Building Ships on Ground

Build 4.0 Project Planning: How shipbuilding principles can increase construction efficiency

Build 4.0 Project Planning is a new way of designing and planning the construction of buildings. Some of the tools and working methods have been adopted from other industries such as shipbuilding. Build 4.0 makes use of modern digital tools, is iterative in nature, and promotes more effective collaboration between professions. Among other things, it can halve the cost of constructing residential buildings.

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Med stöd av forskningsrådet Formas - Smart Built Environment

1. What is Build 4.0 ?

Build 4.0 offers a new way of implementing construction projects. It makes use of digitalization to reduce costs, increase quality and enable more innovative methods. As with other digitalization processes, the primary keys to success are the new working methods and altered roles that are made possible by digital tools. The interplay between new methods and new tools leads to radical improvements, or “disruption”. The new tools can support and automate design, planning, management — even construction, with robots and 3D printers for example.

Tools and working methods have been largely adopted from other industries such as shipbuilding, which means that their usefulness and effects are relatively well-known.

Build 4.0 achieves large effects by attacking the waste of materials and work time which today results from an organization of the construction process which is much too fragmented and handwork-intensive, and where much of the planning and decision-making occurs during ongoing production. Today’s working procedure is also an obstacle to the introduction of automated production with, for example, robots, 3D printers and the fabrication of large complete units in factories.

With digital tools that enable more effective collaboration, more detailed design at an early stage, and more precise planning, total costs and times for construction projects can be reduced by ca. 50%, sometimes more. Introducing new digital tools without accompanying changes in work processes can yield some results, but not the same degree of radical improvement.

It is entirely possible to introduce Build 4.0 in stages, which may be preferable for established companies. But for new enterprises, both in production and as digital startups, there are advantages with a more comprehensive introduction. Build 4.0 is in keeping with Industry 4.0, where the number 4 refers to the fourth of the major development stages: 1) Mechanization and Steam Power, 2) Assembly Line and Electricity, 3) Computers and Automation, 4) Digital Manufacture and Online Products.

This development is occurring internationally in many places — not least in the USA where enormous private resources are being invested in completely new kinds of construction enterprise. One example is Katerra, with a risk capital of circa USD 8.8 billion, which is developing a digitally managed system for the industrial production of housing.

For the Swedish market, Build 4.0 offers the possibility of constructing high-quality housing at remarkably low cost. For companies in the construction industry, early adoption of the new work methods means dramatically increased power to compete, even internationally.

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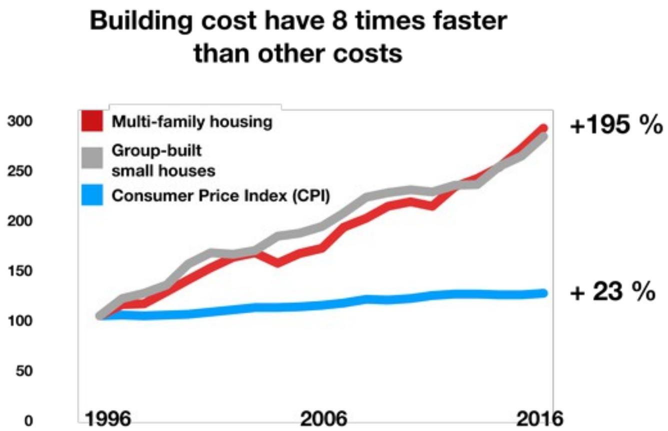
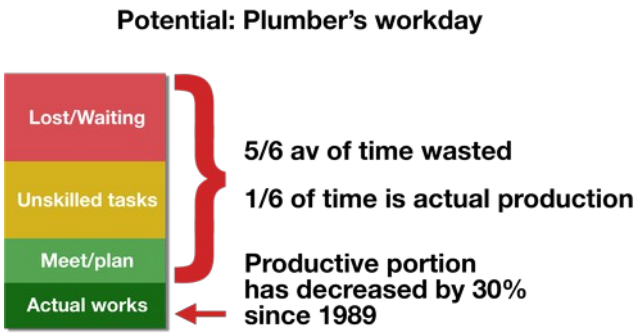
2. The Potential Is Great

Construction costs have increased much faster than other costs in Sweden. That cannot be explained solely by increased land prices or higher quality of new housing. The industry has simply been unable to keep pace with other developments.



Construction costs have increased 8 times faster than other costs (CPI) the past 20 years[1].

A good example of the potential can be seen in the area of HVAC. One time-use survey in the construction of multi-family housing found that roughly one-sixth of plumbers' average workday was used for actual production[2]. The other five-sixths were wasted in waiting, unskilled tasks, meetings and planning. The productive portion has decreased by 30 percent since 1989. Corresponding potential exists in other areas, such as roofing. The same roof could be laid in one-sixth of time by a better prepared work group with good planning[3]. Similar results were shown in planning and architecture.



1/6 of the workday is actual production and has decreased by 30% during the past 20 years.

Thus, there is a great potential for substantial reductions in building costs. Given that in most cases the potential is related to expenditures of time, total construction times would presumably be shorter, as well.

[1] Källa: SCB: pr0501_bpi_med_avdrag2016 (Index omräknat 2006=100
[2] Survery on HVAC installations, 2010, the Swedish Plumping Association
[3] A survey conducted by a major construction firm that wishes to be anonymous in this report

3. What is the problem?

The construction industry has developed from a craft tradition, where each trade has its own special expertise. Architects design buildings, including floor plans and facades. Carpenters form and erect frames. Plumbers are experts in heating, ventilation and sanitation systems, and are exclusively entitled to install them. Electricians lay out and install electrical systems. Painters apply paint and wallpaper. Roofers prepare and lay roofs. In a craft, there is no distinction between designing and making a product.4 Despite the introduction of increasingly advanced construction systems, new tools, and factory manufacture, the craft model largely remains in the allocation of tasks and responsibilities.

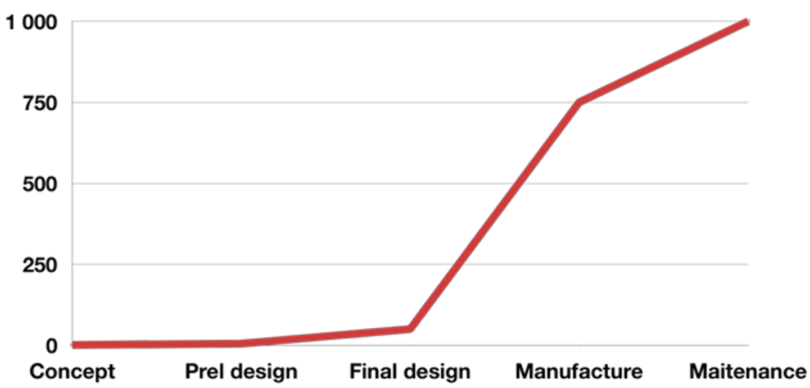
Developer, architect, mason, inspector, wall-maker and other specialists

Buildings are typically far from fully formed at the start of construction. The process is therefore only schematically planned, as follows:

- It is a largely sequential process
- Many decisions are made during the course of construction
- Changes are made and the final design takes place with little knowledge of the consequences for other components or the whole

A hypothetical example that is not at all unrealistic: A plumber must draw a pipe to an extra radiator. For that, a carpenter must make a hole. But first an electrician needs to move a wire to the other side of a wall. A junction box needs to be fetched or purchased. The hole is made. A painter must apply spackle. Then the plumber can measure, cut and install the pipe. The carpenter needs to set up a bracket. The painter can paint. Then the plumber can install the radiator.

This is how low productivity occurs among plumbers. It is a phenomenon that is well-known in manufacturing industries. Changes and decisions made late in a process — especially changes made during production — are extremely costly, as can be seen from the diagram below.



The relative cost of changes and decisions at various stages of a process[4]

[4] Källa: NASA/SP–2015-3709 Human Systems Integration (HSI) Practitioner's Guide

4. Solution: The Principle is Simple

The goal is that decisions on the design, components, systems and planning of a building shall be made entirely within the framework of the Build 4.0 Project planning before the start of construction. The result is an improved process based on the following principles:

- All design and calculation is completed before the start of construction
- For the building to be a high-quality product that can be efficiently constructed, everyone involved must participate and collaborate before the start of construction
- This process is iterative so that various viewpoints, ideas and solutions can be included in the project planning.

This procedure requires and is enabled by integrated digital tools for 3D drawings, construction, calculation and planning. They fulfill what is sometimes called BIM Level 3. The most efficient approach is to test-construct the building, or at least crucial stages of the process, in computers in order to organize and plan the construction process.

Industrial construction — not always large series

Industrial production is sometimes associated with large series, but the two concepts need not be related. An industrial process differs from craft production in that the product and its manufacture are designed and planned before the process begins — whether one or a thousand buildings are to be constructed. As a result, the so-called "temporary factory" in fact becomes an established factory and can benefit from efficient production methods. Important contributions are made by completing major components at workshops, at suppliers and to a greater extent assembling them on the construction site.

5. What can we learn from shipbuilding?

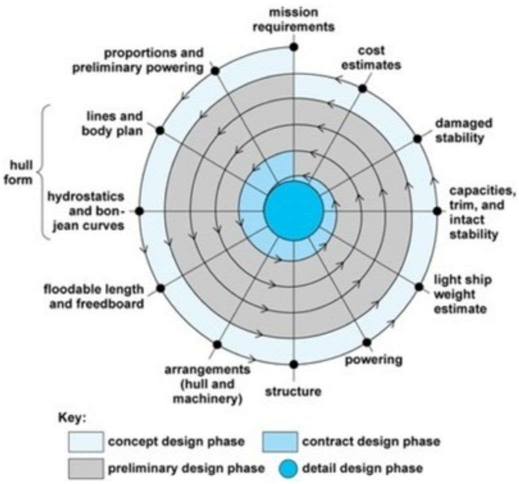
An industry that manufactures complex objects individually is shipbuilding. The construction of cruise ships, in particular, has clear similarities with the construction of buildings. Such ships are produced one at a time and are essentially a sort of holiday residence with accompanying recreation facilities. They also resemble homes in that large portions of them consist of piping, HVAC and electrical systems.

Harmony of the Seas – a city district for 9,100 people

The world's largest cruise ship can be used as a benchmark.

The specifications for Harmony of the Seas are extensive and include [5]:

- 3000 hotel rooms, 2000 with balconies, and cabins for 2800 crew
- 20 restaurants
- Ice rink
- Complete casino
- Large waterpark, including surfing simulator, 4 large pools and 10 hot tubs
- Broadway Theater/3D cinema with 1400 seats
- DreamWorks "Disneyland".
- Shopping mall
- 11 000 artworks
- 20% reduced energy consumption compared with earlier cruise ships



Harmony of the Seas was built in three years, from the initial order to the first cruise with passengers. Most of the design was carried out during that time. It was built in France at a partly state-owned shipyard and cost ca. 1.1 billion euros.

The rooms alone would take 1/3 of the budget if built "on ground"

In comparison, a standard hotel room in Sweden costs slightly over one hundred thousand euros to build[6]. Thus, built on land, the ship's rooms alone would consume one-third of its entire budget. The key to the efficient production is that the ship is designed completely in detail, and that the building process is also planned in detail. This done in a collaborative, iterative process that has been standard in shipbuilding since the 1950s. This makes it possible for much of the construction to take place "off-site" and be efficiently assembled. Essentially no decisions are made concerning design, parts or the manufacturing process after the start of construction.

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[5] Sources: Wikipedia & https://www.icruise.com/c/cabin-list.php?WMPHShipCode=532 Accessed 180415

[6] Case from Jönköping: https://www.svenskbyggtidning.se/2018/02/09/skanska-saljer-hotellbyggnad-jonkoping-cirka-430-miljoner/ Accessed 181003

6. The Solution: Build 4.0 Project Planning

Traditional Project Planning

Traditionally, project planning is divided into phases, each producing a set of documents, typically:

- Program document
- Schematic design
- Detailed design and structural engineering
- Construction document
- Production document

Typically, these documents are produced sequentially by various individuals performing different roles. The importance of the architect's role is substantially diminished after the schematic design is completed. Often, the construction firm first becomes involved in connection with the detailed design or construction document. In theory, it is possible to go back and change previous documents if some idea, problem, or suggestion for improvement arises. In practice, however, that is unusual. The documents are usually not complete, in the sense that they precisely describe what is to be built, how it is to be built, and everything that will be included. Consequently, many specific solutions are devised during the course of construction. There is even an expression for that: "solved on site". T**he consequences include delays, low productivity and reduced quality.** In today's construction process, many decisions are made in an order and at timepoints that are not conducive to efficient product development and construction.

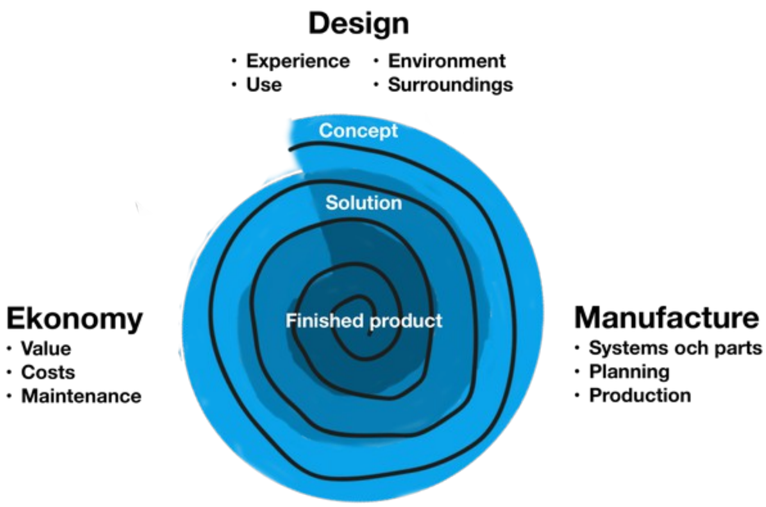
Build 4.0 Project Planning

In a Build 4.0 project planning, these "documents" are not distinct from each other, but are various sections of data in a common digital platform which also includes cost projections and production planning. Work on different parts and systems occurs in parallel. For example, some systems may be designed early. This might include, for example, digital systems in a building where the developer wants certain types of solution — such as digital weak grids and other IoT systems — where several different electrical systems are replaced by a common digital network. Such a network can be used to regulate heating, access etc. Installation is different, takes up less space and requires different skills. In order to benefit from these features, the "detailed design document" part of the project planning should be developed at an early stage.

Construction and production documents are also developed as parts of a project planning. This means that discoveries and insights can be dealt with and made useful more quickly and at lower cost than if those documents are developed at the start of construction. Documents required by law such as building permits, for example, can be exported at suitable junctures. The iterative, digitally supported process enables decisions to be made when most suitable, and to study, manage and benefit from the consequences of those decisions — as long as it occurs before the start of construction. Also, given that the construction process is specified in detail, the entire construction can be carefully planned with regard to purchasing, logistics and the preparation of work phases well in advance.

Iterative design

Iteration means to repeat a process two or more times. But it is not a simple repetition: With iterations, the results of previous instances are included with each new one. The advantages of an iterative design are that it is successively refined, and that the same competence and specialties take part every time. Consequently, ideas and problems that are discovered by everyone involved can be dealt with and influence the entire product and production process, before decisions and investments are made. One might, for example, discover a better way to build a boiler room so that its size is reduced. The space thus saved can be used for something else or be eliminated. Other examples might be found in ventilation systems, where space requirements for shafts vary depending on the solution.



An iterative process also increases learning and understanding among the occupations involved. In addition, the cost of testing various solutions and ideas is much lower in early stages, which can increase the degree of innovation. Individuals can use the work of others to develop and enhance their own contributions. While performing iterations, it may be necessary to reconsider ideas and results if they do not function or contribute adequately to the project as a whole.

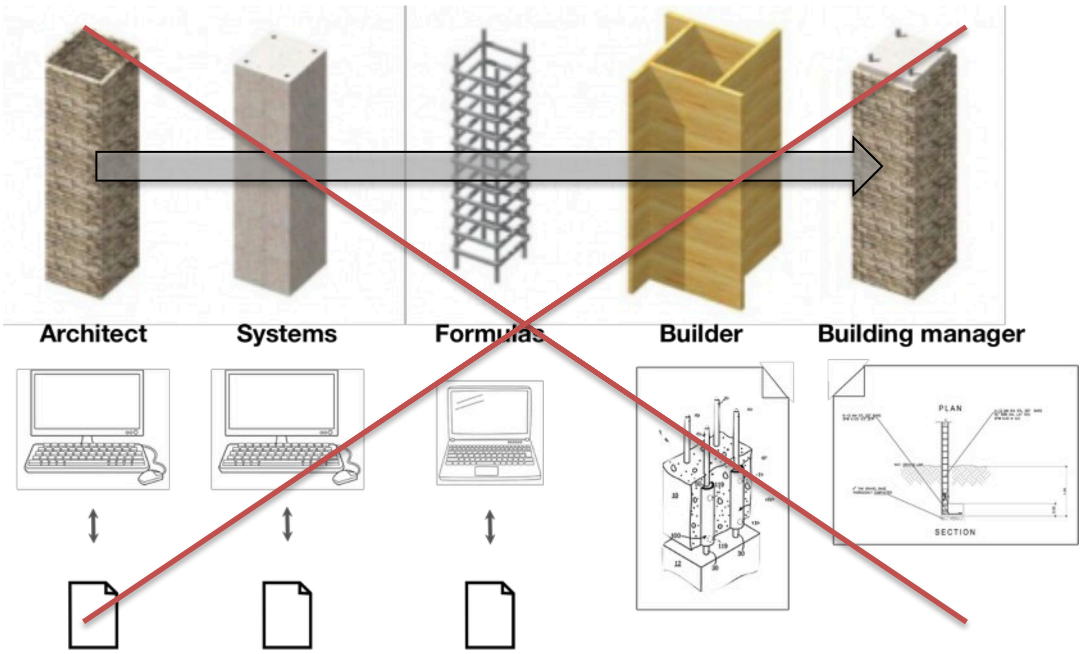
The development of a product always includes two outcomes: the product's design and the production process. Producing these two results is necessarily iterative and they must be coordinated with each other. Information regarding, for example, production costs is important at the design stage. But until there is a design proposal, there is no basis for calculating production costs. The same applies to time schedules for various components and for the building as a whole

To summarize: Iterative design in this context can be described as:
developing, adjusting and refining a building in order to maximize its value in relation to experience, use, economy, environment and surroundings, in an exploratory learning process, until a satisfactory design and production process has been achieved — before the start of production.

Today, digital tools can support such a process across organizational boundaries and be effective even for individual projects and completely unique buildings.

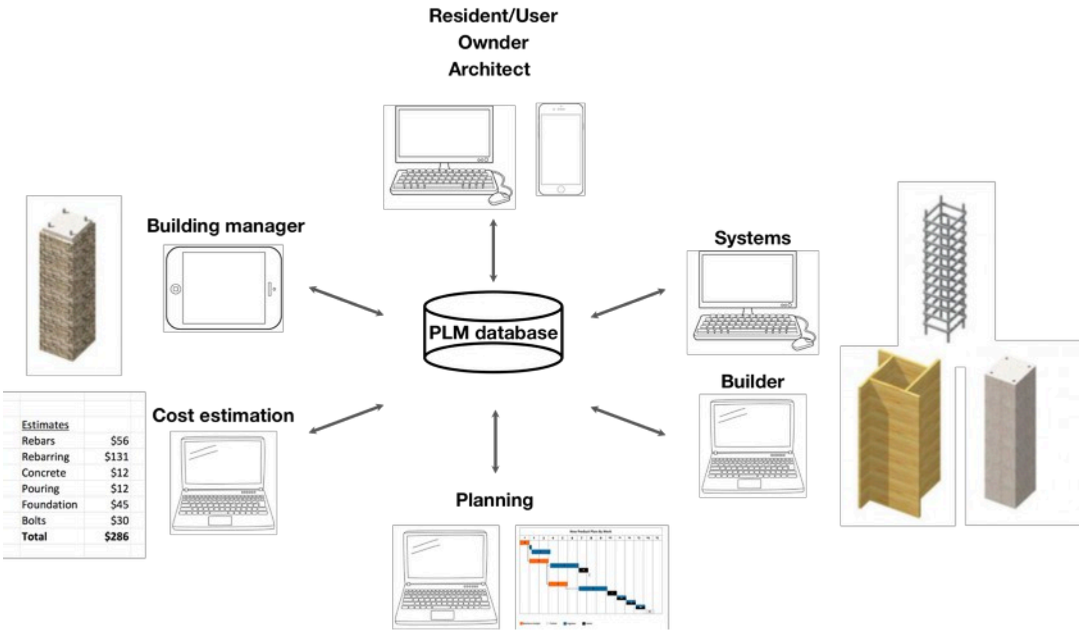
7. Digital Support

Today's sequential, unidirectional workflow from stage to stage, with few roles in each stage, has made it possible to work with digital support with a low level of integration and co-ordination. Computer files are exported from one tool and loaded into another. To a great extent, each role and field of expertise exists as a separate "island" of information. This is not conducive to collaboration and iteration, because it is difficult and time-consuming to export and then bring files together again. Due to the lack of integration among tools, much work needs to be repeated when computer data changes.



Typical IT platform today. Different actors use different computer programs with various file formats. Printouts are very important. This reinforces the sequential workflow and hinders both collaboration and iteration.

Build 4.0 strives for a system environment in which various tools work in real time, live, using a common database. Time, work and the cost of changes can be dramatically reduced. There is also a reduced risk of error caused by different individuals working with different versions of drawings and other documents. The database is also used on the building site. It is updated with what is actually produced, for example serial numbers, service intervals, guarantee times and conditions regarding installed parts. Changes are of course made if necessary. As a result, those who manage and maintain the finished building have a complete so-called digital twin, with all data and other information in one place. In this way, such a database becomes an exact and highly developed as-built document Such a system is often called Product Lifecycle Modeling (PLM) and is a generic term within the manufacturing industry for databases which gather data on a product for its entire lifecycle.

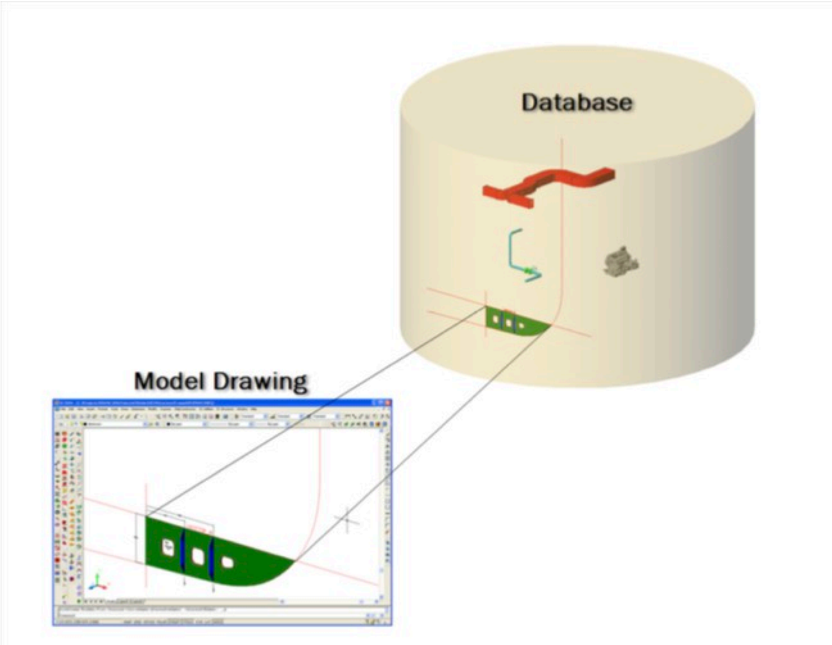


In a Build 4.0 project, all participants work in real time using the same database. A complete 3D model, all constituent parts, formulas, calculations and plans are related to each other and constitute working material, contracts and agreements, bids and documentation.

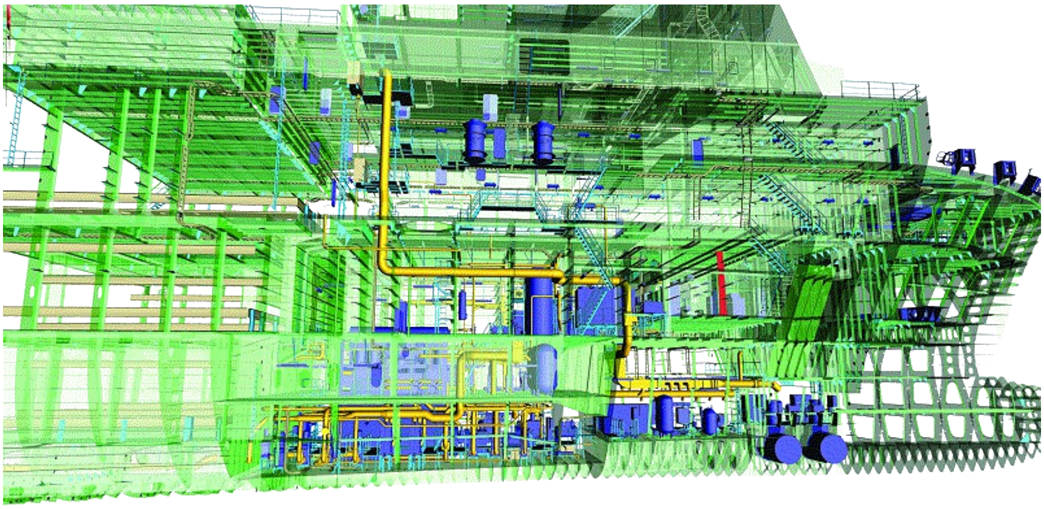
Examples from shipbuilding

These principles can be studied in systems for the design of ships[7]. Branch-specific IT systems that are based on shared databases rather than on files, are often used in the shipbuilding industry. Such a database can contain details on the 3-4 million parts of a large ship. Many of the digital tools are automatic or operated parametrically, where various calculations and controls are carried out automatically, based on the data of a 3D model and other sources such as pricelists or algorithms for stress analysis. For example, the costs of metal plates are estimated automatically by a digital tool which calculates the amount of plating, the lengths of all cutouts, and the number of times the plates are lifted/moved. Preliminary calculations are done parametrically, i.e. based on previous projects and key figures. When the actual costs become known, e.g. from bids, they replace the parametric estimates as they are received. These tools can also automatically optimize how many parts can be cut out of a given plate in order to minimize metal waste and production time, taking into account the order in which the various parts are needed. A precondition is that the outlines are drawn with adequate precision, e.g. to 1 mm. All parts of a building can be drawn in this way. That results in a dramatic increase in the quantity of data, making it inefficient or even impossible to work with single files. But PLM systems for complicated products in projects spread all over the Earth are well-proven. Nor are there any direct advantages to working with single files; in fact, that involves a risk of problems with different and outdated versions.

[7] These examples are provided by ShipConstructor, Aveva and AutoDesk



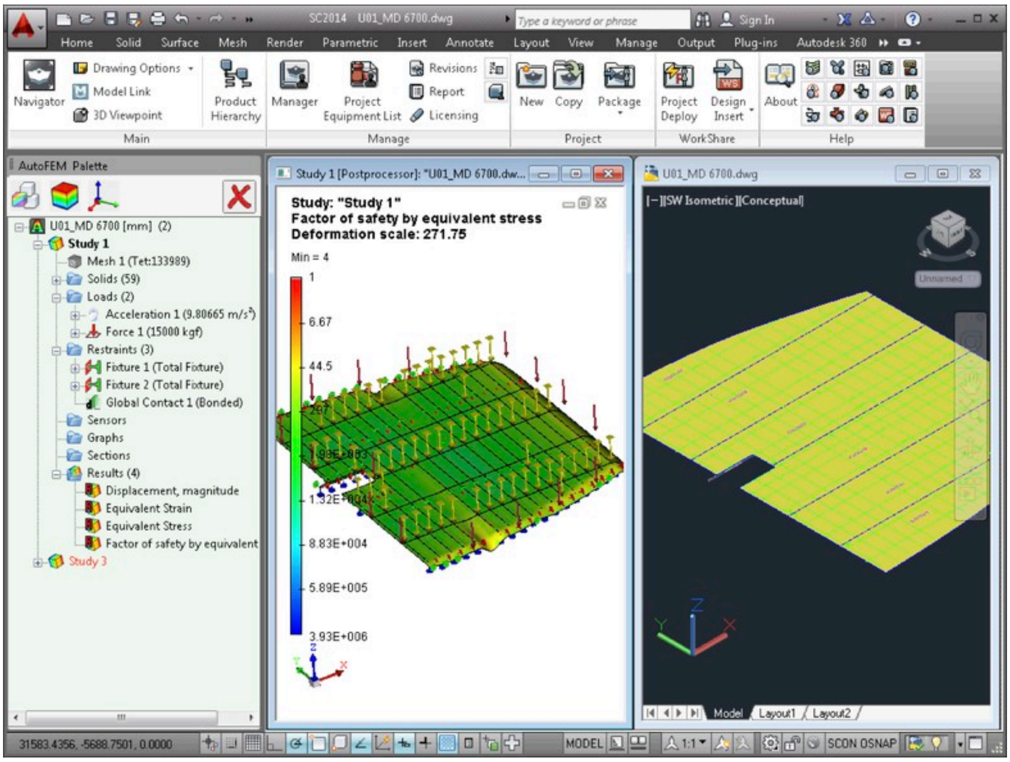
CAD systems work with subsets of data instead of large single files



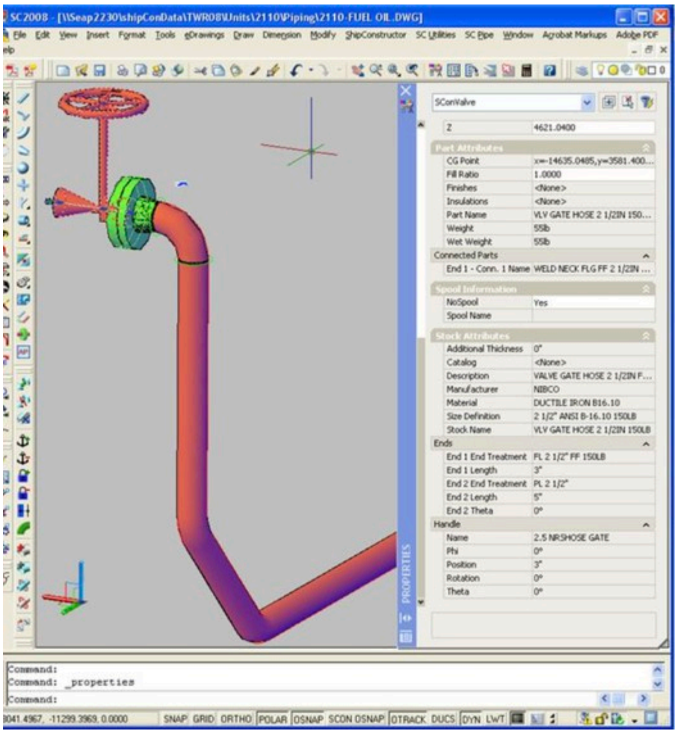
This enables complete 3D models with all constituent parts, even for an extremely complicated product.

Digital tools to increase process efficiency

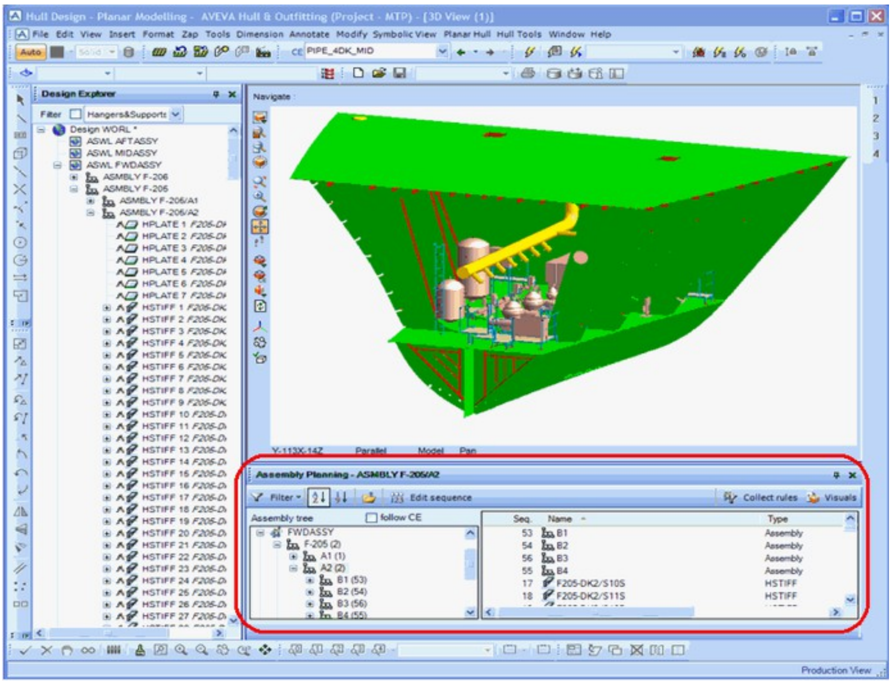
In addition to keeping track of all data and increasing the level of detail, there are digital tools that can support more effective co-operation, a more effective product, a more efficient production process, and even automate some steps.



Special tools, such as automatic stress analysis, can work in real time with all data. Also costs can be calculated automatically.



Subsystems such as ventilation can be designed with special tools, while details on all constituent parts are stored in a PLM system. 3D objects are linked to product data, formulas and installation descriptions

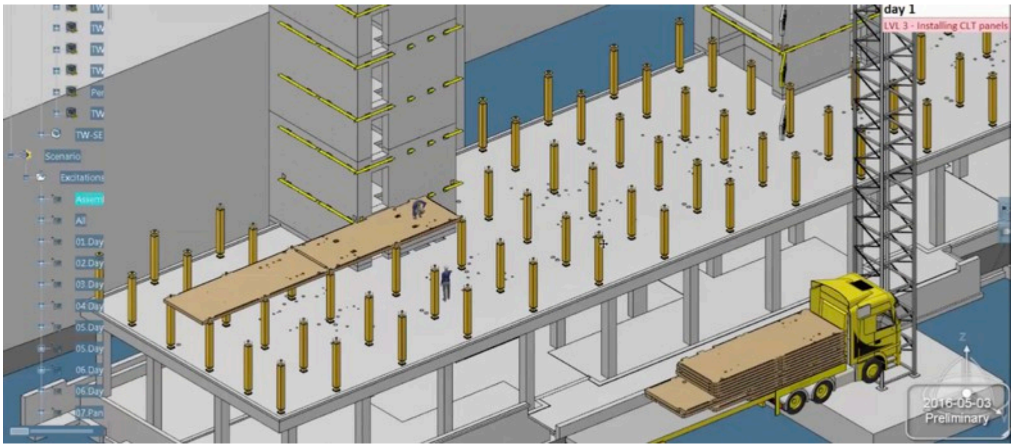


Production planning, e.g. assembly sequences, and detailed time and activity plans are also done with PLM databases

Examples from the construction industry

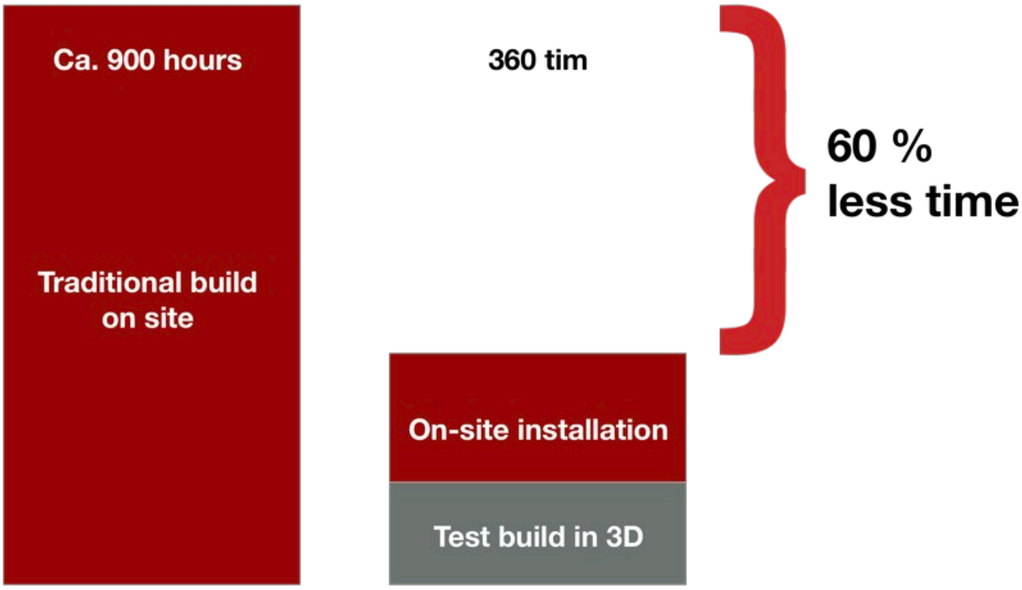
To date, 3D modelling in the construction industry has been focused on the early stages, for example in producing realistic rendered images. Companies such as BIMobject collect and offer 3D models of a great many products directly in CAD systems. But some experiments have been done with methods that are more like those of Build 4.0 Project Planning. One example is the digital test project depicted below. An animated film of the best assembly sequence was produced and then posted on YouTube, making it possible for everyone involved to quickly and easily see how it was done.

A plumber and a 3D specialist test build a boiler room, ensuring that everything can be installed, the quickest procedure can be chosen, and that all parts are included. Image from CadMakers video.



Simulation of framework raising, including crane placement and movements, lorry flow, and the exact sequence for workers, stages and parts. Image from CadMakers video.

Both tests yielded good results. The framework raising took four months less than originally planned, and the time for building the boiler room was cut in half.



The effect of digitally test-building heating, ventilation and sanitation. Total time savings of ca. 60%. (CadMakers).

As noted above, the greatest benefits from these sorts of digital tool are produced when they are used in an efficient process such as Build 4.0 Project Planning.

8. BIM, PLM, BLM?

BIM stands for Building Information Modeling and is a collective term in the construction industry for data modelling of buildings. The concept of BIM is today applied in many contexts, which can lead to some confusion.9 PLM stands for Product Lifecycle and is a collective term in the manufacturing industry for data modelling of a product's entire life cycle. Common to these two concepts is that they focus on data models and file formats.

Unfortunately, even the most advanced BIM system can be used inefficiently, for example in a sequential process with printed drawings as working material.

Therefore, the primary focus of Build 4.0 is to change the process and working method; that is how real change is achieved.

6D BIM level 3?

With the so-called BIM staircase[8], a project that uses unrelated 2D drawings can under certain conditions be regarded as a BIM project. On the BIM staircase a Build 4.0 project planning is on the highest step, level 3. According to the Swedish Transport Administration[9], BIM can also have more dimensions. 3D means that a completed building's 3-dimensional geometry can be specified with a 3D CAD system.

With a 4D BIM system the construction time plan, i.e. its sequence, is included. With 5D BIM, costs are included, as well. Some actors e.g. Dassault, also speak of BIM 6D where the maintenance is included. According to Dassault, the result is BLM, Building Lifecycle Management, rather than BIM[10]. That requires IT support which, without going into all the details, should properly be classified as ”6D BIM, Level 3” — which is closer to the concept of PLM than what today is called BIM.

The need for a practical standard

It would be desirable to create more practical definitions that include roles and processes. Software should then be based on schemas for interoperable data rather than, as today, on file formats. It would also be desirable if this could be done on an international basis, or at least jointly within the European Union, in order to reduce costs for systems and platforms, and contribute to internationalization of the industry.

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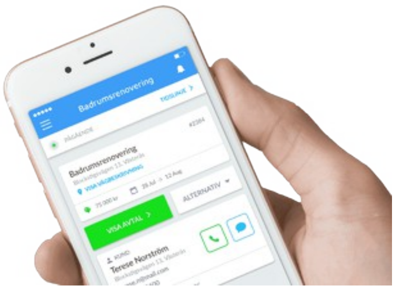
[8] www.bimalliance.se/library/2607/gemensamma_kravnivaer_pa_bim_hos_statliga_aktorer.pdf

[9]www.trafikverket.se/for-dig-i-branschen/teknik/ny-teknik-i-transportsystemet/informationsmodellering-bim/

[10] blogs.3ds.com/perspectives/what-is-bim-level-3/

9. Global Trends in the Construction industry

Globally, there is growing interest in developing the construction industry in three overlapping areas. Build 4.0 Project planning is well in keeping with that trend and in several cases it, or a corresponding working procedure, is a precondition.



Digital tools – New actors such as BuildSafe, BIMObject and Dalux offer process-oriented tools which make individual processes more effficient. Established suppliers such as ProCore, Autodesk and Trimble in the USA integrate their individual products with a more common platform. Suppliers in other manufacturing industries such as Dassault, Siemens and Aveva adapt their platforms to the construction industry. Common to all are the goal of more integrated processes and the shifting of decision-making to earlier stages.

Build 4.0 can benefit from these tools, with effects that are substantially greater than by only digitalizing of today's processes.

Automated production and robots – Robots are being introduced in many areas. In Australia and the USA there are well-developed bricklaying robots. In Japan tests are underway with welding robots that build the frames of multi-floor buildings automatically on site. In China, Russia, The Netherlands and France there are 3D printers for construction with concrete. Common to all of these processes is that they require 3D models and more precise drawings than those used today. Tolerances of 1 mm are most common. Planning must also consider robots' mobility and material supplies, which are new concerns for the construction industry. All this requires the production of 3D models, material supply lists and time schedules before the start of construction.

Build 4.0 working methods are well-suited to such requirements.

Modular production – A new generation of modular producers is emerging. They use advanced modular systems that enable efficient production of a large variety of buildings. Two Swedish examples are Part AB and Lindbäcks. Recently launched Sizes Works is building a factory for completely automated production of modules. To benefit from modular construction, it is necessary to alter the design process. Architects and consultants must understand and stay within the framework of the modular system. Modular production requires that buildings are designed in detail prior to the start of production. In many cases, very high precision is required. Fullstack Modular, which erects high-rise buildings in New York, points out that a precision of 1 mm can result in a deviation of up to 3.2 cm at the 32nd floor which, for example, means that elevators may not fit their tracks. An integrated digital platform can automatically design frames and check deviations.

The Build 4.0 process supports modular production and manages frameworks constructively, so that buildings can be innovative and not mere repetitions.

10. Test – Falköping

A first practical test of Build 4.0 Project planning in Sweden began in the autumn of 2018 when Hyresbostäder i Falköping, the municipal housing company in the town of Falköping, launched a project named Diamanten. It consists of a parking garage and two 8-floor tower blocks providing a total of 75 flats and commercial area for shops.

Hyresbostäder wanted to test the ability of Build 4.0 Project planning to reduce costs and raise quality. Concerning quality, the primary objective was to ensure that the buildings would be relatively easy to maintain — for example, that inspection and maintenance of heating, ventilation and sanitation facilities can be done quickly, perhaps even from stairwells, in order to avoid the need to enter flats. The principle of producing final drawings before the start of construction was applied to the procurement process as follows:

AFD.242…. All project planning shall be in 3D format and coordinated with each other. Checks for possible conflicts between all occupations involved shall be carried out and reported. Conflict checks shall be conducted with computer programs designated for that purpose, and the purchaser shall have the opportunity to be present.

All drawings shall be produced and reported in accordance with 'Bygghandlingar 90'.

All documents shall be sufficiently detailed to provide a complete description of the entire process and an adequate basis for production.

Documents and other relevant information shall be supplied according to a delivery schedule approved by the purchaser.

AFD.42, start time.

The builder is entitled to begin the physical work after the complete, approved construction documents have been delivered and a start time has been decided upon. The estimated start time of this project is 2019-09-01; work on the foundations may begin earlier.

Build 4.0's collaboration with Hyresbostäder has continued during the spring of 2019 and will be reviewed in subsequent reports.

11. Obstacles to Build 4.0

A number of business obstacles to innovation and digitalization affect Build 4.0. They are primarily business models, roles and areas of responsibility which need to be developed in order to support efficient construction.

Compensation per hour — a major culprit

In many parts of the construction industry, especially in the early stages of a project, compensation is based on hours worked. This results in a lack of incentive for improving efficiency. Why invest large sums if it leads to reduced income? This problem is not limited to the construction industry, it is generally observed that industries with hourly compensation as the predominant model have low levels of innovation.

Standard costs

The use of a common basis for costs and the lack of post project cost calculations[11] are big obstacles to innovation and development. They also lead to limited competition. Local traditions, agreements and regulations can also result, for example, in heavy costs for the development of systems and products for which the only market is Sweden.

The lack of vendor-neutral digital platforms

Especially with purchasing in accordance with the Swedish law on public procurement, it is difficult to require specific digital platforms. There is a need for such platforms which are vendor neutral. Today, the only vendor-neutral data format that is generally available is IFC, which is a file format not compatible with Build 4.0 Project planning.

Responsibility issues

There are several obstacles that are related to issues of responsibility:

- **Overall responsibility.** Which actor shall be responsible for overall planning? How is that work to be compensated? How shall the agreement be formulated? Who shall own the models, data and measuring systems? How is the automated design and construction to be handled?
- **Allocation of partial responsibility.** If for example one plumbing company conducts a simulation but another is hired to perform the actual installation, which company is responsible for the time, cost and quality of the final result? Who receives the profit for automation of construction etc?
- **Laws on public procurement** (”LoU”). Today, it is perceived that LoU hinders the involvement of plumbers, for example, at an early stage of planning, as is done by CadMakers in Vancouver, Canada. Those involved before procurement may be excluded from bidding.
- **Choice of construction system.** Today, many subcontractors also supply systems and materials. This calls for the development of a new business model which enables such actors to benefit economically from lowering total cost.
- **Circular economy.** How are data, products and results recycled in a digital process? Which issues concerning ownership, legislation and responsibility are involved?

[11] The Next Generation Administration - hur kommer vi att arbeta i framtiden? Vi frågade ledare i bygg- & fastighetsbolag, Vitec, 2015

12. The Next Step

During 2019 – 2020, Build 4.0 will continue development along two main tracks, with support from Smart Built Environment and Sweden's National Board of Housing, Building and Planning.

Tests in other industries, especially shipbuilding

Collaboration with companies that work with ship design and related digital platforms. Tests of working methods and tools will be conducted, as closely as possible to project planning and actual production. [alt. actual project planning and production.]

Development of business models, procurement and responsibilities

Together with other actors, we will explore the possibilities available with today's general praxis, business models and legislation — both to enable Build 4.0 Project Planning and create incentives to conduct them. This will include exploring possibilities for certification to ensure quality, among other things. In those instances where current praxis and legislation pose obstacles, we intend to develop proposals for appropriate changes.

Collaboration and dissemination

The collaboration with Svensk Byggtjänst and NordBygg – Nordic ConTech to support the growth of a powerful "scene" in Sweden for startups and technology in the construction industry will continue. Also, the Build 4.0 concept will be disseminated internationally to promote larger investments from software vendors and companies within the construction space.

Work should of course continue until a trend breakthrough in construction costs is evident

13. Participants in Build 4.0

Project committe

Petter Jurdell, SABO
Jonas Högset, SABO
Joakim Örn, Veidekke
Markus Tunlid, Veidekke
Petra Åhlund, ÖrebroBostäder
Jan Dahlkvist, ÖrebroBostäder
Robert Larsson, Cementa
Rehan Chaudry, Technia
Tomas Uzdanavicius, Forsen
Edward Klompmaker, Forsen
Lars Albinsson, Maestro Design & Management (Project Manager)

Thematic workshops

171003 - Digital building prototypes, including VR & 3D
171024 - IoT and digital technology in buildings
171114 - Digital simulation of working stages
for planning and increasing efficiency
171205 - Digital tools for work roles on building sites
180116 - Manufacturing] Technology: 3D printers, robots and automated vehicles
180313 - Review of finding and proposals on new processes

Presentationer

2017-01-25	Veidekke; client day, 300 attendees
2017-02-02	Cementa; client day, 320 attendees
2017-03-09	Byggnads, builder meeting, 20 attendees
2017-05-09	Geoforum/BIM alliance; conference, ca. 100 attendees
2017-06-13	Svensk Byggtjänst; board & mgt. meeting, ca. 25 attendees
2017-07-03	SABO; seminar on Gotland with Swedish Minister of Housing, ca. 70 attendees
2017-07-03	Veidekke; ”WeMe Day”, ca. 150 attendees
2017-07-04	Bonava; Gotland, ca. 20 attendees
2018-01-07	NextAge; client seminar, ca. 80 attendees
2018-03-08	Byggmästardagen; Kalmar, ca. 200 attendees
2018-03-16	BuildSafe; semar, ca. 30 attendees
2018-04-10	NordBygg Mässan; 4 seminars & booth, 200-400 attendees
2018-04-20	BIM Alliance; seminar, ca. 150 attendees
2018-05-31	SABO Day; Skövde, ca. 300 attendees
2018-07-02	Byggtjänst; seminar on Gotland with Minister for Enterprise and Energy, ca. 100 attendees
2018-07-03	Iamhome;, panel on on Gotland, ca. 70 attendees
2018-10-02	Smart built Environment; presentation, ca. 70 attendees
2018-10-04	Göteborsboständer; presentation, ca. 30 attendees
2018-11-13	Nordic ConTech; panels & exhibition, ca. 200 attendees
2018-11-22	Skanska; management training, 5 attendees

Media

2017-03-21	Unionen, article
2018-02-23	Plåt&Vent magasinet, article
2018-03-22	AllAgeHub, article
2018-03-23	FastighetsNytt, article
2018-03-27	BuildingSupply, article
2018-04-09	ByggIndustrin, interview
2018-04-10	Byggvärlden, article
2018-04-12	SR - Ekot, feature
2018-04-12	Byggvärlden, article
2018-04-18	Byggaren, article
2018-04-18	Byggindustrin, editorial
2018-05-15	Svensk byggindustri, interview
2018-05-30	Abax, article
2018-08-01	Telia, article
2018-11-19	Samhällsbyggaren, article
2018-11-20	Målarnas Facktidning, article
2018-11-22	Eletrikern, article
2018-12-07	ÖrebroNyheter, article
2018-12-11	Hem & Hyra, article
2018-12-13	Hela Kedjan, podcast
2019-01-09	VästgötaBladet, article
2019-01-11	ByggNyheter, article

Information sources

Kai Wartiainen	A+D	Professor, Architect
Albert Bengtsson	Apple	Business Development Manager
Mats Johansson	Assemblin	CEO
Klaus Nielsen	AVEA	Ship Design Specialist
Lotta Niland	Besqab	Regional Director
Olle Samuelsson	BIM Alliance	CEO
Christian Green	Bluebeam	CEO
Jyrki Samela	BoldArc	Business Developer
Tobias Fröberg	BoldArc	CEO
Ylva Gunterberg	Bonava	Chief Designer
Mathias Farnebo	Brunkeberg	
Andreas Söderberg	Build R	CEO
Rasmus Petterson	Build R	
Leo Sydow	BuildSafe	CEO
Victor Broberg	BuildSafe	
Daniel Dahlström	Byggtjänst	ConTech
Erik Kalmaru	Byggtjänst	Head of Marketing
Jan-Olov Edgar	Byggtjänst	Senior Advisor BIM
Urban Månsson	Byggtjänst	CEO
Javier Glatt	CadMakers	Co-Founder & CEO
Ronny Andersson	Cementa	Head of Research
Göran Thuiin	Cisco	Sales Manager
Adam Shwartz	Cornell Tech NY	Director, Jacobs Technion-Cornell Institute
Arnaud Sahuguet	Cornell Tech NY	Tech Lab
John Stokoe	Dassault Systems	Head of Strategic
Patrick Mays	Dassault Systems	Vice President Strategy
Stefan Engeseth	Detective Marketing	CEO
Christopher Granfelt	Epicenter/SIME	
Ingmar Paulsson	ESF	Program Head
Claes Kalderén	Feathersome	
Cajsa Lindgårdh	Forsen Project	Head of Marketing
Anders Edwall	Forsen Projekt	Affärsenhetschef, Bostad & Care
Johan Berg	Forsen Projekt	Projektchef
Jörgen Hultmark	Forsen Projekt	CEO
Åsa Brantberger	Forsen Projekt	Project Leader
Jed Klebanow	Fullstack Modular	COO
Carolina Björklund	Företagsakademin	CEO
Nicklas Lundberg	Google	VP Policy EMEA
Erkki Hanhirova	Havator	CEO
Jonas Deibe	Hiot Labs	CEO
Sebastian Karlsson	HomeMaker	CEO
Anders Johansson	Hyresbostäder i Falköping	CEO
Peter Jormeus	Hyresbostäder i Falköping	Project Leader
Thomas Randes	IPQ innovationsjuridik	CEO
Eva Schelin	IQ Samhällsbyggnad	CEO
Rikard Espling	KTH/KRESP	
Christer Larsson	Malmö City	Urban Director
Katja Lankinen	Meyer Shipyards	Naval Architect
Anders Eklund	Myloc	Affärsområde Myloc Construction
Staffan Ström	Nacka Municipality	Rector, Adult Education
Fredrik Anheim	NCC	Business Manager Stockholm
Jan Byfors	NCC	CTO

Peter Wågström	NCC	CEO
Stephan Boucher	New York City	Project Manager, Housing
Tobias Degsell	Nobel Museum	Curator
Thomas Wildig	Projekt Grön Bostad	
Mikael Damberg	Swedish Government	Industry Minister
Peter Eriksson	Swedish Government	Minister of Housing
Petter Jurdell	SABO	Head of Property Development
Amin Omrani	Serendipity	CEO
Nick Danese	ShipConstructor	Sales Executive
Nick Danese	ShipConstructor	
Carina Ståhl	Sizes Works	CEO
Niklas Andersson	Sizes Works	Board Chairman
Tiina Koppinen	Skanska Finland	Project Manager – Xchange
Lotta Wibeck	Skanska Sweden	
Linda Nyström	Sliperiet/Umeå Univ.	Leader, Project X
Marlene Johanson	Sliperiet /Umeå Univ.	Head
Mocki Hägg	Solna Municipality	Project Leader
Natalia Gura	Solna Municipality	Project Leader
Katarina Nylander	Spotscale	CEO
Martin Fischer	Stanford University	Professor/VDC
Mike Williams	Stanford University	Executive Director/PPI
Magnus Höij	STD-företagen	CEO
Micael Ekberg	Studio Ekberg	Architect
Tobias Olsson	Sveriges Arkitekter	CEO
Henrik Edholm	TechniaTranscat	Affärschef
Jonas Gejer	TechniaTranscat	CEO
Rehan Chaudry	TechniaTranscat	Business Developer
Cecilia Holmström	Tengbom	Strategic Housing Advisor
Johanna Frelin	Tengbom	CEO
Linda Camara	Tengbom	Kontorschef, Kalmar
Soon Hammarström	Tengbom	Head of Arch.Tech. & Future
Rolf Lundgren	Swed. Transport Admin.	Head of Research
Anders Thulin	Triton	Partner
Sussanne Rudestam	Träbyggnadskansliet	CEO
Emile Hamon	Veidekke	
Jimmy Bengtsson	Veidekke	CEO
Joakim Örn	Veidekke	
Lennart Weiss	Veidekke	Commercial Director
Malin Hart Randes	Veidekke	Head of Marketing & Sales
Markus Tunlid	Veidekke	
Terje Håkansson	Veidekke	
Greg Dingizian	Victoria Park	Founder
Fredrik Bergström	WSP	Head of Analysis & Strategy Section
Lars Elner	ÅF Consult	Consultant
Tobias Davidsson	ÅF Consult	Consultant

Building Ships on Ground

Build 4.0 Project planning: How shipbuilding principles can increase efficiency in construction

Build 4.0 Project planning is a new way of designing and planning the construction of buildings. Some of the tools and working methods have been adopted from other industries as shipbuilding. Build 4.0 makes use of modern digital tools, is iterative in nature, and promotes more effective collaboration between professions. Among other things, it can halve the cost of constructing residential buildings.

Med stöd av forskningsrådet Formas - Smart Built Environment