

THE ARCHITECTURE OF QUALITY. PERFORMANCE BASED QUALITY CHECKING OF VIRTUAL' DESIGN AND AS BUILD' PROTOTYPE IN BIM.

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Abstract:

Quality Checking: As main item the determination of quality and communication on technical quality of building project needs well organized "tools" for data handling. Performance based technical quality information as meta data file perhaps needs an intelligence structure of it's own. Technical building quality of complex projects can be related to a lot of items. The principle question is: "what is the overall architecture of the technical quality" and how can this mass of information be organized fit for data - handling, -mining, -storage and exchange/sharing?

Keywords: interoperability, overview, coherency, data handling, prototype-testing

INTRODUCTION

The problem definition: Private client specifications, national public codes and guaranty conditions are the main reference basis for Quality Checking of building projects. Exchange of project related reliable building information is essential for integration and collaboration of all partners in the building process. Quantity take off (QTO), Version Management are other relevant items and have to be in full control. The problem is which IT tools in BIM are available for delivering all the relevant data?

The study on the architecture of quality is a fundamental research study. One of the study items is focussed on existing and developing new tools from the view of 1: science philosophy (ref 1 Chalmers) 2: mathematics (set theory) and standardization (ref: 2 Blind) and 3: analyse of studies on building regulation and quality in the construction sector (ref: 3 Ph doc studies (5) of Visscher, Scholten, v. Overveld, Hasselaar and v/d Heijden)

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CHANGING ROLES 2009 INTEGRATION AND COLLABORATION

A lot of several disciplines are more and more involved in the design and production phase of capital good (like the auto/motive- , nautical- and aerospace industry) In this paper of course the full focus is on the products in construction sector with the building or the building construction as end-result. (In this paper the mentioning of the word: building has also the meaning: building construction) In the contrary to the other above mentioned sectors the output as end-result in the construction sector is most of the time the one (and often) only prototype of the capital good as real estate. Some times this prototype is planned to be repeated in a serial way (like the housing sector) The production cost of this prototype has in author’s country 15 % as average failure cost and the “after sale” has to solve the problems of this failures in quality. (ref: 4) This failures are most of the time also the reason for time delay (looping in planning and/or time needed for solving un-foreseen problems), extra engineering and juridical cost and waste. Sometimes the client (as end-user) did not get where he/she always dreamed of (RIBA/UK definition) but gets a nightmare where the ghosts out of the Pandora Box appear. (author statement in 1999 during the UIA World congress on the Tsinghua. University in Beijing) In author’s country the construction sector causes during the day ca 25 % of the traffic pollution (not in rush hour) Decreasing environmental pollution

by traffic and decreasing traffic intensity should have high priority.(ref: 5) So more in general the construction sector (as producer of high tech capital good) is very motivated for improving integration and collaboration in an early stage. Looking for possibility's of developing new technical tools for participants in the design and manufacturing phase e.g. in the cad-cam sector is there for highly recommended.

How BIM effects the role of the building participants

The fact that so called building information models of all kind and types are more and more available for most of all the building participants, BIM becomes an magnificent tool of growing important, not only for the design phase but also for the cam phase. Only if a so called as-build model is available during the whole life cycles good maintenance and renovation can supported. E.g. Material waste in the construction sector is a major problem and is in author country the second in dimension after domestic waste. In case we can increase the re-using of existing building (also relevant in area's with declining population) and give them new destination and a long second life the availability of all the relevant building information of the original building is essential. See author's contribution on the Adaptable '06 conference in 2006 in Eindhoven NL.(ref: 6) If all this information is stored in an intelligent IT way, professional building participants can act on higher level. In general professional participants can have with a good IT BIM an overview on the relevant items and can see in an ideal situation the coherence. Non- or semi- professionals can use warning systems in a good IT BIM; that system informs them to consult professionals because perhaps things are going wrong. (e.g. class- controls in the dimensional area's and performance based quality checkers) Good BIM can speed up the efficiency of all participants and increase the effectiveness of the collaboration.

THE ARCHITECTURE OF QUALITY

Project information on quality, quality related process information and information about the producer of quality information are the three main relevant items which have to be taken into account. Quality is of course not only restricted to architectural quality or the physical aspects of the build reality. The quality of the production process is also relevant and have most of the time financial influence in case of producing capital good. The quality of facility management can shorted or improved the exploitation of the project. Information related to the item quality proves to be related in the construction sector to more then 10 separate groups of relevant items. This groups with principle different characters are so called abstract levels (AL) and have been presented and discussed on an earlier CIB conference in 2002 on the Hong Kong University.(ref: 7) In author's country more then 60 technical main-aspects are relevant for getting a building permit. So project related information is the main relevant part of the three parts on technical information about total quality . Second is process related quality information: Because trustworthy information on the right moment during the process is also a quality. It is an essential but not a sufficient condition for getting so called "Total quality" Generating essential technical information on the wrong moment is sometimes information that is 1: second best (better late then never) 2: of sub standard quality.3: simple to late to be real relevant in the rest of the process.4: only relevant in case of damage control. The third part of quality information is the professional quality in fact the competence of a person who produces the information on quality and has also to be taken into account. All the professionals that produce Quality Information based on their discipline and responsibility give quality statements that as such also have a kind

of quality.

Triple A quality rating:

Author has published a rating system of the quality of quality information in the construction sector (ref: 8) This publications say that a triple A rating is reserved for information from an information producer that is defined / delivered 1: on the best way 2: on the right moment and 3: by the right person. B rating is second best and some times also acceptable. C. rating deemed to be satisfied. D. rating Extra control is recommended etc. This professional publications on Triple A Quality Rating are mentioned as good practice in official assessment systems for national building permits in author's country.(ref: 9)

Performance based quality checking of virtual 'design and as build' prototypes in BIM's.

In the eighty's of the past century the European Parliament stated (Reference: so called New Approach EU 1988) that it is highly recommended that in case of technical regulation the Member States (MS) and the EU put technical public rules not in their regulation but in national standards (NS) and or EU standards. This standards have to be so called performance based. So on a standardised way by using well defined methods of 1) testing in situ or laboratory, 2) measurement after and before production and or 3) calculation, the quality can be determined performance based. By using such above described system the idea was that standards will promote 1) Innovation 2) Juridical certainty and 3) Uniform the rules in the field of technical quality of building. (Reference: See also the Pebbu project of CIB financed by the EC ca 5 years ago) In case we could create A) a so called " virtual" IT model with building information about a building prototype (in the several design phases); B) a model related on de building process as such, that tells us how the construction really will be and/or is build; and C) by giving us information which building products will be or have been used in which using condition in this specific building. In this above described ideal situation of A,B and C performance based quality checking in future is in principle possible.

Interoperability, overview, coherency, data handling, prototype-testing

The above mentioned keywords came up.(Preferable software independent) Interoperability of IT data must be based on trust worthy possibilities of exchange. Technical information as output, have to be fit for use as input in other systems without losing intelligence and information richness. Because not all the IT Quality checking programs are produced by one and the same software firm. Try outs of testing several IT programs on interoperability by two independent members of building Smart International Alliance of Interoperability (IAI) on two technical university's in two different country's in Europe pointed out in 2008 that in the best situation 85% of the IT information is after exchange and using again in an other new IT programs trust worthy. (ref: 10) In the field of interoperability between IT programs from several software firms there is a lot work to do like standardization of data handling and standardization of producing input data (ID) and checking using conditions (UC) of determination methods. Integral prototype testing on all relevant items can only in case the above problems are fully solved.

Overview on all aspects and coherence between all elements can only be guaranteed when this job is done on world scale. In Europe (CEN) there is a so called Vienna agreement that means that activity's programmed and planned by ISO will not be doubled by CEN activity's .ISO takes and hold the lead.

Some ISO background information in a comprehensive way :

In the field of Pre- and Co- normative research experience based on some try outs with available (draft) standards: iso 12006-3 have been hold and draft IT tools are under construction also based on:

IFC: Industry Foundation Classes is a neutral data format for exchange and sharing building data.

IFD International Framework for Dictionaries filled with product specifications by using a language of defining a product ontology.

IDM Information Delivery Manual is a description of (sub)processes and specifications of information a specific partner has to deliver in a specific phase of a process.(not yet a standard)

The ITM and IDM international working groups and the w.g. Smart Codes & Smart standards of Building smart IAI are active in trying to solve problems in practice.

(The ISO TAG 8 group has at the end the responsibility on this field of ISO related items in the Construction Sector CS)

INTRODUCTION MORE IN DETAIL AND PROBLEM DEFINITION:

Not only the national public codes and rules are relevant in a BIM. Of course also private client specifications, and guaranty conditions are to gather the three other main reference basis for quality checking of building projects. Exchange of project related reliable building information is essential for integration and collaboration of all partners in the building process. Quantity take off (QTO) relevant as basement for the price of production is a very important one. Version Management is an other relevant item and have to be in full control during the design and production process. (Think on the item of authorizing versions. In relation to commercial, juridical and planning consequences)

Quality checking (not only the determination of quality but also the communication on technical quality of building project) needs well organized “tools” for data handling. Performance based technical quality information (as meta data file) perhaps needs an intelligence structure of it’s own. Technical building quality of complex projects can be related to a lot of items. In author’s country on sub item level more then 600 exact technical questions in relation to the building rule and permit have been defined and published in 3 professional national publications in 2005. (Ref: 11) They have an relation to more then 40 1e line nat. standards and ca 160 2e line nat. standards and so on. First line means: mentioned in official national codes and 2e line means: mentioned in 1e line standards. The principle question is: ”what is the over all architecture of the technical quality” and how can this mass of information be organized fit for data - handling,-mining, -storage and exchange/sharing.

Virtual visual checkable quality versus calculated quality and quantity:

If in the design phase the project is virtual hosted in a Building Information Model some aspect can be checked (visual or calculated) by hand or automatically. (e.g. the 2 or 3 dimensional aspects of special quality) See e.g. the dimensional checking programs of spaces of Solibri Finland (Ref: 12)

If in the fully “ as build “ phase a still virtual project is hosted in a BIM other quality aspects can be checked (e.g. calculation in the field of construction safety or physical aspects and so on) Only the technical aspects based on specific “testing in situ” of new items / new solutions can on principle reasons not be tested in BIM’s. but perhaps simulated and / or visualized. This testing aspect are air- and water- tightness and some

fire safety aspects b.e.) See also the Health performance publications of Hasselaar. (Ref:3)

Mathematical definition of a formula for covering all exact information in the field of objectified quality of a project (in the building sector).

In case IT tools in a BIM are programmed on an intelligence way it is essential that the source codes of the program is defined on a proper mathematical consistence way. Author presented ca seven years ago this mathematical formula for the building sector on a CIB conference in 2002 on the Hong Kong University and has been published then by CIB 2002 (Ref: 7) Since that time this formulas are in practice been “ loaded” in 2005 with the outcome of above mentioned more then 600 exact questions and have been published by the national state publisher.(Ref:11)

Building product- and production information in relation to Quality Information:

Most of the building products were produced else where in a fabric situation under full condition. In line with the CE marking and other quality labels relevant information is (web based?) available loaded with info from the producers. Under their responsibility and sometimes checked and authorized by the web-organization. In author’s country there are three initiatives for developing general CAD product files with several information also on quality that informs the CAD user about relevant items product related.(Ref: 13) A lot of this technical information is needed as “input data“ for quality checking and “using condition” must be checked in relation to quality assurance.

Virtual prototypes in a BIM: Are they drawn or “as-build “?

Looking to models in a BIM every body know that the model is not the build reality. When the computer is well programmed the machine “ knows”, that what is shown, is not the build reality. But the real essential question is: Do we know in the field of quality checking which information is lacking. And does the computer program informs us which relevant information is lacking. And does the “machine” ask for that relevant information and does he warns us that e.g. some combination of product are a against (all) rules in the field of guarantee assurance conditions.(Ref:14) Which assumption is reasonable and which assumption do we (as professional?) have to do by hand. Or is it a proposal form the “ machine”

In author’s country there are quality IT programs based on a fix authorized combination of assumptions which delivered always sub optimal good solution fit for use. In contrary to this there are also more sophisticated quality programs that need detailed as build data input that delivered detailed “special work” in the field of quality checking as output. (Ref:15) So in theory it is possible to have in the design phase of a project that project in a BIM based on a computer aided drawing system and later on in the “as-build” phase that drawn model of that project has two or more alternatives based on several choices of possible building products. The outcome is, that in both or several more detailed versions of that model in the building preparation phase of the model we have also alternatives in quality. But some quality items can only be determined when the building (part) is fully detailed. On the contrary of course there are also quality items that can be determined earlier and independent from the building details that came available in the later phase.

Version control and quality checking:

So the conclusion is: Version control and Version management is not only important in relation to the item of authorization but also in relation to keep alternative solutions as

possibility's open as options. Which part of the project is decided and authorized in the model and which parts not yet. And why must some possibility's / alternatives absolutely kept open for quality-, financial- and or more strategic management project reasons .

So in theory it is possible to “ shortage “ the design phases of the development process and to start as quickly as possible with the “ as build “ phase, because then we can start full quality checking of all items on a proper way. But when the outcome in detail or on the whole is disappointing, then the call for alternatives becomes louder. The loop in the planning starts then and perhaps the project goes back form the “ as build” phase to the design phase.

Exact information of objectified quality of producers, processes and projects.

Producers of information are (as we do hope) professionals. Good project management starts most of the time with selecting team players and team building of the professionals of several discipline needed for realization of that specific project. There are systems of qualification of professionals and their firms. Branch organizations have some times their quality restrictions and conditions. So in selection phase of the team players it is relevant which risk is connected with which choice and know the team player his own risks and on which way this risks will be tackled by the team player himself or his firm or others (?) (risk management Ref:18) In author's country there are no formal restriction on choosing team players in relation to the public building permit accept on some detail items connected to discipline's like asbestos reconstruction and installing fire alarm installation.(Ref:19) In the contrary to this in some other European country's the building permit is fully related on legal restricted authorized private persons. (reference: Belgium) Also other possibilities in other country's exist: b.e. two independent private professional organization and / or persons have to control quality on detail level in advance (4 eyes systems reference: Germany)

Processes where the information on quality is related on are formally most of the time free. Branch organization of several disciplines and sectors have organized (and more or less standardized) their activities in a recommended way (some times obliged by e.g. assurance company's) In each phase of a process building information with a certain level of quality is available and that building information of that project is phase after phase of course growing. But to have proper decisions that make sense, trust worthy input data on the right moment of the process is of course essential. In author's country are in the architect- and engineering- sector the phases of processes fully detailed on the level of which information is (ought to be) available and forms the basses of which decision can be taken (by the client) (Ref: 16)

Project information in relation on quality is mentioned several times above and have already their mathematical formulas that covers the over all quality in case of performance based building quality is required.(Ref: 7)

Mix of above mentioned situation of process and project information exist of course: Starting the procedure of getting a building permit required a lot of quality information. Getting the building permit means that the government expected that if the building is build in line with the controlled information the minimal quality is all right. The real situation is that first not all the available technical information is fully checked. And second not all the checking's occurred on the right way.(Ref: 3: J van der Heijden: Ph doc: Building regulatory enforcement regimes 2009 DUT/OTB) So Quality Checking in BIM controlled by the government can also play and enormous role in increasing the quality of the public permit related control by the local government.

Call for Round Robin research proposals on false negative and false positive building permits:

It is a very pity situation that 20 years after introduction of the earlier mentioned philosophy of performance based building by the EU parliament (New Approach) there is world wide still no fundamental research results available on the scientific principle rating question: False positive and False Negative . (This is the crown jewel of scientific research) How many building permits are officially given with a quality level that is too low. (False Positive) And how many building permits are refused based on the wrong arguments (False negative) Author's firm is involved with delivering the building permits of ca 40 local authority's the last 15 years and / or give in company training on it. Author is audit assistant as expert in the quality control system as private alternative for the public national quality control system.(Ref:9) It is in author view scientific highly recommended that based on the principles of "Round Robin" all the country's with members in CIB cooperate to gather to come to this missing link in field of false negative and false positive (Temporary code name: Pebbu II ?)

Quality in the Construction phase:

In case of a right building permit there is a basis for starting the building preparation. If a minimum of information is available the building process can start. Further on in the process if supplementary technical information becomes available, first it has to be officially checked and some times when the building is partly ready this can be judged separately. Mostly in case a technical aspects they can be easily checked after all, scientific publications are made with out-come following the system of false positive.(Ref: 3 Hasselaar Ph doc study) False negative asked more desk research (on officially project documents) but is still possible.

From scientific view the source of information related to assurance systems (b.e. France) and client /end user guarantee experience (b.e. the Dutch GIW system) can give also a lot of specific information as input for scientific research on the item False negative / False Positive . Author has some specific experience in the field of arbitrage and as court expert.

CONCLUSIONS

The architecture of information relevant to the quality of building:

If we oversee the results of above mentioned study's and legal background documents it is proved to be possible to put all this information in a new mathematical definition of a formula with combination of information presenting " the architecture of information relevant to the quality of building " Author will present this draft formulas and explain it on the hand of examples above given and other examples found in practice. Next it is also possible to program on the hand of this formulas (on a systematic way) which items have software tools fit for use in a BIM and with items need some pre- and co-normative research to reach the ideal situation of full total quality control / IT based. (Supposing we want that and supposing we need that)

Cooperation on global research level is essential to tackle a lot of (sever?) problems that will be determined. The Research Centers and Technical University's member of CIB and or building Smart International and of course all other parties involved have to collaborate world wide together.

More in detail: Harmonization as way out?

As a result of an on going author's Ph doc study on the architecture of quality the outcome will be presented of research on the items of Smart Codes & Smart Standards (performance based) in a specific EU country with more than 15 years of experience. The need and profit of harmonization of input data (ID) and using condition (UC) and recommendations how to come to a Quality Information System (QIS) in BIM's will be presented and can be discussed on the conference. The statement is that:

A so called Triple A Quality Information System for capital technical products is the set of P Total (= Performance capacity / see BBAsys © 2002) determined on the set of all process phases relevant moments (see the DNR and NS's Ref:16) by the set of all relevant competent persons as observers. (see the Law restrictions Ref: 19)

BIM Rating: “Show me your diamonds”

There are all type of BIM's . The using of the word BIM is not restricted to one special form. BIM has become a “ commercial “ word. Based on this above mentioned mathematical formulas BIM-Models of several kinds can be classified and ratted as tool for the construction sector as followed. It is thinkable that the software firms can “show their diamonds “ in a scientific virtual “ Diamond Exhibition” (web based)

Relevant question are b.e.:1)How many software programs of the same family can be used?(little BIM) 2)With which software programs of other firms data exchange is possible? 3)Is software independent data exchange possible? / big BIM 4)Is the building information model a drawing model fit for the design phase.? 5)Is the building information model a so called “ as-build” model? 6)What are the possibility's of model hosting on servers.? 7)What proved programs on Quality Checking for which items and for what kind of project are available? 8) Can the CAD program be combined in the BIM with CAM programs? See also: Ref: 17

BIM What is next?

As build CAM prototype combined with the Lean methods (next generation) can be a very attractive future vision: This Lean philosophy [developed in the auto- motive-sector (Toyota competes GM with this; quote of GM self)] can be virtual used in a BIM combined with CAM programs. Relevant information related on the production phase can give information on building equipment and fully optimized the building/construction process. BIM next generation can promote on this way collaboration and cooperating between all partners concerned . BIM is the key for optimizing time and price in relation on quality.

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