delivering their knowledge and input at the commencement of the project start. Figure 20 displays the current internal working process. It is more integral then the traditional working process, as the knowledge and input is starting to become more concurrent than sequential. However, with the adaptation and use of a BIM software package the integral design can be improved, as BIM facilitates simultaneous work by multiple design disciplines. Figure 20 illustrates such an integral design process.

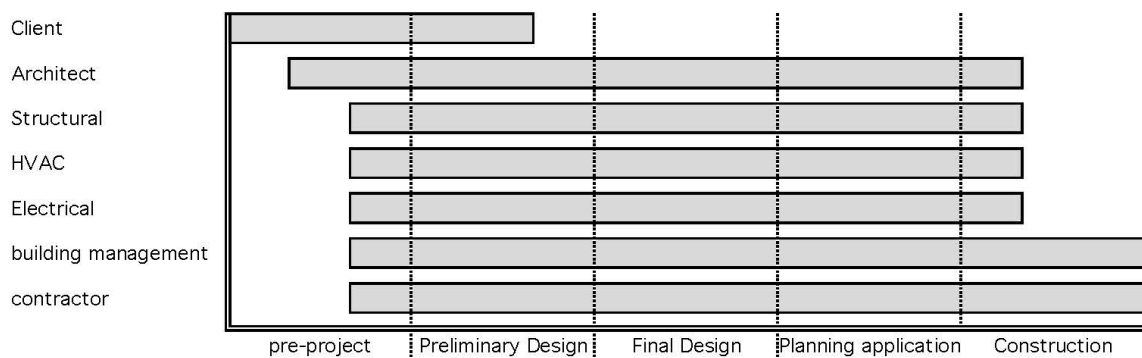


Figure 20

## Literature

The use of BIM, Building Information Modelling, allows moving from a one-dimensional representation towards building objects. The Information exchange therefore becomes data centered, and information can be shared with other applications. This will address the need of a holistic approach in order to facilitate coordination. (Inpro, 2010) In order to have a perpetual BIM process, the aspect of Integral Design is very important, as BIM and Integral Design go hand in hand, BIM does not work efficiently without it. Therefore, the adaption of BIM in a multidisciplinary company, such as ATP, can further stimulate and improve the internal integral design working method.

Concurrent engineering involves the creation of design teams with representatives of all important design perspectives, for each distinct design subspace (i.e. subset of design issues). Design decisions can be caught and revised relatively quickly and cheaply. (Klein et al., 2001) Illustrating the benefits ATP stands to gain from improving their integral design working process.

An integral design BIM project is a very complex endeavor, as when a project team is appointed to collectively deliver a BIM product or service, they're actually being

- requested to coordinate their processes and to lower their exchange barriers. (Succar, 2011) According to Succar, the following 3 aspects are crucial to full complete a collaborative BIM process selectively:
- 1.
  2. The BIM Goals need to clearly defined by the Client
  3. The participants of the project should comprise of a BIM competence level relative to the BIM Goals of that project.

A common willingness to collaborate and a clear understanding of how to exchange information data.

### 2.5.3 Process

Definition of Process according to the Oxford Dictionary:

*a series of actions or steps taken in order to achieve a particular end*

*Current*

Because BIM asks for a different working process, an extensive investigation into the work process at ATP was carried out. As all disciplines are in-house, the focus was held with the internal working process, as described in the Scope chapter. The internal working process is conscientiously described, and available to all staff members through the ATP network, and called the Workline. The Workline is mainly based on the HOAI, the official law regulating services of engineers and architects amended by German law.

Figure 21 illustrates ATP's Workline. (For a more detailed Workline overviews see Appendix 12). It is an electronic release of the internal work process, in prescribed manner per phase what the teams should accomplish.

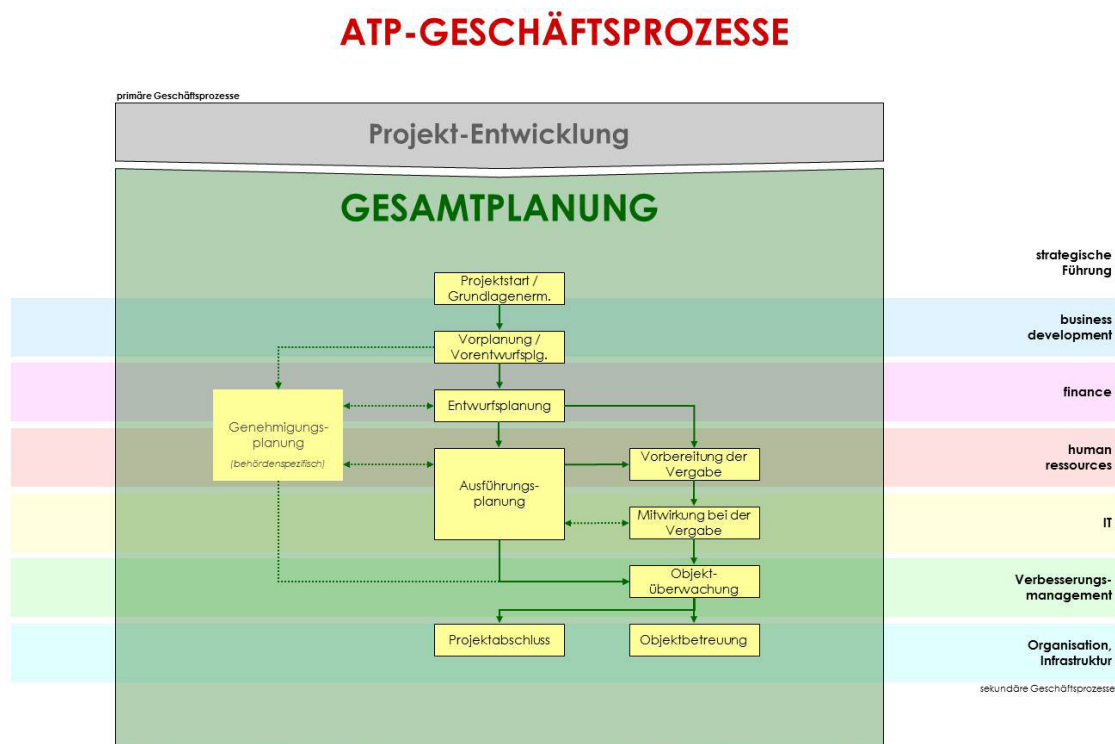


Figure 22 – Illustration of the Workline from the ATP Network

The Workline is a process that establishes an integral design process on a Macro level. As the process is based on an integral design process and not specifically to that of a traditional 2D process, and retains a more Macro prescription of the process, it does not hinder the BIM process. However the Process on a more Micro level, i.e. indicating particular BIM tasks, is not represented in the current form of the Workline. This will be included in the outcome of the research.

From the interviews held during the Diagnosis phase, the current BIM process can be described as trial and error based, as the process scattered and disordered. Issues regarding the retaining of the documents are a foreseeable issue within the current BIM work process. Especially as currently there is no agreement regarding the saving of verified documents at the end of a design phase. There is a system in place to how and where the BIM model should be placed, but not so much when in the BIM process should the BIM model be verified and saved.

Within the current BIM process the Electrical and HVAC disciplines work from the same software program, Revit, but this is currently not done in a concurrent method. Figure 22 intends to describe the current collaboration process. At present Architects and Structural engineers mostly work on the live model. During set phases the HVAC and Electrical shareholders partake in a copy of the model to work alongside the live model. The model copies are not update frequent and often enough, resulting in a hindrance to work in an integrated manner.

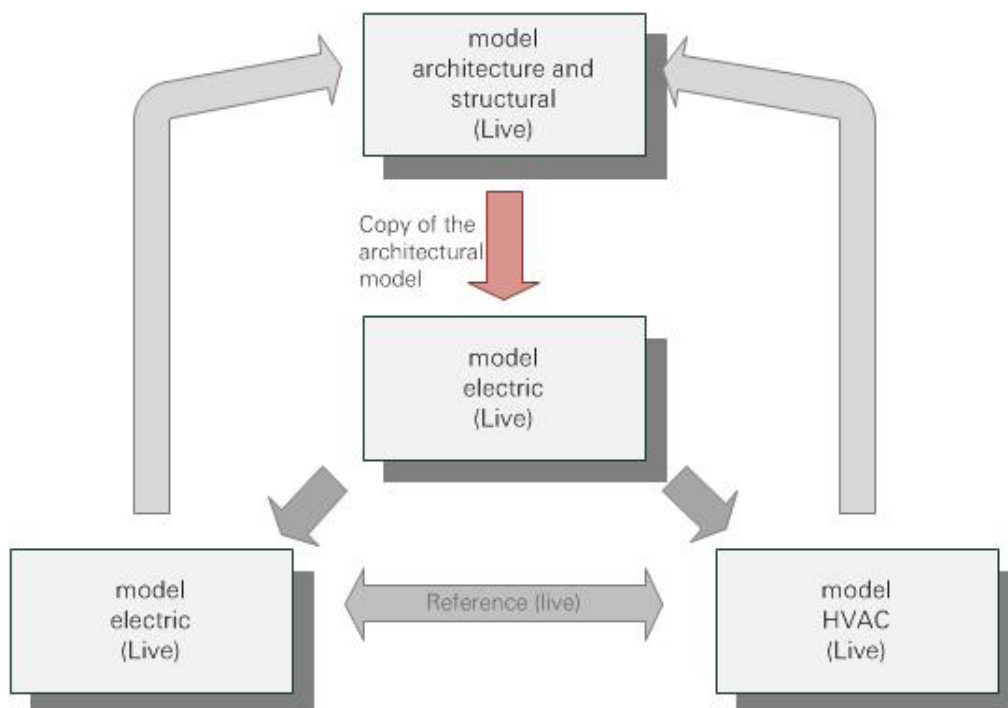


Figure 21- Current BIM process

## *Literature*

Within the work process BIM should bring benefits at all scales and phases of the project:

- Conceptual Design typically includes the building orientation and massing, satisfaction of the building program, addressing sustainability and energy issues, construction and possibly operating costs and sometimes issues, requiring design innovation. BIM potentially supports much greater integration and feedback for early design decisions.
- The integration of engineering services; BIM supports new information workflows and integrates them more closely with existing simulations and analysis tools used by consultants.
- Construction level modeling includes detailing, specifications and cost estimations. This is the base strength of BIM.
- Design-construction integration addressing the scope of innovation that can potentially be achieved throughout a collaborative design-construction process, such as with the design-build procurement model.

(Eastman et al., 2008)

The predominant aim of this research is to enhance the BIM workprocess of ATP Innsbruck. As Eastman points out (Eastman, 1999), all phases in a building lifecycle, starting from a pre-design phase of feasibility studies, then design, construction planning, construction, facility management and operation, can get described as one holistic process. (Eastman, 1999) only then does the change to working with BIM become beneficial.

BIM is an integrated model in which all process and product information is combined stored, elaborated, and interactively distributed to all relevant building actors. As a central model for all involved actors throughout the project lifecycle, BIM develops and evolves as the project processes does. (Sebastian, 2010)

## 2.6 Organizational Breakdown structure

*Organizational Breakdown Structures are an efficient way of organizing and communicating the overall structure of the Project Team. An Organizational Breakdown Structure, OBS, compliments the Work Breakdown Structure and Resource Breakdown Structure per project. Its main intent is to communicate how those tasks with delivering the project will be organized and structured as a Project Team. It's without a doubt the simplest of the three structures in terms of understanding, yet performs a great role in communicating the hierarchy of the team and consequently the reporting lines within a project.*

### Current

In essence, an Organization Breakdown structure is a fundamental modeling technique for defining and organizing the total scope of a project. Figure 23 illustrates the OBS of the current projects within ATP Innsbruck. This is based on the general team projects in the office during the course of this research.

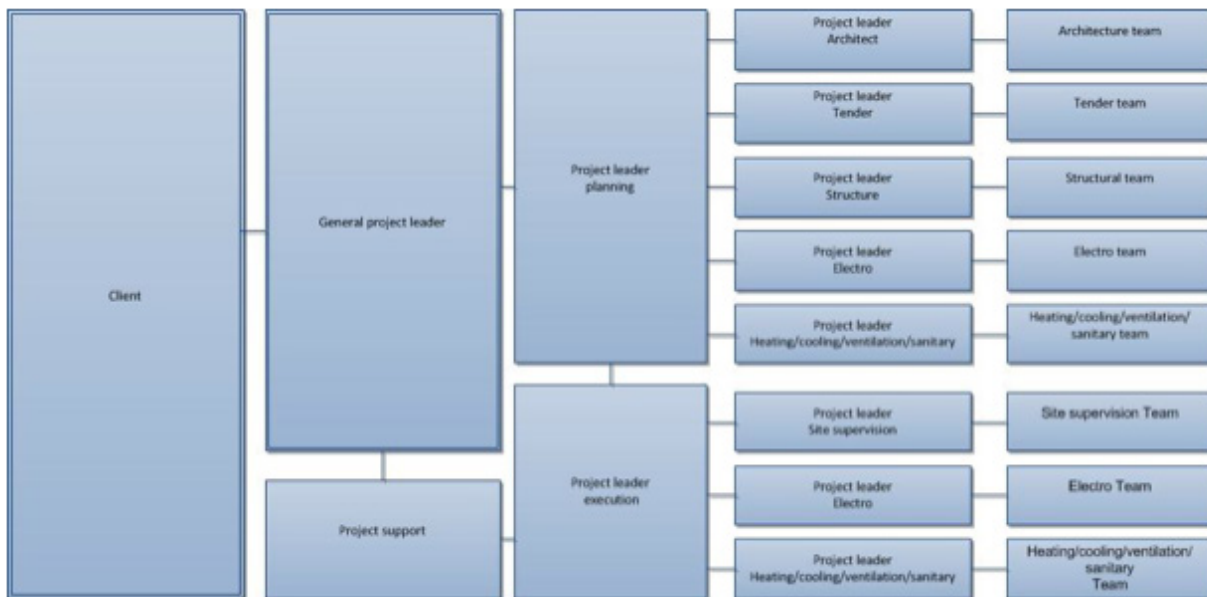


Figure 23- the current Break down structure.

*Recommended*

The OBS is additionally used to introduce the potential change from the original OBS to establish the BIM functions within the organization, for the project teams. This is represented in Figure 24.

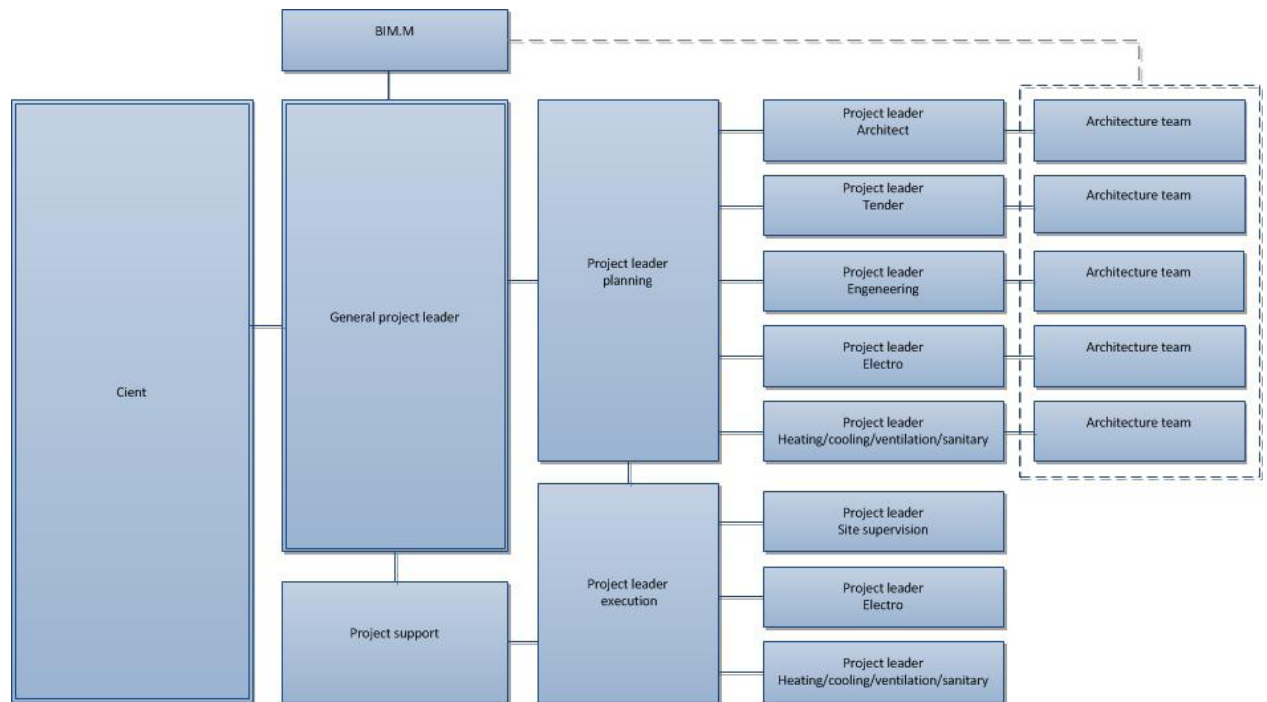
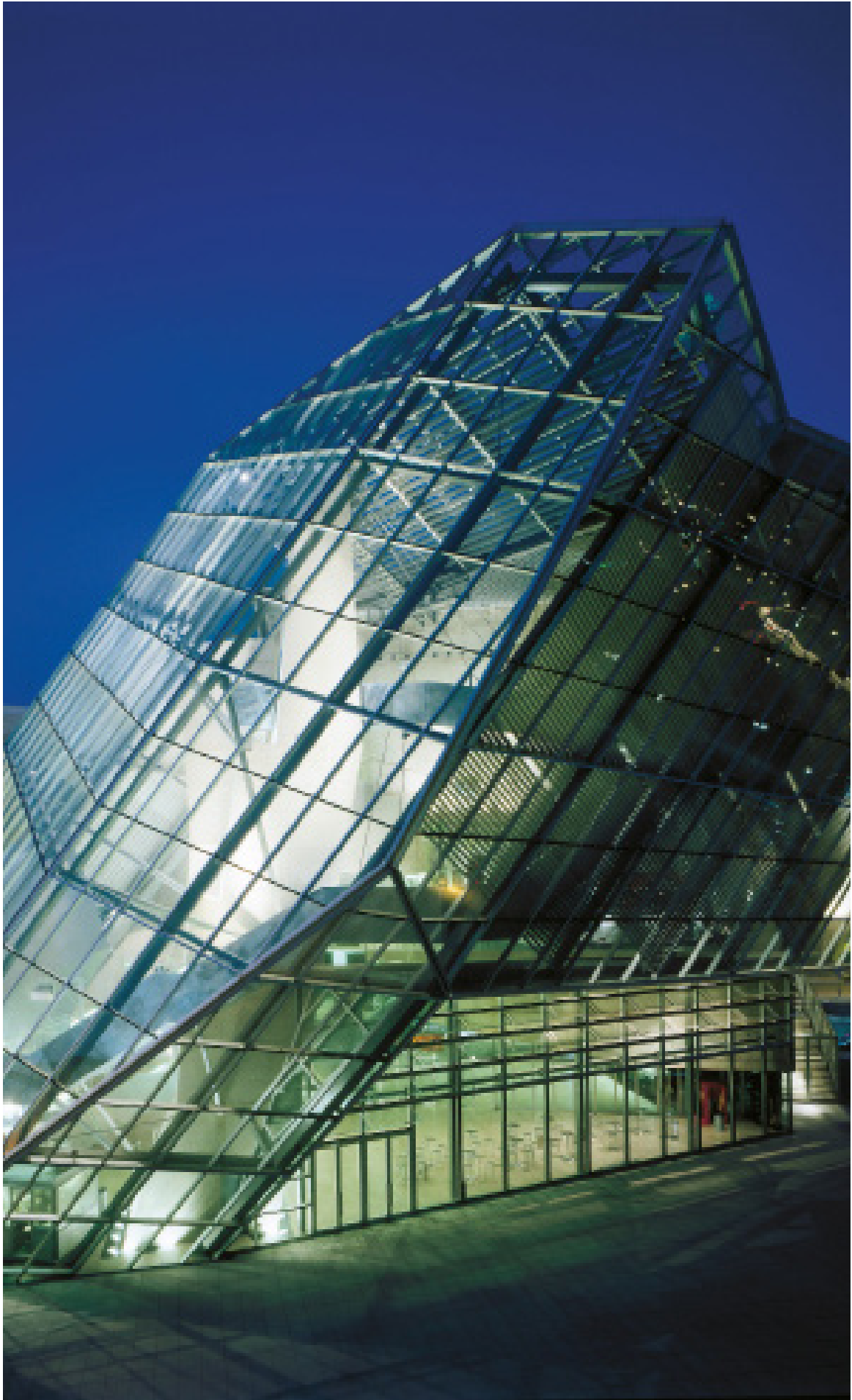


Figure 24- the recommended BIM breakdown structure





# 3. Design

### 3. Design

*This instrument was developed based on the outcomes of the analysis phase. During the analysis phase it was concluded that: 1) the establishment of new management positions surrounding BIM are needed to be created, 2) the importance of stimulating the communication and collaboration in the project teams and 3) the integral design ability and finally 4) the working process. This chapter is dedicated to the Design made, a BIM Workflow Guide, for navigating towards an efficient BIM working process. During this chapter, the Development of the Design will be illustrated, as well as the design itself, and the explanation as how to use the instrument. Also, the validation process will be clarified and articulated in this chapter.*

#### 3.1 Development of Possible Design Solutions

The development of a BIM process instrument aims to resolve the shortcomings of the existing process description, by introducing a new tool, which can serve as a standard BIM working process instrument for ATP Innsbruck, and with the potential for the other ATP offices, to adopt it for their working method.

Three main steps were taken during the designing of a process instrument, namely:

- step 1 - exploration field and desk research;
- step 2 - developing analytical method of setting-up assessment criteria;
- step 3 - development, practical verification and validation of the prototype tool.

The first step included the exploratory research fields, through interviews among employees at ATP Innsbruck, mostly interviews with management staff, but also interviews with employees from all disciplines and all levels of the organization

In order to determine the most important aspects to objectively assess, during the BIM process at ATP, information was gathered from a workshop where employees, from all the Design Disciplines, attended. Additionally, the exploration field research through a questionnaire was carried out among Architects and Engineers to gain insight into the motive and the drive of working field at ATP, to present their BIM competencies (as mentioned in the survey chapter). Simultaneously the desk research was performed on the existing BIM guidelines, handbooks, measurement criteria and assessment tools. The critical review, as presented in the previous chapter, also resulted in lessons learned from the development and use of the existing assessment tools.

The second step comprises decision on the underpinning method, used for the new process tool to meet the needs of the organization and tool users, i.e. ATP employees, as well as to create the highest practical impact. In step 1 relevant aspects for a canonical BIM process was established, cross-referenced by the found literature. Much time and effort was then spend on restructuring, detailing and refining the aspects of an ideal BIM process in comparison to the current work process as described in the

Workline. The Workline was taken as a concrete ATP work process. This process of this step was done through literature supporting the BIM process, as well as meetings with the necessary employees at ATP Innsbruck and Experts within the BIM field. One of the experts was from TNO, currently developing the TNO QuickScan and the second expert was from b.i.m.m., a practicing BIM company in Austria.

The third step comprises of a verification process of the initial design. This is a verification that it is done both internally and externally. In order to determine if all aspects explored during the analysis phase were covered, and to observe if the instrument addresses the current working process of the organization. The third step comprises of a validation of the initial prototype.

### 3.2 Design specifications

Gathered from the Literature and a set of interviews together with a workshop session with ATP employees, a set of conditions and requirements were augmented. These requirements are displayed in Table 2. It indicates the information that a BIM model should display during each of the design phases.

Phase	Pre-project	Preliminary Design	Final Design	Planning Application	Construction Design	Construction
<b>Content</b>	<ul style="list-style-type: none"> <li>- Sketch of Possibilities</li> <li>-concept</li> <li>- Spatial programming</li> <li>- Site analysis</li> <li>- Planning</li> </ul>	<ul style="list-style-type: none"> <li>- Design</li> <li>- Reviews</li> <li>- 3D coordination</li> <li>- Room Programming</li> <li>- Structural concept</li> <li>- Visuals</li> <li>- Volume study</li> <li>- Existing conditions</li> </ul>	<ul style="list-style-type: none"> <li>- Visuals</li> <li>- Programming</li> <li>- Acoustic</li> <li>- Scheduling</li> <li>- Authoring</li> <li>- Structural analysis</li> <li>- Mechanical Analysis</li> <li>- Lighting analysis</li> <li>- Sustainable evaluation</li> </ul>	<ul style="list-style-type: none"> <li>- Visuals</li> <li>- Programming</li> <li>- Indoor environment</li> <li>- nD scheduling</li> <li>- Acoustic</li> <li>- Structural analysis</li> <li>- Mechanical Analysis</li> <li>- Lighting analysis</li> <li>- Sustainable evaluation</li> <li>- 3D coordination</li> <li>- Cost calculation</li> <li>- Detailed time schedule</li> </ul>	<ul style="list-style-type: none"> <li>- Site Utilization</li> <li>- Construction system</li> <li>- nD Coordination</li> <li>- Digital fabrication</li> <li>- Values</li> <li>- Visualization</li> <li>- Programming</li> <li>- Lighting</li> <li>- Indoor environment</li> <li>- Acoustic</li> <li>- All manufactures</li> </ul>	<ul style="list-style-type: none"> <li>- Complete BIM model</li> </ul>

Table 2- Results summarized from workshop

BIM Maturity means the extent, depth, quality, predictability and repeatability of the BIM deliverables and services, and a BIM capability is the ability to generate BIM deliverables and services. (Succar, 2011) In order to improve the BIM working process of ATP, the focus must be made towards achieving a BIM Maturity, where the internal process become predictable and repeatable.

So therefore, in order to deliver an improved BIM capability to ATP the focus must be made on establishing a BIM Maturity. For this a company needs: an overall BIM strategy, tailored training plans, modeling standards and workflow protocols.

Indicated here by Succar, is the focus on creating an overall strategy, for ATP's BIM implementation and use. Creating a mature BIM workflow can be achieved through

repeatability. This can be organized by having a 'BIM Workflow Guide' that helps the middle management in the firm to arrange a process, applicable for the use of an efficient BIM, in which some of the key aspects are brought forward to assist them into implementing BIM, and adapt the organization to a new working method. BIM and Collaborative design are also used to stimulate an integral design working method, internally at ATP, and to allow for working with external companies and the option of facility management in the future. Illustrated below in figure 25, is the ambitious development from the current ad hoc/defined BIM maturity level, to an optimized maturity level.



Figure 25- An Illustration describing the BIM maturity levels by Succar (see Appendix 11)

### 3.3 The Outcome

The research outcome is the development of the tool, which will aid the internal BIM process at ATP. It is a guide generated to support the organization with the process at the beginning of any BIM project, as well as to divide the responsibility of the project between the team. It serves as a framework for ATP, during the establishment of BIM. The design is developed for the office of ATP Innsbruck, with the underlining thought as how to implement it in the other ATP offices as well. In relation to this, the design had to be specific enough to apply to this organization while allowing for a small shift or difference in working methodology. As ATP Innsbruck has all disciplines in-house, compared to other ATP offices, which currently do not have those, the instrument needed to be adaptable to apply to another ATP office, which may or may not have all disciplines in-house.

The Design is developed to aid ATP Innsbruck to navigate its processes and to adapt to a BIM process, and to be able to create a repeatable and predictable BIM process. This is a guide developed, to create or stimulate the methodology for such a repeatable BIM process

To successfully implement BIM in a project, the project team has to develop a detailed BIM realization Plan. The BIM realization Plan defines uses for BIM on the project (e.g. design authoring, cost estimation, design coordination and Document management systems), along with a detailed recommendation of the process for executing BIM throughout the project, allowing for future development of facility management. The Design is displayed in Appendix 13.

### 3.4 Users

The Instrument is a Guide, which helps and provides aid to the working process of BIM for each team or project. It is set up to give clarity for the organization as a whole, but specifically to give aid to the team and the employees working on the project. However, it should be mostly used by the project leaders, i.e. the GPL or the Project Leaders (PL-P), during the commencement of the meeting, as to negotiate and discuss all the relevant information to all the team members. Hence the name Guide, as it is simply a method to start of every project.

The intend of this BIM execution manual is to provide a framework that will guide the GPL and the PL-P during the BIM process, that will let all the involved stakeholders (client, architect, engineers etc.) deploy BIM collaboration and communication on this project more strategically. This plan delineates roles and responsibilities of each party, the detail and the scope of the information to be shared, relevant business processes and supporting software. The instrument is to be merged with the current CREAMline.

CREAMline is a system ATP has setup in the last three months; it is a sharing system provided in the network of the organization and allows the team to overview all the necessary information regarding the project.

### 3.5 Guide

During the Analysis phase, a set of inefficiencies have been characterized and described (See analysis chapter). In order to answer the main Research Question, the BIM inefficiencies of the organization have been taken into consideration during the design of the final instrument. In order to satisfy all Design criteria, the guidance chapter will break down the instrument by each aspect and explain the research outcome. The design outlines four steps to develop towards a more improved BIM process. The four steps are Collaboration, Requirements Management, Technology and Project Review, as illustrated in figure 26. The design outline aims to identify the appropriate BIM process and to improve the internal BIM process at ATP.

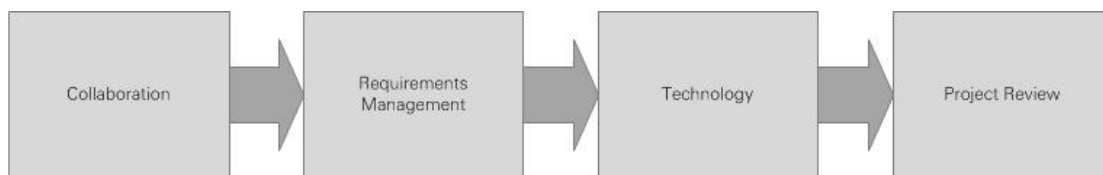


Figure 26

In this part of the report, the four described aspects will be individually covered with a brief explanation, as to why these topics are relevant to improve the internal working process at ATP, and how they should be answered or used when implementing the BIM Workflow Guide in the Organization.

The BIM Workflow Guide is to be cogitated in the early or commencement stages of the project, and it should be done with as much of the team present. In order to stimulate an efficient and effective integral working process, the BIM Workflow guide should not be developed in isolation. To have a successful project using BIM, full coordination and collaboration by all team members is an absolute necessity.

#### ***Collaboration***

The Collaboration Chapter of the Guide aims to stimulate and enhance the Organization objective through the following topics: Transparency, Team and Core collaboration agreements. Prior to identifying the roles and duties of the team members within the project, the General BIM goals and uses must be outlined. The BIM and project goals should be specific to the project at hand, and strive to improve the clarity and transparency to all phases of the project.

*“Team communication is dependent on the communication acts of team members and the ability of managers to facilitate, stimulate and motivate them.”(Otter, et al. 2007)*

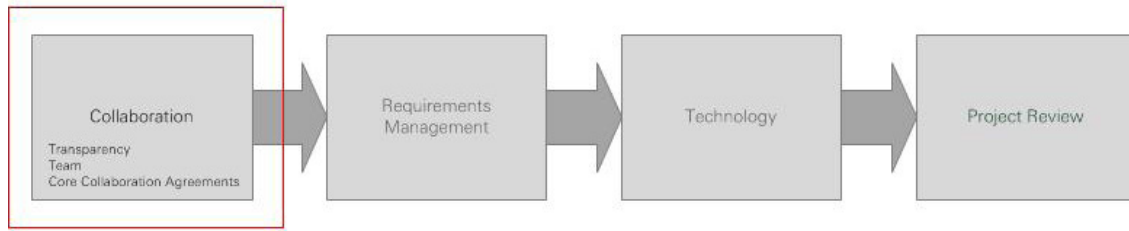


Figure 27

### *Transparency*

For BIM to be implemented successfully, it is critical that team members understand the future use of the information that they are developing. BIM is not only a tool to aid collaborative design, but it also a communication method, to communicate the design ideas between different disciplines in a concurrent working process. To emphasize the lifecycle of the information, a core concept of the BIM goals, uses and deliverables need to be clear at the project commencement, as the future use of this data can frequently impact the methods, used to develop the model, or identify quality control issues, related to the data accuracy for tasks.

To complete the transparency section of the BIM Workflow guide, the team should proceed through the following steps. It would be advisable for the GPL and/or the PL-P to have gone through this section with the Client prior to discussing it with the team. It is therefore important for the GPL/ PL-P to be able to advise the benefits BIM can bring to the client and the project. Additional knowledge the GPL and PL-P should obtain is briefly described in Attachment B of the instrument.

As the outcome of the interviews indicate, majority of ATP employees find it difficult to indicate the level of depth the BIM model should contain, therefore this has been taken on during the transparency section of the guide. It asks for the team to list the level of information that should be contained in the BIM model at each phase of the design. It is important to have the BIM aims and goals clear before indicating this information into the Guide.

### *Team*

The team section focuses on the distribution of roles and responsibilities, and stimulating Integral design. In order to achieve the canonical team collaboration, indicated in figure 16, it is important to establish who is in the team, and what the duties and functions of each team member should be. According to Herzberger's two-factor theory described in chapter 3.2, giving employees responsibilities is an effective way to motivate and to achieve job satisfaction within the team. Therefore, point i. and j, of the research outcome (see appendix 13), were included in the design. In order to achieve a plausible timeline for the BIM process time should be taken to ensure the team members get enough time to accomplish the tasks.

As the BIM workflow Guide overall is a formal communication method, and chapter 5.1 points out, both formal and informal communication are needed for a



coordinated mechanism. Therefore, the ATP Radar is part of the tool, to stimulate the formal communicational system within ATP, as the informal cannot be organized. As soon as the informal communication method becomes organized it changes to that of a formal communication system, therefore in this chapter of the instrument, refers to the formal communication established with the outcome of the research, a network communication. The ATP Radar, the network communication aid, should be digitalized and programmed to the Project Intelligence to indicate the availability of the employees. It would be advisable to have the ATP Radar live on the ATP Network.

### *Core Collaboration Agreements*

As employees during interviews have indicated that they are not always included in all project meetings, it would be beneficial to set up a collaboration agreement specific to the project. As the projects a brief, ATP receives have a wide variety, it means that each project is going to vary regarding its process needs.

### **Requirements Management**

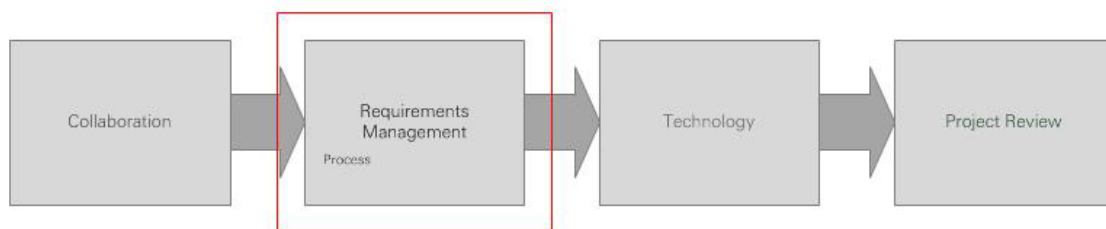


Figure 27

### *Process*

The Requirements Management Chapter focuses on how a BIM process can take shape for that project. Once the team has identified the BIM goals for the project, Team role distribution, and Core collaboration agreements have been made, a process map for the BIM strategy can be made. This is to allow all the team members to clearly understand how their work processes should look, and through which points what level of Details should be shown in the model, and each phase of the project.

A BIM Map can be developed from the information and output of the Collaboration phase of the Guide. However, during this phase, a more detailed process map should be developed, as a response to the additional information, regarding timeframe and deliverables, which are to be discussed by the team. It is important for the team members to clearly understand the information content and to be knowledgeable about which team member has done what part of the model.

## ***Technology***

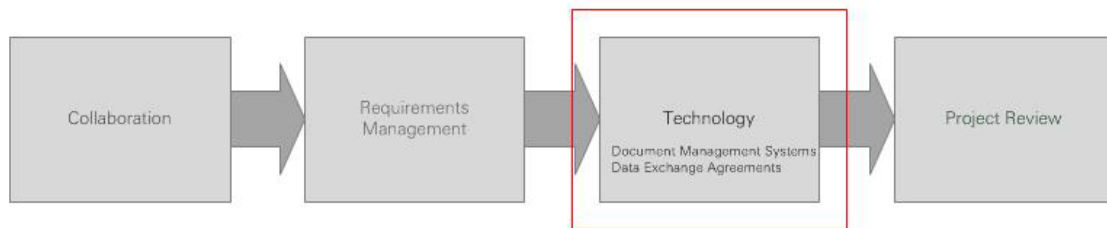


Figure 29

Once the appropriate process maps have been developed, the information exchanges between the team members should be clearly identified. The more Technological aspects need to be agreed. Communicating the necessary aspects of where, how and how often the BIM copies should be saved and updated, as well as what level of checks should be done over the BIM Model to ensure a consistent Quality level of the Model.

## ***Project Review***

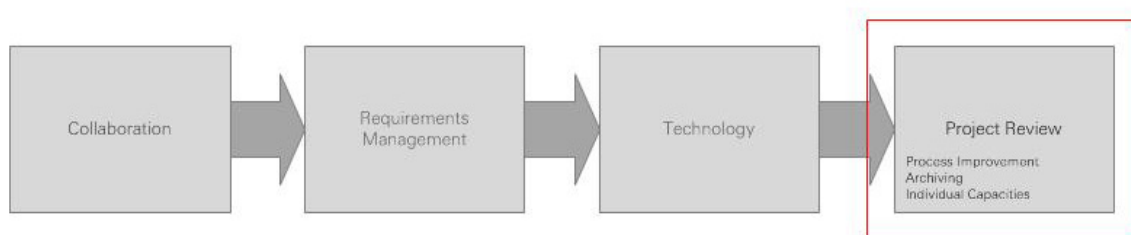


Figure 30

The Final aspect of the Instrument is the Project Review. This part of the instrument is the only aspect that should be used at the end of the Project. It gives the team members a chance to deliver feedback regarding their overall process, so the BIM Workflow Guide can be improved and adapted, as the proficiency of the BIM Maturity, of ATP, improves with more experience.

### **3.6 Internal validation**

The initial validation was carried out on the preliminary design of the instrument. This was organized through a series of meetings with one to two employees from each discipline. By holding meetings with each discipline individually, the sessions lead to the necessary information that is needed from the perspective of each discipline. The list of employees and their function and discipline interviewed for this part of the verification process are illustrated in Appendix 2.

The face validation sessions were held to verify the preliminary design and to improve the final design. Every session was setup and organized in the same fashion. Each session consisted of a detailed survey of the preliminary design run through, as it would at the commencement of every new BIM run project. Afterwards, the participants were able to bring input, ask questions and reflect on the preliminary design. This way, the practicality was measured and a good insight of how staff would adopt BIM was achieved.

It is of importance that the end design does not deviate from the information needed of each discipline to complete the design process. This is necessary for the adaptation of BIM and the motivation of the employees at ATP. For this purpose the design is tested on clarity, readability and compared to pre-described work processes. From this process some iteration has been made, as to upgrade the instrument to be usable by all disciplines in the organization. Upon completion of the evaluation session, participants were given one to two days to come back with additional questions and feedback. Hence allowing the participants to contemplate over the Preliminary design and associate it to their everyday work process and their experience, thus far, with a BIM process. The internal validation has led to a series of small improvements and expansions and illuminations.

Another appropriate validation session would be to sample the preliminary design at the commencement of a running BIM project. Unfortunately, this could not be done, as the company had no Revit project running at an early phase of the project, in order to deem the experiment as advantageous. Therefore, the reflection questions at the end of the Manual were developed more to allow the instrument to be improved, as the organization develops their BIM experience, navigating ATP towards a refined BIM process. During the testing of the internal validation, the points for improvements were mostly found to be on structure, wording and explanation of wording.

### **3.7 External Validation**

After the initial internal validation sessions, the evaluated and iterated preliminary Design was validated with external companies. The two companies chosen for this validation session were companies nominated for the competition “Hoe slim is uw BIM” (How smart is your BIM). The competition assesses the candidates on their BIM experience, focusing on the organization; its processes, competencies of the staff,

information flows, richness of the BIM model and the tools used. Ultimately it is not simply assessed on the BIM deliverable, but also on the way in which their models are created. The two companies that were selected for the external validation were companies nominated for the competition. The companies are ZEEP architecten, and Atelier PRO. (For additional information regarding these two companies see appendix 6)

During the external validation, the design was evaluated on applicability in practice, accuracy in the information, required for a suitable BIM process. Both external validations were carried out in the same configuration. The interviewees both were informed of the aim and objective of the instrument a week prior to the session, allowing them to manifest on the given information. The validation sessions were then discussed step by step as one would do at the commencement of a BIM project. The initial feedback from the sessions were then processed, and the interviewees were given an additional week to emulate any additional comments and observations.

### **3.8 Improvements**

*It is important that the design is as accurate as possible, to allow for a fluent transition during the implementation of the Manual. Therefore the issues emerged during the validation session have been processed in the Design.*

#### *Structure*

- During the validation of the initial Design at the internal validation it was noted that the questions should be organized according to the topic they are related to. Due to the fact that this distinction was missing the Initial Design, it was perceived to be obscure and indistinct. Employees had difficulty comprehending the document in the initial organizational form and therefore compromising its feasibility.

#### *Usability*

- Because of the nature of the questions they could be misinterpreted. Therefore, this set of example tables have been added to the Design for clarity and to avoid aberrations in the use of the Manual.

-A digital completion of the instrument is recommended, so that the instrument can be interlinked with the additional systems, already active within the ATP internal working process. During the validation session, it appeared that it was useful to have a pdf version of the instrument to bring or take along during the project meeting, but it also seemed appropriate to have a database available on the network, potentially one that is programmed to interlink with the BIM process attachment.

#### *Content*

-The process design was changed back to its original canonical methodology, from a more practical work process, as most employees found it more helpful to see how the process should take place, so they can ambition to work in the most efficient way possible.



# 4. Conclusions and Recommendations

## 4. Conclusions and Recommendations

*The Following chapter contains a summary of the findings of this investigation. The intent is to reflect and conclude on the obtained answers of the research questions, as well as avail a number of recommendations for further research.*

### 4.1 Conclusions

As stated in the first Chapter of this Research, an improvement to the internal BIM Process at ATP will provide benefits to the organizational implementation of BIM. An efficient and effective BIM working process has the potential to enhance performance, optimize solutions and enrich design collaborations, within the AEC industry. ATP aims to gain the benefits of BIM, as well as too implement a software system that can be used by all in-house disciplines. As the mission of ATP is to provide an integral design service, the adaptation of BIM process will help in further growth of strength the organization.

The current organization needs to advance their internal BIM process, in order to gain more benefit from the adoption of their chosen BIM software package, Revit. As BIM is an nD workflow instead of the traditional 2D paper based workflow the organization should adapt their working process to be more suited to an nD workflow. Therefore, there is a need for a guide to aid the internal BIM process.

*How can ATP improve their BIM competence, while enhancing an effective and efficient integral working process?*

In order to answer the above stated research question, which will lead to a suitable design outcome, the following Sub research questions were resolved:

*What are the positions and duties needed for an improved BIM process at ATP?*

Established from the analysis it can be concluded that, in order for the BIM capabilities to advance, new management positions need to be created. The Positions of BIM Managers and that of the BIM Officer would have to be created, within ATP. The BIM Manager would be a position, which aims to stimulate the performance of BIM, achieve and monitor BIM standards within the organization, and a proprietor of the technological aspects of the BIM Model. The position of the BIM Officer would be to manage the distribution of BIM Managers within the office, guard that the Revit Standards stay uniform and advanced, and to keep a general overview of all projects, with regards to the BIM Model. It was also found that 1 BIM Officer should be positioned in each Office of ATP, and 4 BIM Modelers should enrolled at ATP Innsbruck.

*What are the most crucial aspects, within the internal working process, for an improved BIM process for ATP?*

According to information from the Analysis phase, the most crucial aspects for a developed BIM process are:

1. Communication

By creating a communication network, the communication lines are curtailed to stimulate clarity, and essentially solving or reducing the solutions undefined project aims and goals, and undefined positions and duties within the design teams. The ATP Radar will stimulate communication within ATP.

2. Integral Design

As BIM facilitates simultaneous work by multiple design disciplines, knowledge and input should be delivered at the commencement of the projects start, creating a concurrent working process instead of a sequential working process. The BIM workflow guide will facilitate integral design .

3. Process

The current working process needs to be better suited towards that of a BIM Process. For this the guide contains a tool, which describes a suitable process for ATP to use with BIM. The BIM Process Map provides ATP with a suitable BIM process.

It is important to strengthen and improve these three aspects, in order to improve the BIM competence of ATP. As BIM involves a paradigm shift from drawing to modeling, more than just technical adaption is involved in the implementation of a BIM software.

*What level of BIM competence should ATP strive to achieve to improve their BIM competence?*

The level of BIM competences is based on interviews carried out during the analysis phase, which is compared to the literature source of Succar. Based on this, the organizations current BIM competence can be categorized as Ad-hoc/ Defined, this indicates that the organizations BIM process lacks an overall strategy and the BIM tools are deployed in a non-systematic fashion. However, the opportunities arising from a BIM implementation are recognized, but in relation to business opportunities arising from BIM are identified but not yet exploited. As the implementation of BIM is driven by senior managers, in order for ATP to achieve a BIM capability similar to their mission statement. The BIM requirements and process should be integrated into the organization and the knowledge of BIM is integrated into the organizational system, BIM productivity and process is now consistent and predictable. Also the BIM implementation strategy and its effects on the organizational model are continuously revisited and realigned with other strategies. With aid of the developed guide this BIM capability level can be achieved.

The results of the Sub Research Question constitute input for the Instrument that provides an answer to the Main research question. The Instrument will provide aid to further develop the communication, integral design ,and internal BIM process with additional tools to the guide: the ATP Radar as well as the BIM Process Map. Furthermore, the design stimulates and strengthens the integral design working method at ATP. The Instrument will help ATP Innsbruck to adapt their current working process to that of an efficient BIM process. In a methodological manner that is designed so that every BIM project can be carried out in a comparable configuration. The Design



will help further develop the BIM adaptation at ATP Innsbruck.

As the instrument is essentially a communication tool, it will stimulate transparency within the project teams as well as the organization. It should be used at the commencement of every project to clarify and distribute all the roles within the team, the BIM Goals, and to prescribe a repeatable BIM Process. Aiding ATP to improve their BIM process and competence, as well as it will support the integral working process at ATP.

## 4.2 Recommendations

### *Workshops*

One of the most important recommendations I would make is to organize or develop a series of workshops. Currently the organization enrolls all members into a workshop, which allows them to develop a building model using Revit. Even though it guides through all the aspects an ATP employee needs to know how to carry out their work, it is also very general. Hence my recommendation for a series of different training workshops allowing different disciplines to find the information they need, based on the work that they have to do, or the function that they have at ATP. For example:

- A workshop for the Project Leaders, teaching them how to make parti models using Revit.
- A workshop to BIM Managers and Super Users how to make 'Revit Families'.
- A workshop for Draftsperson to teach them how to organize and setup the layout of the model.
- A series of workshops to teach employees how to upload and collaborate their work on a central model.

### *Learning*

Another Recommendation would be to stimulate learning from each other in the organization. So that people become more involved, as they can help or be helped by their co-workers on how to work with the software, and teach each other the most efficient ways of working on BIM software.

### *Updating*

The latter part of the instrument contains a Project Review chapter. It would be recommended to have the BIM Officer taking all the comments and feedback on board after each Revit project completion. Also, to summarize all feedback on a frequent basis to update the BIM workflow Guide. The recommendation would be to review this every one to two years.

### *Synchronization*

In the future, as the organization becomes more adapted to working with Revit, the recommendation would be to take the working process from a synchronized model to an online model. Currently some of the disciplines are working on a synchronized

model (see chapter 5.4 Process).

#### *Programming*

The Instrument would be most beneficial to a team, if it was programmed to link the responses of the guide to that of the BIM Process, giving each Project a prescribed BIM process as aid to the team.

The ATP Radar will only be beneficial to the organization, and stimulate an integral working process, if it is life on the network and programmed to the Project Intelligence (PI). PI is an internal program, where the hours spend on each project is indicated. The hours indicated in the PI can then be translated into the ATP Radar indicating the busyness of each individual.

#### *Hours*

It is recommended that the elementary calculation of the Average amount of time spend by Modeler, or BIM Manager, per project (See Table 1) is to be revisited after a series of Revit projects. It would help to make a more accurate review of the hours spend by the BIM Manager per project.

#### *Motivation*

*In order to get employees more motivated to involve themselves in the opportunities BIM can bring them, a series of interesting lectures by experts in the practice of BIM could be hosted in the Campus.*

#### *BIM Statement*

*The instrument guides each BIM project to develop their BIM Goals and Statement at the commencement of every project. This is to articulate what BIM can bring to each project according to the needs and objectives of the client. It would be advisable to have a general BIM Statement for the entire organization.*

#### *Further investigation*

*A further investigation can be made to see how ATP can work using BIM with external companies. The focus of this research was to improve the BIM competence, internally at ATP Innsbruck. Once the internal BIM working method is improved, it would be beneficial for ATP to look at how the BIM working method is best addressed to exterior companies.*

#### *Document Management System*

*Additionally it would be recommended that ATP would investigate at how the 'Revit families' are organized and kept, as momentarily this is not transparent for all employees. A clear system should be arranged for this, as well as a method of keeping the 'Revit Families' up to date.*



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## Appendix 2- Summary of interviewees

The following is a list of all the interviewees for this research, it is organised according to phase of the research and the date when the interview took place. Behind the name of the interviewee there is additional information, such as: When the interview took place, the function of the interviewed as well as their discipline. When the interviewee was an external of ATP Innsbruck, the companies name is also provided.

### Orientation Phase

1.	Werner Blunder,	11.05.2012	Gruppenleiter, Architecture
2.	Diana Praxmarer,	15.05.2012	Team Architect Level 3, Architecture
3.	Meinhard Legerer,	15.05.2012	Team Architect Level 2, Architecture
4.	Phillip Berchtold,	21.05.2012	Gruppenleiter, Architecture
5.	Wolfgang Klabacher,	21.05.2012	Team Architect Level 2, Architecture
6.	Martin Bachlechner,	21.05.2012	Team Engineer Level 3, Architecture
7.	Stefan Zoller,	22.05.2012	Head Engineer, ÖBA
8.	Andreas Kussegg,	22.05.2012	Team Engineer Level 3, HKLS
9.	Alois Salzburger,	23.05.2012	Prokurist, TWP
10.	Hans Kotek,	25.05.2012	Head Architect, Architecture
11.	Matthias Spiss,	29.05.2012	Team expert Level 2, Modeller
12.	Wilhelm Alexander,	29.05.2012	Team Engineer Level 2, Elektro
13.	Alfred Feichter,	30.05.2012	Gruppenleiter, Architecture
14.	Gerhard Oberrauch,	30.05.2012	Gruppenleiter, Architecture
15.	Hannes Reichholf,	05.06.2012	CAD, Plandata
16.	Olaf Hermann,	05.06.2012	CAD, Plandata
17.	Arthur Staudacher,	06.06.2012	Team Architect Level 2, Architecture
18.	Nadja Haberfellner,	08.06.2012	Junior Expert, Modeller
19.	Marc Mark,	20.06.2012	Geschäftsführer, ATP Sphere
20.	Klaus Hessenberger	20.06.2012	Senior Architect, ATP Sphere
21.	Robert Kelca,	21.06.2012	Geschäftsführer, Architecture
22.	Magdalena Obermair,	22.06.2012	Team Expert Level 3, Architecture
23.	Martina Fellner,	25.06.2012	Team Expert Level 1, Architecture

### Analyses Phase

1.	Ulf Bambach	29.08.2012	Geschäftsführer, Architecture, ATP N+M
2.	Oliver John	29.08.2012	Team Architect Level 3, Architecture, ATP N+M
3.	Anton Gasteiger	31.08.2012	b.i.m.m. External Expert
4.	Niko Stamoulopoulos	04.09.2012	Team Architect Level 2, Architecture, ATP kfp
5.	Tanja Bernet	04.09.2012	Team Architect Level 1, Architecture, ATP kfp
6.	Gerd Maurer	18.09.2012	Geschäftsführer, ATP München
7.	Magdalena Obermair,	19.09.2012	Team Expert Level 3, Architecture
8.	Phillipp Nowak,	20.09.2012	Junior Architect, architecture
9.	Nadja Haberfellner	20.09.2012	Junior Expert, Modeller
10.	Matthias Spiss,	20.09.2012	Team expert Level 2, Modeller
11.	Christine Nedl	26.09.2012	Assistentin der Geschäftsführung
12.	Marco Thurner	28.09.2012	Team Engineer Level 1, TWP
13.	Veronika Mair	13.11.2012	Team Architect Level 3, Architecture
14.	Jakob Hirn	27.09.2012	Team Expert Level 1, BIM Manager
15.	Rizal Sebastian	14.09.2012	TNO, External Expert
16.	Hr. Reiner	05.09.2012	Geschäftsführer, ATP Wien
17.	Hr. Zeggel	24.09.2012	Team Architect Level 3, Architecture, ATP München

*Design Phase*

*Workshop* 19.11.2012

- |    |                     |                                     |
|----|---------------------|-------------------------------------|
| 1. | Martin Abentung     | Senior Engineer, TWP                |
| 2. | Wilhelm Alexander,  | Team Engineer Level 2, Elektro      |
| 3. | Martin Bachlechner, | Team Engineer Level 3, Architecture |
| 4. | Werner Blunder,     | Gruppenleiter, Architecture         |
| 5. | Jakob Hirn          | Team Expert Level 1, BIM manager    |
| 6. | Stefan Demetz       | Senior Engineer, TWP                |
| 7. | Hans Kotek          | Head Architect, Architecture        |
| 8. | Andreas Kussegg,    | Team Engineer Level 3, HKLS         |

*Verification*

- |     |                     |            |                                      |
|-----|---------------------|------------|--------------------------------------|
| 1.  | Paul Bos            | 29.11.2012 | ZEEP Architekten, External Expert    |
| 2.  | Jakob Hirn          | 05.12.2012 | Team Expert Level 1, BIM Manager     |
| 3.  | Martin Bachlechner, | 07.12.2012 | Team Engineer Level 3, Architecture  |
| 4.  | Phillip Berchtold,  | 11.05.2012 | Gruppenleiter, Architecture          |
| 5.  | Wolfgang Klabacher, | 11.12.2012 | Team Architect Level 2, Architecture |
| 6.  | Wilhelm Alexander,  | 11.12.2012 | Team Engineer Level 2, Elektro       |
| 7.  | Andreas Kussegg,    | 13.12.2012 | Team Engineer Level 3, HKLS          |
| 8.  | Stefan Zoller,      | 14.12.2012 | Head Engineer, ÖBA                   |
| 9.  | Jakob Hirn          | 17.12.2012 | Team Expert Level 1, BIM Manager     |
| 10. | ErnestJan Cornelis  | 07.01.2013 | Atelier PRO, External Expert         |

*Supervisors from TU/e*

Dr. A.den Otter

Mr. H. Pels

Prof. B. de Vries

*Supervisors from ATP Innsbruck*

Dr. Rieser

Mr. Salzburger

Mr. Blunder

Ms. Obermair

Prof. Achammer



### Appendix 3- Abbreviations

nD	multidimensional
BIM	Building Information modeling
TU/e	Technical University of Eindhoven
ADMS	Architectural Design Management Systems
AVA	Tender
TGA	Mechanical building equipment
HKLS	Heating Ventilation and Cooling
ÖBA	Site supervision
OÜ	Building supervision
TWP	Structural Design
SWOT	Strengths Weaknesses Opportunities and Threats
AEC	Architectural Engineering and Construction
CADv	Computer Aided Design 'Verantwortlicher'
BIM.M	BIM Manager
GPL	Gesamptprojektleiter
PL-P	Project Leader Planung

## Appendix 4 Definitions

Stakeholders	The people who obtain power to affect alter and change the outcome.
Interviewee	a person who is interviewed
Interviewer	a person who carries out an interview

### Integral Design

Integrated design is defined as “the simultaneous and interdisciplinary interaction of the creative input of all those involved in the design process”.

In a time of complex challenges which can only be met by cooperative networks integrated design is, in our long experience, the most appropriate way in which our industry can respond to the demand for excellent results.

ATP architects take the lead in this integrated design process in intensive cooperation with the client. All creative contributions to meeting the challenge in question are dealt with simultaneously and treated as of equal importance as they are integrated by ATP’s architects and engineers into the design process with the aim of contributing to the sustainable quality of our buildings and, hence, to the core processes of our clients.

This development over many years of a shared language between clients, architects and engineers has put ATP Architects and Engineers in the position to develop sustainable building solutions of the highest quality which fully meet the expectations of our clients.

Information source:<http://www.atp.ag/home/services/integrated-design/index.htm>, December 2012)

## Appendix 5- TNO QuickScan explanation

BIM QuickScan-TNO Built environment and Geosciences

*The BIM QuickScan tool aims to 'serve as a standard BIM benchmarking instrument in the Netherlands'. The scan is intended to be performed 'in a limited time of maximum one day' (Sebastian & Van Berlo, 2010)*

The BIM QuickScan tool is organized around four chapters: organization and management, mentality and culture, information structure and information flow, and tools and applications. 'Each chapter contains a number of KPIs

## Appendix 6- External Experts

### *TNO*

TNO is an independent research organization whose expertise and research make an important contribution to the competitiveness of companies and organizations, to the economy and to the quality of society as a whole. TNO's unique position is attributable to its versatility and capacity to integrate this knowledge.

Innovation with purpose is what TNO stands for. We develop knowledge not for its own sake but for practical application. To create new products that make life more pleasant and valuable and help companies innovate. To find creative answers to the questions posed by society.

### *ZEEP Architecten*

ZEEP architecten is a medium large architectural office in the Netherlands. The office participates in a wide variety of projects. They are continuously looking for innovative and sustainable concepts within their projects. The office is very focused on research and new innovative solutions within the Building and Construction Industry. This innovative approach led them to implemented BIM in their working process in 2007. ZEEP has won the competition: 'BIM model van het jaar 2010' (BIM model of the year award 2010). The office is located in Amersfoort in the Netherlands, and has around 15 employees.

### *Atelier PRO*

Atelier PRO focusses mostly on the residential projects, but has also done projects for educational facilities, health care institutions and multifunction accommodations. Atelier PRO manifest in items such as high sustainability scores, trend-setting strategies for educational buildings and successful office layouts for The New World of Work. Atelier PRO has successfully completed a number of projects using BIM. The company is located in Den Haag in the Netherlands, and has around 65 employees.

## Appendix 7–Interview Approaches

### *Interview Approaches*

The interviews for each of the design phases were carried out through a half structured methodology. One week prior to the interview a list of questions and or topics would be send out to the interviewee, provided by the interviewer. This, interview-document, provided an aid during the interactive interview, whereby the interviewer guarded the outcome of the interview. The method kept guard as to the content of the interview, besides keeping an open atmosphere in which the interviewee was able to openly communicate his or her opinions and perspective.

During the orientation phase of the research the interviewers were chosen from as many different disciplines as possible in order to get a wider perspective on the internal working process and capabilities of BIM. Thus, it includes discussions with architects, structural engineers, HVAC engineers, electrical engineers, tender surveyors and construction managers. So that as many different disciplines could illustrate their perspective on the subject matter. The people who were approached for these interviews were either chosen by their experience in their BIM process, technical understanding or because of their organizational understanding and the effects of the BIM implementation. However, many of the interviewers were able to combine these perspectives. A list of their names and positions are illustrated in Appendix 2.

During the interviews the following subjects were discussed:

- General motivation and opinion on Revit.
- BIM experience and understanding
- A comparison between the original project process and their perspective on the BIM process.
- The organizational adaptation and perception of BIM
- The future value of BIM at ATP
- The current hindrances and perceived problems with BIM
- The applicability of the current functions for a BIM process

## Appendix 8- BIM Manager

*Please note that this is not the original job description, it is a translation from the existing German description.*

Job Description: BIM-Manager

03.10.2012

Preamble:

The BIM Manager BIM is to model all planning areas. The range of objects to be modeled is from conceptual models to the execution phases of all types of projects. A BIM Manager should obtain a clear understanding of design and construction processes.

As a basis for the preparation of this BIM models both 2D drawings and sketches, and CAD data from various sources are used to existing 3D data from Revit or other BIM platforms.

The BIM Manager is responsible for the correct installation of the BIM model, the creation of the required project-specific families and the monitoring of the current project to ensure compliance with the ATP standards. Thus ensuring the quality of the model which best a necessary condition for the cooperation is integral. Further processing is done in close collaboration with internal and external partners in the different fields in which the BIM Manager ideally with continuous duration of the project is developing more and more of the active agent role in the position of project coaches. The controlling and monitoring of the entire model is still perceived by the BIM Manager from start to completion of the whole project.

### 1. Functional goals:

- Creating a perfect model that is suitable for further processing of all the departments and for additional benefits (calculations in TGA, TWP, AVA and more).
- Monitoring compliance with the ATP - and CAD - standards throughout the project period.
- Further BIM (CAD standards, project families, templates, textures, additional programs, add-ons ...)

### 2. Task Profile

#### 2.1 Coordination tasks:

- Timely and thorough communication and coordination of the distribution of tasks to engineers.
- Coordination of CAD audits with the CAD site managers.

#### 2.2 Control tasks:

- Continuous monitoring of the qualitative performance of the model designers involved.
- Feedback on deviations to the project manager and the CAD site managers.

#### 2.3 Project-related tasks

- Establish and setup of the BIM model.
- Creation and holistic responsibility for the digital building model.
- Review of the BIM model to meet the quality standards.
- Participate in planning meetings.
- Preparation of the necessary for the project families.

#### 2.4 Information to:

- Information of the overall project manager on the state of the BIM model.
- Informs the management of the development team on newly created Revit families and families need not yet existing.
- Monitors the ongoing advances in BIM for usability and potential applications of ATP and informed

the management of the development team on this research.

3. Requirements:

- Super user Revit skills.
- Knowledge of Revit family creation.
- Expert knowledge of their own area out to meet the demands of integrated planning to be.
- English: Level B1 of the Common European Framework for Languages.
- Structured and organized way of working.
- Good communication skills.

4. Organization:

- Direct, by a member of the GL.
- In the project directly to the GPL assigned staff position.

## Appendix 9- Survey Analysis

*Below is a summary of the Challenges indicated by ATP employees. The list is a result of a reply to an open Question in the Questionnaire. The responses are left anonymously to encourage employees to speak freely.*

- Model Accuracy is important; therefore every user needs to be very good at Revit, for the departments to work well together.
- It is difficult to create 'Revit Families'.
- Difficulties with implementing 'Revit Families'.
- Every team at ATP using Revit needs a Revit super user in the team, at least at the commencement of the project.
- You're faster to form the whole building but detailing is as many work as you working with Auto-CAD.
- Users with no Revit experience can require longer because of their learning process.
- During the first phase you need too much detail input about the building, although it is too early within the Design process.
- There are no advanced Revit courses for employees. Practical courses teaching how to detailing or model staircases would be very beneficial.
- There was only Revit Friday with very specialized topics, but little practical support.
- It is difficult working with more people on the same Model, especially when there's a different level of Revit abilities.
- The status of a real BIM expert should be more recognized.
- The advantages of Revit arise when the program is further developed; currently there are no benefits for the structural design department.
- A number of things still have to be developed for a BIM working process, i.e. 'Revit family' support, labels, etc.
- Reinforcement modeling is currently not possible.
- Currently, in the structural engineering discipline, only plans are created in the architectural model modeled. A systematic plan to extract the structural design needs to be developed.
- Revit has a long learning-curve, so there where many challenges in the past I had with it, but the largest amount of challenges lies in the future, because it's always a long way to absolute perfection.
- Revit is a very complex application especially in the beginning phase.
- The software program is very complex.
- If you will use Revit in the discipline "AVA" the model has to be accurate, that means every user has to be very good at 'Revit'.
- To create 'Revit families' you need to be a super user at Revit.
- Revit is still enough of a challenge for me, as I am still learning. But the first start with Revit was the hardest challenge of all, because everything was new and the software id very complex.
- I have to think about things first on paper, before I start working in Revit.
- It does not make sense to design every single detail in Revit (window frames etc.)
- Everything new has to be learned and to be understood by the users.
- There are many challenges because I want to apprehend good 3D model ability. So every new construction part is a challenge.
- Because we are building a 3D Modell in Revit, I must think about different details earlier on in the design process, than when working with AutoCAD.
- The cooperation with other departments and/or sites is often difficult. It is not really clear who modelled what in Revit. That's a problem in my opinion. The way of working with Revit also changes constantly. It still requires a clear restructuring.



## Appendix 10- BIM functions

A short summary of the different positions as described per literature and what the current duties of each job description entails. This is gathered directly from the following Literature; Eastman et al., 2008; Succar, 2009;

### **BIM officer – client company**

- Is required to have basic knowledge of BIM technology.
- Responsible for linking the knowledge and technology abilities to the needs of the owner organization and identifying possible support opportunities.
- Is required to have knowledge of contracts that will involve project team in an integrated practice.
- Required to have knowledge of how to use model for facility management.
- Responsible for setting standards for BIM knowledge and use by project team.

(Eastman et al., 2008)

### **Chief BIM officer – design team**

#### *Technology responsibilities:*

- Responsible for providing general network and interoperability capabilities between collaborating organizations, across the project team.
- Support both the design consultant and the fabricator consultant collaborations (may include general intranet services, server services and general software platforms adopted by the design team, including the hardware and platform-level IT and BIM services relied on).

#### *Process responsibilities:*

- Responsible for the setup of the physical and knowledge infrastructure required to run the project.
- Responsible for acquiring the necessary human resources, and ensuring the required skills and experience are assigned to the BIM team roles.
- Responsible for ensuring that all parties understand the project's product and service specification, as well as the general delivery approach throughout the design team.
- Responsible for the general leadership aspects of the BIM effort within the project team, namely the strategic, organizational, communicative and managerial attributes of the project organization.

#### *Policy responsibilities:*

- Responsible for the implementation and use of available standards and classifications throughout the design team
- Responsible for establishing a common set of guidelines and benchmarks for all parties within the BIM team. These benchmarks and guidelines will extend beyond the design phase, therefore they will have to include the requirements of both the F and contracting BIM officers.
- Responsible for monitoring that BIM-specific contractual responsibilities, rewards and risks are met and awarded accordingly
- Responsible for determining and facilitating, if necessary, any preparatory efforts required by the BIM team members, such as educational and/or training programs

(Eastman et al., 2008)

(Succar, 2009)

### **Project Model Manager**

- Responsible for the negotiation and the planning of the workflow exchange mechanisms for the overall process workflow, as defined by the client, consultants and contracting partners
- Responsible for maintaining the workflow exchange mechanisms and the evolving project data throughout the project life cycle
- Responsible for overseeing the protocols for version control and managing releases, based on the conventions organized by the Chief BIM Officer
- Responsible for determining the policies for managing and overseeing the model's data integrity, establishing read-and-update privileges, for merging consultants' work and other data into the master or federated model(s)

(Eastman et al., 2008)

### **Model Analyst**

- Responsible for the assignment and monitoring of specific attributes and relations in the Model authoring tool consistent with the requirements of the analysis tools.
- Responsible for establishing and monitoring of methods for compiling the analytical data model containing the appropriate abstractions of building geometry. Different types of analyses will require different abstracted models.
- Responsible for selecting the exchange format for data transfers, with particular focus on maintaining the associations between the Building Information Model and the abstracted analysis models to support incremental development on both sides of the exchange.
- Responsible for the dissemination of analyses results to all parties concerned, under the supervision of the Design team BIM Chief Officer.

(Eastman et al., 2008)

### **Modeller**

- Responsible with drafting/generating plans, diagrams and schedule consistent with instruction, guidelines and CAD/BIM standards.
- Is required to provide design assistance to Designers and/or Engineers.
- Responsible with modify CAD/BIM files for use in design drawings (clean-up, audit, reference and troubleshoot).
- Is required to assist in constructability review.
- Responsible for preparing projects for client submissions.
- Is required to work side by side with design teams in-house and external design teams to complete BIM projects.

### **Chief BIM officer – construction**

#### *Technology responsibilities:*

- Support both the design consultant and the fabricator consultant collaborations (may include general intranet services, server services and general software platforms adopted by the design team, including the hardware and platform-level IT and BIM services relied on).

#### *Process responsibilities:*

- Responsible for establishing the standards for BIM technology and work processes that support project activities such as: planning, coordination, clash detection and correction, and procurement
- Responsible for acquiring the necessary human resources, and ensuring the required skills and experience are assigned to the BIM team roles.
- Responsible for ensuring that all subcontracting parties understand the project's product and service specification, as well as the general delivery requirements to the fabricators.

#### *Policy responsibilities:*

- Responsible for the implementation and use of available standards and classifications in continuation of those used by the design team.
- Responsible for establishing a common set of guidelines and benchmarks for all subcontracting and fabricator using BIM. These guidelines and benchmarks are a continuation of those established together with the BIM design team.
- Responsible for monitoring that BIM-specific contractual responsibility, rewards and risks are met and awarded accordingly.
- Responsible for determining and facilitating, if necessary, any preparatory efforts required by the BIM team members, such as educational and/or training programs.

(Eastman et al., 2008),(Succar, 2009)

### **Project Model Manager –construction**

- Responsible for the management of the subcontractors' and fabricators' workflows to ensure the efficiency of the project team.
- Responsible for establishing and maintaining the temporary components libraries, and making them available to all project participants concerned.
- Is required to ensure that the construction model maintains the specification information associated with each corresponding building component and this information is available when purchasing or constructing each component.
- Responsible for acquiring and disseminating analysis data related to performance level and project requirements to the subcontractors and fabricators.
- Responsible for updating the model with information regarding the design and construction progress status of each component (relative to design, procurement, installation and testing).

- In the situation when the client desires an accurate “as built” model, the Project Model Manager is responsible for seeing that updates of all relevant project models are made as changes occur or out-of-tolerance conditions emerge.
- Responsible for turning over the as-built model to the client, and possibly for commissioning and operating practice handover.

(Eastman et al., 2008)

#### **Model Analyst – construction**

- Responsible for the assignment and monitoring of specific attributes and relations in the Model authoring tool consistent with the requirements of the analysis tools.
- Responsible for establishing and monitoring of methods for compiling the analytical data model containing the appropriate abstractions of building geometry. Different types of analyses will require different abstracted models.
- Responsible for selecting the exchange format for data transfers, with particular focus on maintaining the associations between the Building Information Model and the abstracted analysis models to support incremental development on both sides of the exchange.
- Responsible for the dissemination of analyses results to all parties concerned, under the supervision of the Design team BIM Chief Officer.

(Eastman et al., 2008)

#### **Modeller – construction**

- Responsible with drafting/generating plans, diagrams and schedule consistent with instruction, guidelines and CAD/BIM standards.
- Is required to provide design assistance to Designers and/or Engineers.
- Responsible with modify CAD/BIM files for use in design drawings (clean-up, audit, reference and troubleshoot).
- Is required to assist in constructability review.
- Responsible for preparing projects for client submissions.
- Is required to work side by side with design teams in-house and external design teams to complete BIM projects.

#### **Chief BIM officer – M&O**

##### *Technology responsibilities:*

- Responsible for providing general network capabilities for operating and updating the maintenance model.

##### *Process responsibilities:*

- Responsible for the setup of the physical and knowledge infrastructure required to run the project model.
- Responsible for establishing and disseminating the FM specifications to be incorporated in the building information model.
- Responsible for acquiring the necessary human resources, and ensuring the required skills and experience are assigned to the BIM team roles.
- Responsible for the general leadership aspects of the BIM effort within the project team, namely the strategic, organizational, communicative and managerial attributes of the project organization.

##### *Policy responsibilities:*

- Responsible for the implementation and use of available standards and classifications in continuation of those used by the design and construction teams.
- Responsible for establishing a common set of guidelines and benchmarks for all maintenance and operation parties. These guidelines and benchmarks are a continuation of those established together with the BIM design and construction teams.
- Responsible for monitoring that BIM-specific contractual responsibilities, rewards and risks are met and awarded accordingly.
- Responsible for determining and facilitating, if necessary, any preparatory efforts required by the BIM team members, such as educational and/or training programs.

(Eastman et al., 2008,(Succar, 2009)

#### **Project Model Manager – M&O**

- Responsible for the management of maintaining and operate teams’ workflows to ensure the efficiency of the project team.
- Responsible for establishing and maintaining the M&O building model information up to date

and associated with manufacturer and life cycle cost information for each building component(whenever applicable).

- Responsible for acquiring and disseminating analysis data related to performance level and project requirements to the M&O teams.
- Responsible for maintaining the model updated with information regarding changes in program, geometry and performance of the building throughout the M&O project.
- Responsible for delivering to the client an “as is” model when the duration of the M&O contract has been completed or terminated.

#### **Model Analyst –M&O**

- Responsible for the assignment and monitoring of specific attributes and relations in the Model authoring tool consistent with the requirements of the analysis tools.
- Responsible for establishing and monitoring of methods for compiling the analytical data model containing the appropriate abstractions of building geometry. Different types of analyses will require different abstracted models.
- Responsible for selecting the exchange format for data transfers, with particular focus on maintaining the associations between the Building Information Model and the abstracted analysis models to support incremental development on both sides of the exchange.
- Responsible for the dissemination of analyses results to all parties concerned, under the supervision of the Design team BIM Chief Officer.

(Eastman et al., 2008)

## Appendix 11- BIM Maturity Index

Source: Episode 13: the BIM Maturity Index (gathered from the Succar website, see Appendix 1)

BIMMI has five distinct Maturity Levels: (a) Initial/ Ad-hoc, (b) Defined, (c) Managed, (d) Integrated and (e) Optimized. In general, the progression from lower to higher levels of BIM Maturity indicates (i) better control through minimizing variations between targets and actual results, (ii) better predictability and forecasting by lowering variability in competency, performance and costs and (iii) greater effectiveness in reaching defined goals and setting new more ambitious ones[3 & 4]. Figure 2 below visually summarizes the five Maturity Levels or “evolutionary plateaux”[5] followed by a brief description of each level:

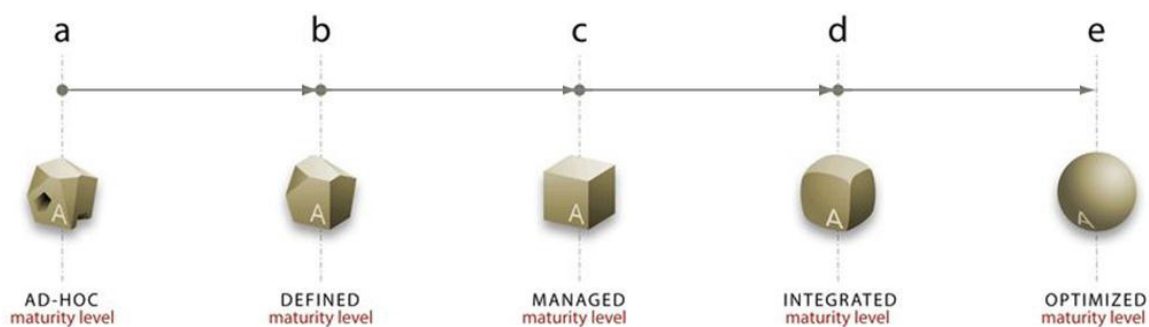


Figure 2. The Five Maturity Levels (depicted at BIM Stage 1)

**Maturity Level a (Initial or Ad-hoc):** BIM implementation is characterized by the absence of an overall strategy and a significant shortage of defined processes and policies. BIM software tools are deployed in a non-systematic fashion and without adequate prior investigations and preparations. BIM adoption is partially achieved through the ‘heroic’ efforts of individual champions – a process that lacks the active and consistent support of middle and senior management. Collaboration capabilities (if achieved) are typically incompatible with those of project partners and occur with little or no pre-defined process guides, standards or interchange protocols. There is no formal resolution of stakeholders’ roles and responsibilities.

**Maturity Level b (Defined):** BIM implementation is driven by senior managers’ overall vision. Most processes and policies are well documented, process innovations are recognized and business opportunities arising from BIM are identified but not yet exploited. BIM heroism starts to fade in importance as competency increases; staff productivity is still unpredictable. Basic BIM guidelines are available including training manuals, workflow guides and BIM delivery standards. Training requirements are well-defined and are typically provided only when needed. Collaboration with project partners shows signs of mutual trust/respect among project participants and follows predefined process guides, standards and interchange protocols. Responsibilities are distributed and risks are mitigated through contractual means.

**Maturity Level c (Managed):** The vision to implement BIM is communicated and understood by most staff. BIM implementation strategy is coupled with detailed action plans and a monitoring regime. BIM is acknowledged as a series of technology, process and policy changes which need to be managed without hampering innovation. Business opportunities arising from BIM are acknowledged and used in marketing efforts. BIM roles are institutionalized and performance targets are achieved more consistently. Product/service specifications similar to AIA’s Model Progression Specifications[6] or BIPS’ information levels[7] are adopted. Modelling, 2D representation, quantification, specifications and analytical properties of 3D models are managed through detailed standards and quality plans. Collaboration responsibilities, risks and rewards are clear within temporary project alliances or longer-term partnerships.

**Maturity Level d** (*Integrated*): BIM implementation, its requirements and process/ product innovation are integrated into organizational, strategic, managerial and communicative channels. Business opportunities arising from BIM are part of team, organization or project-team's competitive advantage and are used to attract and keep clients. Software selection and deployment follows strategic objectives, not just operational requirements. Modelling deliverables are well synchronized across projects and tightly integrated with business processes. Knowledge is integrated into organizational systems; stored knowledge is made accessible and easily retrievable[8]. BIM roles and competency targets are imbedded within the organization. Productivity is now consistent and predictable. BIM standards and performance benchmarks are incorporated into quality management and performance improvement systems. Collaboration includes downstream players and is characterized by the involvement of key participants during projects' early lifecycle phases.

**Maturity Level e** (*Optimized*): Organizational and project stakeholders have internalized the BIM vision and are actively achieving it[9]. BIM implementation strategy and its effects on organizational models are continuously revisited and realigned with other strategies. If alterations to processes or policies are needed, they are proactively implemented. Innovative product/process solutions and business opportunities are sought-after and followed-through relentlessly. Selection/use of software tools is continuously revisited to enhance productivity and align with strategic objectives. Modelling deliverables are cyclically revised/ optimized to benefit from new software functionalities and available extensions. Optimization of integrated data, process and communication channels is relentless. Collaborative responsibilities, risks and rewards are continuously revisited and realigned. Contractual models are modified to achieve best practices and highest value for all stakeholders. Benchmarks are repetitively revisited to insure highest possible quality in processes, products and services.

## Appendix 12- Workline explanation

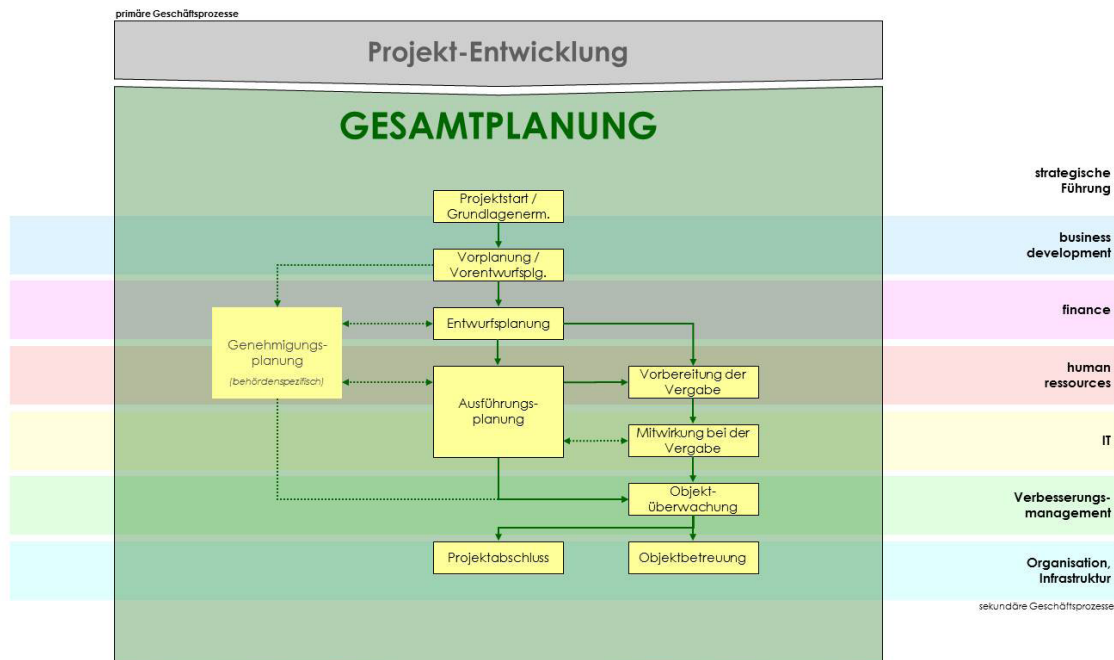
This navigation instrument for integrated design which was developed by ATP is the electronic representation of the integrated design process.

Therefore, the quality management system is process oriented which is an important factor for the development of the certification in the sense of quality norms. ATP has been using integrated design in its work for a long time. Now there is a way of representing this in words and images: all design processes can be examined in terms of both phasing and the various professional disciplines and this information is linked with various ATP standards, checklists and standard documents.

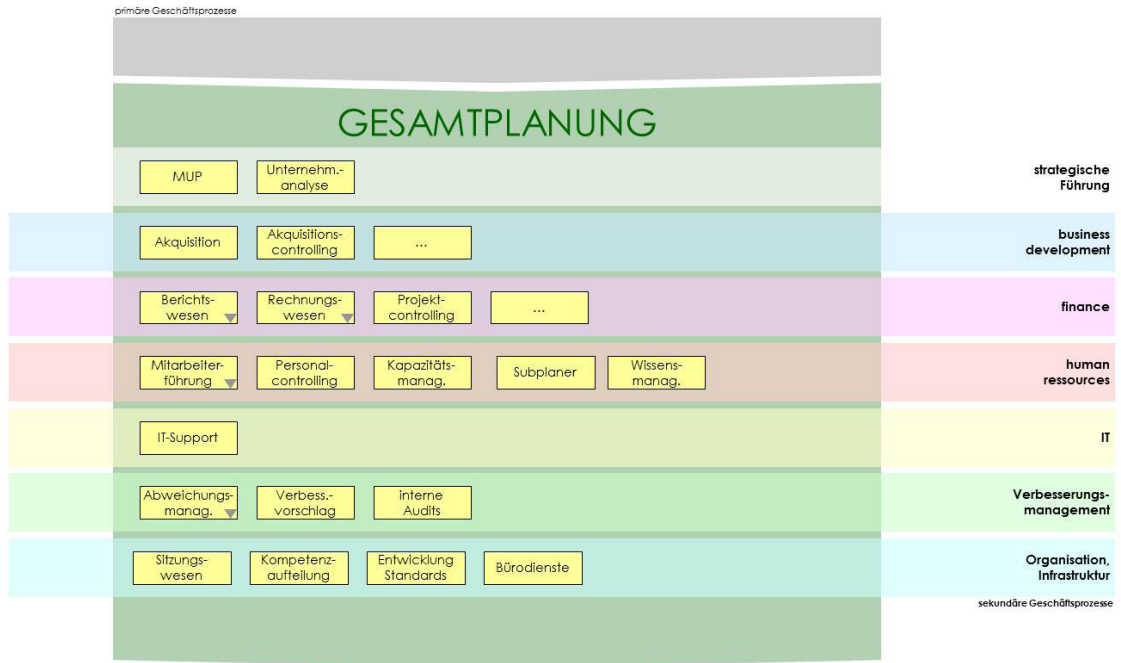
“WORKline gives our colleagues a speedy insight into the integrated cooperation between the different professional disciplines in each individual design phase” explained Andreas Rieser, who was intensively involved in the programming of WORKline. “Thus we ensure a uniform approach which is, in turn, essential to ensuring ATP’s customary high quality”.

Work processes are represented by WORKline on three levels between which one can navigate. The first level gives an overview of the integrated design process and below this there is a second level covering each individual design process. The lowest level covers individual actions and partial processes within each part of the design process with links to all applicable electronic aids.

## ATP-GESCHÄFTSPROZESSE



# ATP-GESCHÄFTSPROZESSE





## Appendix 13– The instrument

BIM workflow Guide v 0.1

### 1. Collaboration

#### *Transparency*

During the project emphasis should be made on transparency. The overall aims and objectives of the project should be clearly articulated as well as the program requirements and specific BIM goals. During the commencement of the project this should be communicated and gathered from the client. Here are some examples of BIM aspects that should be clarified with the client and communicated to the entire team:

- a. **What is the BIM mission statement for this project**  
(A short statement clarifying what the client envisaged for the project)
- b. **What do all parties want to achieve?**  
(A short statement of the aim of each stakeholder and there desired achievements for this project.)
- c. **What are the major BIM Goals for this project?**  
(Describe how the BIM model and facility data are leveraged to maximize project value i.e. design alternatives, life-cycle analysis, scheduling, estimation, material selection etc.)
- d. **BIM facility and data requirements**  
(This selection should include the BIM requirements of the Client. It is important that the clients BIM objectives are taken into account for the commencement of the project as to incorporate this into the BIM process)
- e. **BIM uses**  
(To indicate what information is expected to be delivered during the process of the project, and what the BIM model will be used for, during the design development and upon delivery)
- f. **Potential BIM uses**  
(To indicate what information would be beneficial to be delivered during the process of the project, and what the BIM model could be used for, during the design development and upon delivery)
- g. **BIM Deliverables**  
(A list to indicate the BIM deliverables derived from the level of information in the BIM model broken down per phase)

Phase	BIM-Level	Due Date	Model Information	Deliverables	Notes
Pre-project	Concept Model		Programming Site Analysis Concept		
Preliminary Design	Volume Model		... ...		
Final Design	Basic BIM Model				
Planning Application	BIM Model				
Construction Drawings	Complex Model				
Completion	Final Model				

*Team*

Who are the team members, and who are the most suitable employees to be working on this project.

- h. Determine the team members of the project
- i. Determine the projects BIM roles and responsibilities (see Attachment A)  
Determine the general roles and responsibilities of the team members.
- j. Determine the Design Responsibilities of each Team member  
According to the Design and Revit capabilities of each individual team member allocate the Team responsibilities over the Design. (How much time the team member expects to need to realize his or her Design Duties.)
  - i. How much time does an employee need for that work load
  - ii. Indicate in the table below which employee has taken what responsibility during the process of this project.

Discipline	Staff (hrs.)	Estimated work hours	Location model saved	Updates to the original model	Design Responsibilities
Architecture	Name Name Name	xx hrs.	Address	When?	Stairs Office spaces Etc
Structural					
Electrical					
HVAC					
Tender					

- k. Work division within the company (See Attachment B, ATP radar).  
The ATP Radar, is tool to stimulate integral Design, too enhance the informal communicate with the team members from other disciplines.

**Core Collaboration Agreements**

Indicate and discuss what the team finds suitable with regards to the communication factor for the project.

- i. Core Collaboration agreement
  - iii. Collaboration strategy  
Describe how the project team will collaborate. Include items such as communication methods, document management and transfer, and record storage, etc.
  - iv. Meetings procedures  
The following are examples of meetings that should be considered

Meeting Type	Project stage	Frequency	Participants	Location
BIM requirements kick-off				
BIM executive Plan demonstration				
Design coordination				
Progress review				
Other...				

- m. Interactive Workshop  
The project team should consider the interactive workshops it will need throughout the BIM project to accommodate the necessary collaboration, communication, and reviews that will improve the BIM plan decision making progress.

n. What additional measures need to be taken to successfully use BIM with the selected deliverable method and contract type?

- o. Transparency,  
What the objectives of the Deliverables and the project are should be clearly communicated in a transparent way to all stakeholders.

## 2. Requirements Management

### *Process*

#### a. BIM process design

Attachment C is an example of how the BIM process can run. Please use the collected data from this BIM workflow book and fill this BIM process in to suit the project.

#### v. Project time frame

#### vi. Project phases (Milestones)

#### vii. Frequency of information exchange agreement

How frequent will the linked models be updated into the central model, this is dependent on the project being a fast track or Slow burning project

#### viii. Information exchange

Model elements by each discipline, level of detail, and any specific attributes important to the project are documented using information exchange worksheet. Defining the requirements for information exchanges in the BIM project execution Planning guide for details on completing this template. (see swim lane model information in process design)

### 3. Technology

#### a. Modeling Plan

Advanced planning around which models will need to be created during the different phases of the project, who will be responsible for:

- i. Up-dating the model(s)
- ii. Distribution
- iii. Predetermining the content and format of model(s)
- iv. Model components
- v. When working with external companies, discuss matters such as:
  - File naming
  - Precision and dimensioning
    1. Determine and list the structure for model file names.

#### b. Model delivery schedule of information Exchange for submission and approval

Document the information exchanges and file transfers that will occur on the project. (only applicable when working with external company's)

Information exchange	File sender	File receiver	One-time or frequency	Due date	Model file	Model software	Native file type	File exchange type
Design authoring- nD coordination	Structural engineer		Weekly	Date	STRUC T	DESIG N APP	.XYZ	.XYZ
	Mechanical Engineer		Weekly	Date	MECH	DESIG N APP	.XYZ	.XYZ

#### c. Quality control

- i. Overall strategy for Quality control  
Describe the strategy to control the quality of the model.
- ii. Quality control checks  
The following checks should be performed to assure quality

Checks	Definition	Responsible party	Software Program(s)	Frequency	Dates
Visual check	Ensure there are no unintended model components and the design intent has been followed	GP-L PL-p			
Interference check**	Detect problems in the model where two building components are clashing (incl. hard- soft gates)	BIM.M PL-p			
Standards check	Ensure that the BIM and AEC CADD Standard have been following (fonts, dimensions, line styles, levels/layers etc.)	Architect BIM.M			
Model integrity checks	Describe the QC validation process used to ensure that the project Facility Data set has no undefined, incorrectly defined or duplicated elements and the reporting process on non-complaint elements and corrective action plans	BIM.M			

BIM.M= BIM Manager

\*\*When such a check has been carried out, and a clash between models is detected it is the responsibility of the BIM.M to bring this to the appropriate attention of all disciplines involved in the clash and the Project leader or GP-L on the project. And to organize a meeting or Interactive workshop so that the designers can solve the problem together

**CREAMline**

- d. Project Information, This section defines basic project reference information and determines project milestones (This can be integrated with the CREAMline)
    - a. Project Client:
    - b. Project name:
    - c. Project Location and address:
    - d. Contract type/ delivery method of the information/Model: ( i.e. is facility management included in the contract)
    - e. Brief project description: (spatial requirements, program, number of facilities, size et.)
    - f. Additional project information: (unique BIM project characteristics and requirements)
    - g. BIM milestones:
- Example:

Project phase/milestone	Estimated start date	Estimated completion date	Project stakeholders involved
Preliminary planning			
Design phase			
Construction phase			

- e. Electronic communication procedures:  
 (Note: File, naming and folder structure is discussed in section X)  
 The following document management issues should be resolved and a procedure should be defined for each: Permissions/ access, File locations, FTP Site Location(s), File transfer protocol, File/Folder Maintenance, etc.

Working Documents:

File Location	File structure/Name	File Type	File maintainer	Update	Verification

Verified Documents:

File Location	File structure/Name	File Type	File maintainer	Update	Verification

## **Project Review**

### *Process Improvement*

- Which aspects in the BIM process were not executed competently?
- Where should improvements take place a following BIM process?

### *Archiving*

- Have all standards and families, developed for this project, been saved to be reusable for future projects?
- Are all the families in the Library up to date and of good enough Quality?
- How long should the model remain on the network?
- How long should specific families remain on the network?

### *Individual capacities*

- Did everybody in the team have adequate Revit competences?
- Does any individual need to work on their Revit skills?
- Is anyone becoming a super-user?

## Attachment B- Positions and duties BIM recommendations

### **CAD verantwortlich**

The role of this position is of an executive nature

- Responsible for maintaining and allowing a general BIM network, out-house as well as between different ATP offices.
- Responsible for determining and facilitating, if necessary, any preparations efforts required by the BIM team members, such as educational and/or training programs.
- Responsible for acquiring the necessary human resources and ensuring the required skills and experiences are assigned to the BIM team roles. (shared responsibility with the BIM officer)
- Checking Family uniformity over the whole of ATP.

### **BIM Officer & Manager** (middle level)

The role of this position is of a managerial nature. The duties of the BIM officer consists mostly of overseeing and coordinating the BIM model managers within the different projects and/or design teams.

- The BIM Officer is a Double function, the function of a BIM Manager, as well as keeping an overview of the quality and standards approved by all the BIM Managers. Comparing all of ATP's modeling qualities, and to keep an overview over the organization of the BIM managers at ATP.
- This function should minimize as the BIM capability level increases at ATP, but is a necessary function during the early phases of BIM implementation.

*Recommendation:*

- This function is to only be available during the transitional phase into a BIM maturity. Once a BIM maturity is achieved this double function should find its self-irrelevant and all the BIM managers should adapt to working more closely together on a similar hierarchical working pane.

### **BIM manager** (responsible over the entire model)

The BIM model manager should be an employee with no hidden agenda and should act as a supporting tool within the BIM process for all ATP employees. The BIM modeler manager acts as a support method for the BIM tool, Revit. The BIM model manager should understand and oversee the higher level of abstraction than the Architects, engineers and draftsmen are unable to. The long term characteristics of a BIM Model manager will lean towards more of a model checker than a modeler (draftsman).

*The BIM Manager is responsible for:*

- Transferring modeling content from one party to another
- Validating the level of detail and controls as defined for each project phase
- Validating modeling content during each phase
- Combining or linking multiple models
- Participating in design review and model and model coordination sessions
- Communicating issues back to the internal and external- company teams
- Keeping file naming accurate
- Managing version control
- Properly storing the models in collaborative project management systems
- Overseeing the protocols for version control and managing releases, based on the conventions organized by the Chief BIM officer
- Setting uniform BIM standards (i.e. families).
- Updating the BIM standards
- Responsible for the setup of the physical and knowledge infrastructure required to run the project.
- Responsible for the implementation and use of available standards and classification throughout the design team.
- Responsible for the assignment and monitoring of specific attributes and relations in the model authoring tool consistent with the requirements of the analysis tools.
- Responsible for establishing and monitoring methods for compiling, the analytical data model containing the appropriate abstractions of building geometry. Different



- types of Analyses will require different abstracted models.
- Responsible for making the Uniform set standard for ATP
- Required to have knowledge of how to use the model for Facility management. (This is momentarily not applicable to ATP, but will be in the future)
- Responsible for approving the uniform BIM standards (i.e. families) created by the BIM model manager. (Making sure that these BIM standards are applicable and usable to all in-house disciplines)
- Responsible for providing interoperable capabilities between collaborating disciplines.
- Responsible to retain an overview in the collaboration between the different disciplines, specifically regarding the BIM process or the Model.
- Responsible for acquiring the necessary human resources and ensuring the required skills and experiences are assigned to the BIM team roles. (Shared responsibility with the CAD responsible)
- Responsible for asking, indicating and managing a common set of guidelines and benchmarks for all parties within the BIM team (in coordination with the other ATP offices and CAD verantwortlich).
- Responsible for monitoring that BIM-specific contractual responsibility, rewards and risks are met and awarded accordingly.
- Responsible for checking the work carried out by the BIM model manager
- Responsible for distributing the BIM model managers between the projects at ATP.
- Responsible that the building model is drawn to the uniform set standard for ATP, and that each employee has done so accordingly.
- Their responsibilities should be to make sure that the model should be completed within the ATP working standard. (there is currently not a uniform standard)
  - o Short term: it means doing a lot more work and education colleagues to work to the same level, but this will be changed in the future as more colleagues become more capable of working with Revit.
  - o This does not indicate that the modeler has the responsibility to do all the work; this means that the modeler has the responsibility to make sure that the model is completed according to the ATP working Standard.
- To save a version of each disciplines model when they have completed a phase. After all versions have collected to link the models to create one model saved separately.

*Capabilities should be to:*

- Have a more enhanced knowledge of BIM technologies.
- Have a good network established between the other ATP Offices.
- Have a super user knowledge and understanding of BIM technologies.

**General Project leader (additions)**

- Responsible for linking the knowledge and technology abilities to the need of the owner organization and identify possible support opportunities.
- Knowledge regarding the contract and contractual options regarding BIM.
- Responsible for ensuring that all parties understand the projects product and service specification, as well as the general delivery approach throughout the design team.
- responsible for the general leadership aspects of the BIM effort within the team project namely the strategic, organizational, communicative and managerial attributes of the project organization
- Responsible for selecting the frequency of the exchange of the copy of the models from different disciplines.
- Responsible for negotiating an planning the workflow exchange mechanism for the overall process workflow, as defined by the client, consultant or contracting partners.
- responsible for maintaining the workflow exchange mechanisms and the evolving project data throughout the project life cycle
- Has to know the setup of the physical and knowledge infrastructure required to run the project.

## Attachment B, ATP radar

