Creating Information Spaces
MAS Digitales Bauen FHNW
Studienarbeit
extended abstract

Daniel Riekert, F.Hoffmann LaRoche AG, Basel, daniel.riekert@roche.com

Bruno Ruch, info CAD, Allschwil, bruno.ruch@infocad-hlk.ch

Summary. Digitization of Engineering and Building businesses requires not only digital systems for a digital work environment and the according workflows but just as much an integrated approach towards data management. This paper introduces a new thinking and concept to process and manage data in a digital (lean) environment. Focusing on Integrated Project Delivery, we propose our concept of Information Spaces, as a new approach of integrated data management. Lean and network principles are considered from the beginning on of conception. A Pilot demonstrates the principle feasibility of the new method.

1. Introduction

Our Vision is that in the future practically all business activities will take place in *integrated virtual information/data environments*, in which information and data are exchanged automatically, reliably and safe in real time. To achieve this, we imagine *Information Spaces*, which are open to any kind of information, process the connection between incoming data and usage software and are freely scalable. Data and data processing is available anytime, dashboards provide live information on data usage.

Our vision has business potential for Real Estate Management, Project Management, Construction industry and beyond. We also see a business opportunity in providing services to bridge the gap between established environments and digital usage.

In this work we develop a concept for Information Spaces and test the basic concept on its feasibility.

2. Information Spaces

Our Vision for buildings is that in near future they will be designed, built and operated completely in a digital environment. Before anything is built, it will be made available as virtual model to enable and support simulations, optimizations and pre-calculation of different scenarios. These models will later be complemented with ‘as-built’ data, thus providing identical virtual models to the physical building. With these virtual models:

- Operations can be optimized (preventive maintenance, minimum energy consumption, workplace rearrangement and moving simulation and optimization)
- Smart buildings enabled (operations data is collected and simultaneously combined with building information, depending on the degree in which AI (Artificial Intelligence) is integrated, operations of the building can be more or less automated)
- Precise information allows to eliminate waste.

We see these virtual models as ‘Information Spaces’ (InS). Vast amounts of information/data are generated during design, engineering and construction of a building. These combined with the operational information/data are available in the InS of this building. But we are currently constrained both on the availability and usability of this information. The value generation out of usage of available information is currently in the low one-digit percentage area!

Currently there is broad agreement in the VDC community, that BIM (Building Information Modeling) is the right method to create virtual models and with that manage the available information of a building [4]. Both authors were actively involved in establishing true BIM environments the past years. Based on the BIM concepts we developed and the experiences made in their implementation, we have come to a good understanding of BIM, of its capabilities but also of its limitations.

Differentiation between BIM and Information Spaces	
BIM (Building Information Modeling)	Information spaces
Fixed system constellation	Open system
‘closed circuit’ software structure	Open platform, no structure
Complex and complicated system	Complex but not complicated platform
Interconnectivity established by User	Interconnectivity established by IT
rigid interfaces	flexible and agile interfaces
Push principles	Pull principles
Proprietary data storage	Cloud data storage

Tab.1: Some principle differences between BIM and Information Spaces.

A big disadvantage of BIM is that it is both complicated and complex for the User. If the chosen option is ‘Open BIM’, then the Users will struggle with the IFC (Industry Foundation Classes) format, because IFC software is not programmed or applied error free. If the choice is to go for a ‘closed (Owner) BIM’, each new project team needs to learn the proprietary BIM system. Often in lack of resources, the constraint of lots of training at project begin, is prohibitive for joining BIM projects or a loss of efficiency at project start needs to be accepted.

Our thought process centers around the question: ‘could we not build a system that allows for pre-condition free information access and retrieval, instantly at the point of demand and usable for whatever purpose I have in mind?’ We will call this system an ‘Information Space’.

The idea is that everybody involved (Project, part-time collaboration, Operations, etc.) works with the tools and on the systems they are accustomed to. The disciplines provide the information / data of their work continuously to the Information Space, but don’t have to worry about the format of the data nor do they have to put work into re-formatting his data. The Information Space is a gated platform with an information processing engine at its heart. It is intended as Cloud based platform. So as information enters the InS, at the entry gate the data format is identified. Most usages of data will be known when establishing the InS, but they don’t have to be. Over time usages can be added or dropped off, just depending on what the InS is intended to be used for. With both the Informations, format of incoming data and format requested for the usage, the InS assembles the appropriate mapping table and provides connect ability. The gateway also has the function of Quality Assurance on the incoming data. Handling of incoming data is fully automated without manual interference or corrections. Parallel to the freely arrange able usage of data, a dashboard capability will allow for quick illustration of specific information requested on the processing and usage of the data. For all usages, data is available in real-time. Information / Data processing can deliver static results (dashboard, documentation) or dynamic results (process- / business- control), which trigger following actions and can be enabled with artificial / machine intelligence.

Whilst starting with buildings as theme for Information Spaces, the concept shall be applicable to other themes, where collaborative teams work with massive information / data generation.

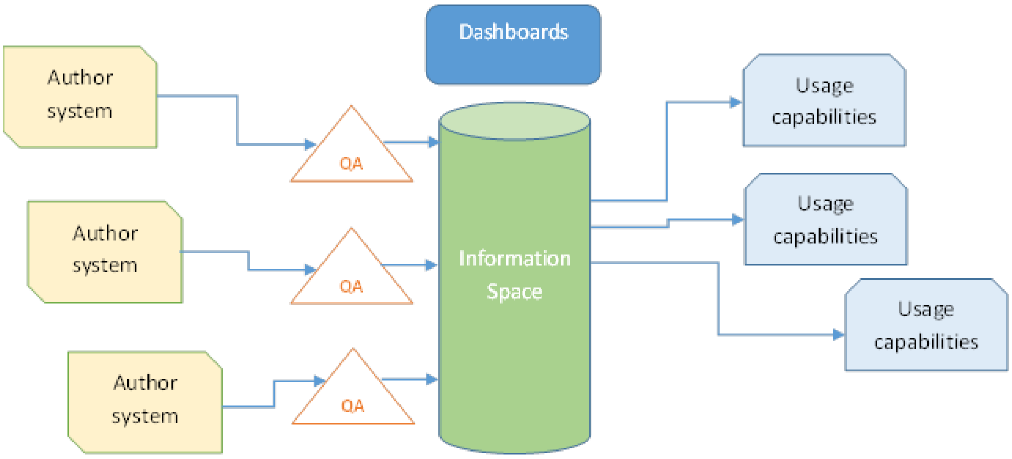

Figure 1: Principle Idea of Information Spaces.

In developing a concept for Information Spaces, intended to follow digital and network principles, we need to consider the aspects of Scalability and Complexity from the beginning on. System performance needs to be expandable on exponential trajectories. Whereas the workflows in BIM environments are typically sequential and therefore limited in performance growth, Information Spaces shall be designed to handle parallel processing.

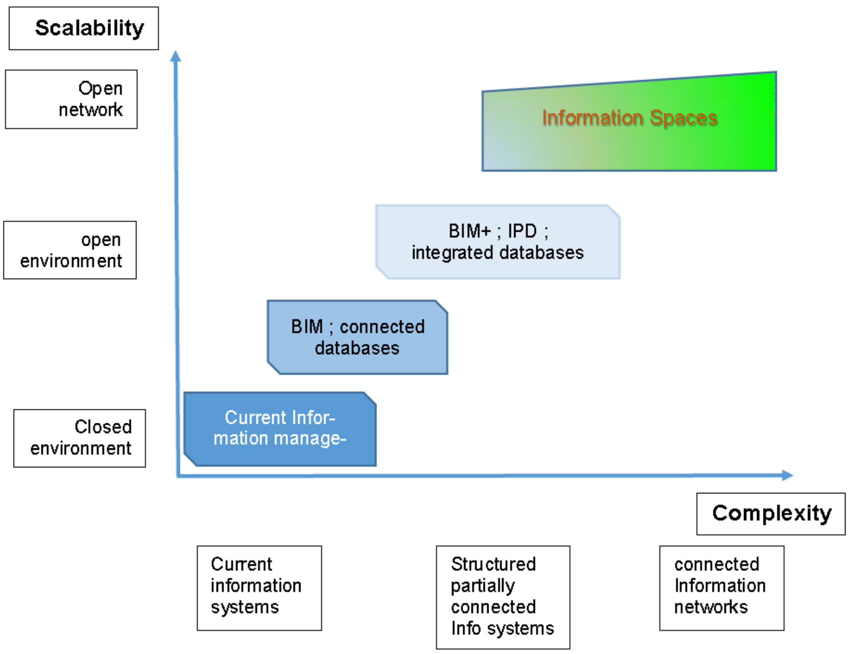

Figure 2: Development of Information Spaces in the force field of Complexity and Scalability.

As both authors come from the world of Virtual Design and Engineering (VDC) and the idea for developing Information Spaces came out of the context of thoughts on further developments of VDC in the future, one of the focus areas is the current ‘state of the art’ environment for VDC, the *Integrated Project Delivery (IPD)*. [2]

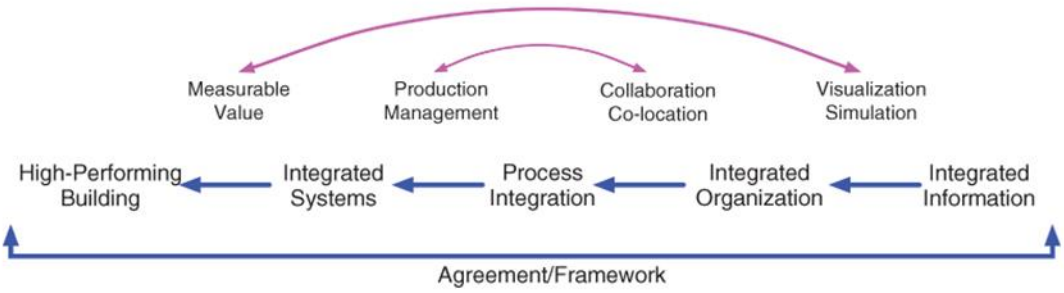

Figure 3: A simple framework for integrating project delivery (IPD). [2]

Some observations around IPD:

- In theory, IPD is to be a fully integrated work environment, but the elements of IPD are typically process oriented and of sequential work order
- The interaction between elements of IPD is often organized over a linear connection (implying singular channels of information exchange)
- The framework shows the elements in sequential order and in 2D arrangement.

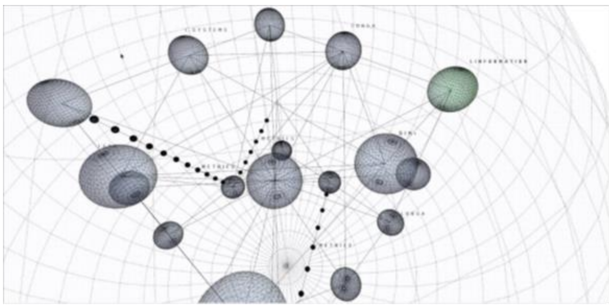

Figure 4: looking at IPD from the viewpoint of it being an Information Space

What if we imagined the elements and work processes of IPD to be building blocks of a three dimensional Information Space?

Where all elements are connected as a network and can communicate and process data simultaneously – like in a digital network environment?

To express this vision, we named the Information Space for IPD to *IPDx*.

3. Pilot test and Proof of Concept (PoC)

To validate our idea and demonstrate the feasibility of the solution proposal, a test environment was established to run a Pilot. The Pilot is built for a subpart of the Use Cases and is representative to demonstrate the principles of our solution. The selected User stories request to assemble 3D CAD models from a specified source, import the model and object information and instantly verify data quality. Then direct required data to cost calculation programs and display results in real time on a dashboard, showing the cost effect of model variations.

By performing a PoC (Proof of Concept) on this Pilot test run, the fundamental idea can be verified and further developed and expanded. The Pilot and PoC were built around the FORGE® Platform from Autodesk®. Nomenclature to align data source with cost calculation program is based on the Swiss BKP® (Bau Kosten Plan). Key success factor is how quick the system works in daily usage, measured as performance of the system. Performance is divided in 'time to establish model readiness' and 'processing time from data intake to result display' (time needed to display the processing results on the dashboard).

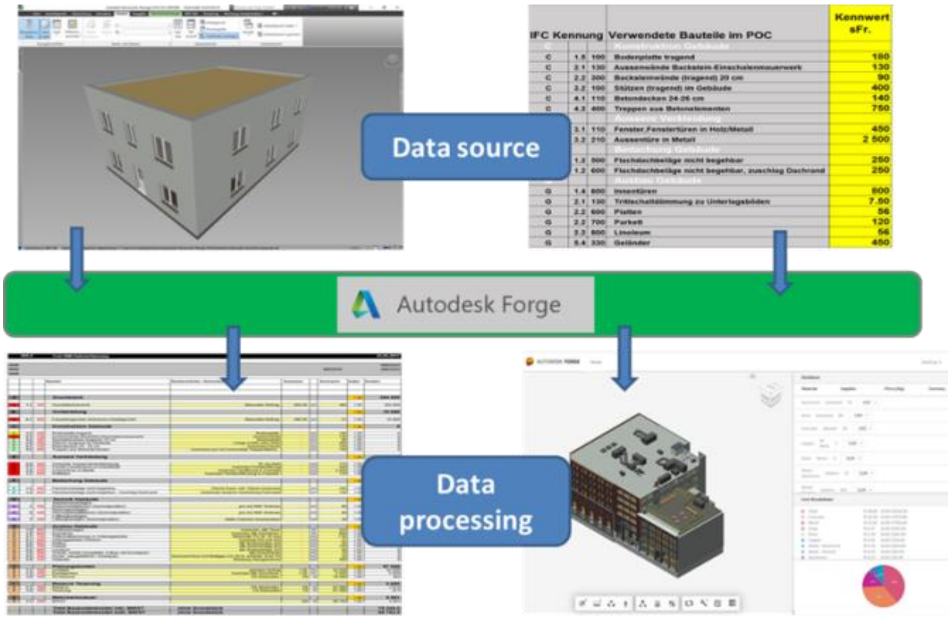

Figure 5: BKP® nomenclature applied to IFC Model.

The workflow and Information Space usage was started for one building. For each subsequent run, the number of buildings was doubled, that way doubling the number of rooms and the amount of data.

			Sekunden	Sekunden
	Modelle	Räume	Modellaufbau	Auswertungsergebnis
Messung 1	1	12	3	12.3
Messung 2			3	12
Messung 3			3	14
Messung 4			2.5	10.3
Messung 5			3	11.9
Messung 6			2.6	11.5
Messung 7			2.6	10.6
Messung 8			3.2	11.4
Messung 9			3.9	11.7
Messung 10			3	11.1
Durchschnitt			**2.98**	**11.68**

In each test run ten measurements were taken on:

- time to assemble the model in the InS

- time to process data for the requested output information

The average value of ten runs is representative as the variance was minimal.

Figure 6: Test run with one building model (12 rooms).

	8	96	Sekunden	Sekunden
	Modelle	Räume	Modellaufbau	Auswertungsergeb
Messung 1			6	50.2
Messung 2			5.5	49
Messung 3			6.4	49.5
Messung 4			7	50.7
Messung 5			6	51.7
Messung 6			7.5	50
Messung 7			6.3	53
Messung 8			5.9	52.6
Messung 9			7.8	50.7
Messung 10			6	49.3
Durchschnitt			**6.44**	**50.67**

Figure 7: Test run with eight building models (96 rooms).

Test runs were conducted for
one building (12 rooms),
two buildings (24 rooms),
four buildings (48 rooms),
eight buildings (96 rooms),
sixteen buildings (192 rooms),
thirty two buildings (384 rooms).

The run with 32 buildings could easily build the model, but no longer process the data.

run	buildings	rooms	sec. Modellaufbau	sec. Auswertung	sec. Modellaufb./room	sec. Auswertung/room
I	1	12	2.98	11.68	0.25	0.97
II	2	24	4.11	17.16	0.17	0.72
III	4	48	6.32	30.95	0.13	0.64
IV	8	96	6.44	50.67	0.07	0.53
V	16	192	6.71	100.30	0.03	0.52
VI	32	384	6.30	-	0.02	#WERT!

Tab. 2: Metrics of Pilot runs.

The average values show that our system has good scalability for model assembly, with the run time per room decreasing over the number of rooms (amount of data)(see Fig.9). But the algorithms for data processing have an unfavorable scalability factor. They need to be reviewed for their parallel processing capabilities.

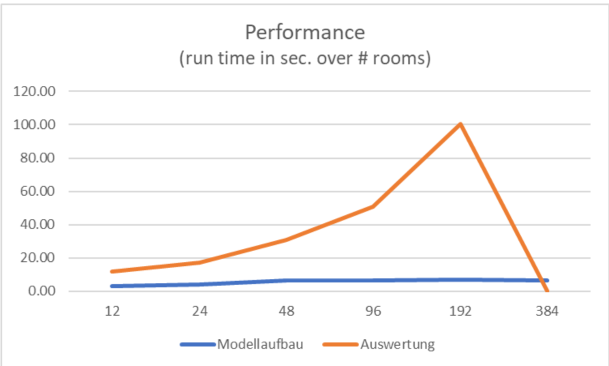

Figure 8: Performance in runtime over rooms.

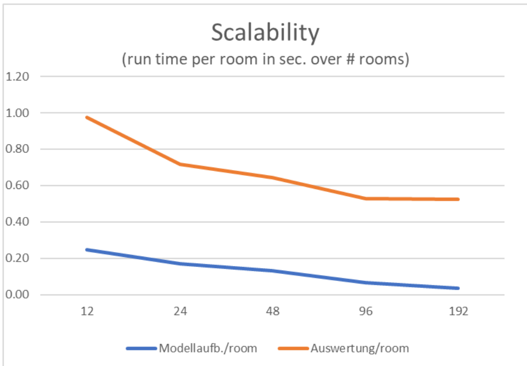

Figure 9: Scalability in runtime per room over rooms.

4. References

[1] Joshua Cooper Ramo, The Seventh Sense: Power, Fortune and Survival in the age of networks, Little Brown and Company, 2016.

[2] Fischer, Martin; Ashcraft, Howard W.; Reed, Dean; Khanzode, Atul. Integrating Project Delivery. Wiley Company, 2016.

[3] Dark Horse Innovation, Digital Innovation Handbook, Murmann Publishers, 2016, www.thedarkhorse.de.

[4] Manfred Breit, Vorlesung: Elemente Innovationsmanagement, workshop Innovationen, Ideenfindung und Projekdefinition, CAS W&T Modul 2, March 2017.