

EXCHANGE INFORMATION ENHANCEMENT IN EXECUTION METHOD BY USING VIRTUAL REALITY

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ABSTRACT:

Applications based on virtual reality (VR) have hit the main stream nowadays. The latest innovations have been kept updating from film, game, automotive to any engineering industry and construction industry is no exception. There are many obvious key benefits gained by go through a completed building project or a construction site in 3D real-time environment which will help saving significant time and cost by the real work on site or reducing repetitive mistakes, errors in designing between disciplines/departments. Moreover, it can improve the exchanged information on site execution with the help of VR and building information model (BIM).

1. INTRODUCTION

1.1 General Instructions

VR first ideas based upon concepts about the desire of human long time ago who want to go over the border of real world and the imaginary one where all interactions happen in cyberspace. Not as a computer aided software in its 3D environment where people play around by using mouse and keyboard, the virtual world allow a person deeply go into a providing real time visual environment immersed in a remote location or in such international areas, which is more natural way of meaning than force someone learn how to use technology by software in a modern computer or device. VR and simulation allow for experiential learning through specifically designed environments. Simulated experiences are comprehended either through apprehension, meaning actual participation in an experience, or through comprehension which requires abstract conceptualization. The transformation of user experience made by reflected activity in virtual environment where user will gain experience as a learner [1]. VR environment either allow user increasing their engagement and adaptability in the required tasks or propose a more convenient experience. There are studies suggest the navigation in freely immersive 3D environment stimulates brain activity by creating a great effect of cognitive action where memory works and correlates to greater success with cognitive retrieval [2]

Virtual reality is a computer simulated environment that allows for user interactions that can allow an active learning environment. One of the important viability of VR has been examined thoroughly is in design stage. At the architectural view, human judgement is independent and different between individuals, thus scaled model or drawing produced to have a deeper view objectively. However, scaled model, drawings or 3D model by software cannot show fully the simulation of environment which structure withstand for the idea concept intentionally sometimes. Without constraints, 3D real world scenario enables bring human to do some following tasks:

Walkthrough a 3D building or a construction site.

Interact directly with the installation set up in the VR environment.

Discussing at a multi-user meeting in real time construction site. Interfere to a virtual operation to see how the task will be conducted.

Organizing the movement of labour force or equipment on site. Learn experience and have a better prediction from a site visit.

Three dimensional (3D) virtual environment generates a spaces relating to physical on rigid object in the earth where allow participants interact with internal objects, other users. In another word, a real world image where dangerous activities can be performed in virtual environments [3]. Virtual reality has been used and desired to enhance human's understanding on many field from design to execution on construction site. It has been proved by recent studies indicating immersive VR crosses by various engineering field regardless of backward time event, safety situation concept [4]. There are some game or mobile application built by construction company with the purpose to train their team in advance of practical work. A developed game focusing on construction management processes where learner showed improved results in problem solving and critical thinking when able to observe risk-free outcomes to decisions that alternatively would have negative real-world impacts [5]. In safety training sector, there was a virtual safety trial program to train user about provide safety information through mobile-based virtual simulations. Materials have been conducted through a typical course, learners were required to identify hazard zones. This platform gives users an experience to practice hazard recognition and have feedback in this virtual environment. After several times trials with protocol development pointed out that the advantages of understanding safety concerns on a dynamic horizontal construction site [6].

With all the existing and incoming technology, the capabilities to offer an experiential experience, which will help improving the information, exchanged through traditional working ways, hand-on, paper documents or manual works without showing it by a specific physical objects. The motivation utilizes using VR

technology based on BIM models and bring it to the construction site will cover the lack of facilities and other necessary material for user, especially engineers and worker's interactions for simulated-project complicated tasks in physical experience. The significant role from developing these technologies may support on live streaming meeting weekly in distance, global training between branches, indirect support through global projects channel where important information exchanges require precise, clear, brief and full. The result in this study phase will move forward in the appropriate content for the purpose BIM implementation procedure.

2. IMPLEMENTATION METHOD FROM A PRACTICAL STUDY CASE

2.1 Description

Mostly project manager will not be involved in model authoring. However, they have to ensure that all key elements required delivering a successful BIM project. Depending on which level of their impact on the life cycle, a map to define BIM stages in details is drawn.

Technology implementation method is the process of adopting an innovation from:

- Awareness;
- Persuasion;
- Decision making;
- Implementation;
- Confirmation.

And this method will go through stages that the awareness and persuasion from innovative technology method in a direct arrow from execution and organization method to construction site in general. It indicates that not every projects have the same factor or scale to applying BIM or digital technology effectively. Almost conventional work in any construction or architectural company can help their team to achieve the task or target successfully. A high storey building, which is sorted as large scale project, does not mean that it causes many trouble for engineer in both design and site team can complete their work. Usually the typical floor repeats through a vertical axis which will makes the steps is easier somehow.

A medium stadium project with its 3D BIM model used to conduct the purpose of the author. The project's name stade Maurice Boyau which is located in DAX city, France. The team has been conducting this project is method engineer belonged to company GTM Batiment Aquitaine. The first model is based on executed method department where they provide to construction sites the assistance in described tasks in BIM Execution Plan (BEP) by drawings, models, suggesting equipment, list of materials, local price or solutions.

The difficulty in this project is the location based on a small city which the selection of materials or solutions to conduct the work will be limited. Also there are no main office of the executed method department near this city causing every discussion must be hand on by phone or online discussion. The next one is the project contract has been signed using both precast and cast in place concrete (which will be the advantage for applying BIM management and assignment), however lack of facilities and equipment in a small city and grounding survey showed that it can be dangerous when the ground assistance was very low requiring to simulate model in BIM software which can point out not the better solution but the perfect solution when equipment will be transported on site for conducting both precast and cast in place concrete under low conditions.

The experiences in previous projects with an adequate library support for execution method in general tasks, the executed method department could not cover all the new tasks may appear when there will be some complicated work requires more practical experiences in variant discipline. 3D BIM model on that moment helps engineers having facilitation in their base office where they assign the information and necessary issues based on solution, other department, company procedure or supplier's catalogue document, which is the standard procedure in the process of issuing a technical document for execution method from office to construction site.

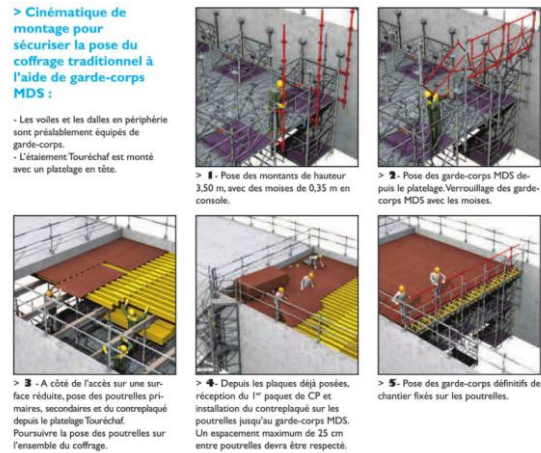


Fig. 1. An example of installing scaffolding for slab formwork in a supplier catalogue MILLs formwork. [7]

The figure 1 below showed that how to install a type of product steps by steps with all necessary information about stability, vertical and horizontal loading relating its height, type and so on. Yet these steps and calculated information have not predicted that how the user adapt the process with a new type of structure or method? Even with the support of BIM model and technical documents, there are still many small details behind which sets of scaffolding must be stable by different type of brace used to operate the formwork for great precast/cast in place beams at eight to nine meter of height as the figure 2 below.

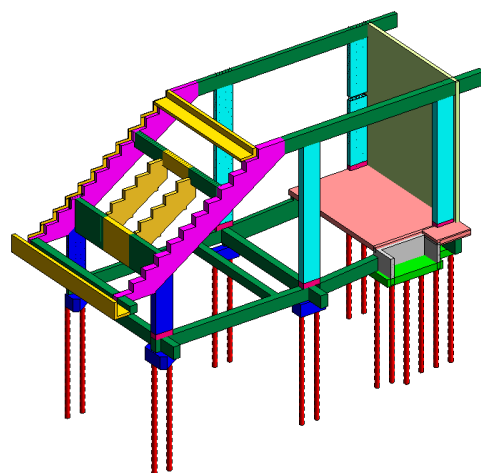


Fig. 2. A part of the stadium project where there are many type of great beams, angle beams, stair beams joining in a zone for execution in place. (Precast and cast in place)

Many calls and discussions were taken place because the experience, point of view in how to build it up is different. Drawings and guide document sent to construction site for

consulting and reviewing. All of these complicated procedure leading to an idea that an interpreter from technical paper document to VR environment will be a solution. A step to make the working procedure from technical paper to reality, from design to be built, from a model built by computer-aided design (CAD) platform to a virtual environment human can interact.

2.2 Integration and interaction between BIM models.

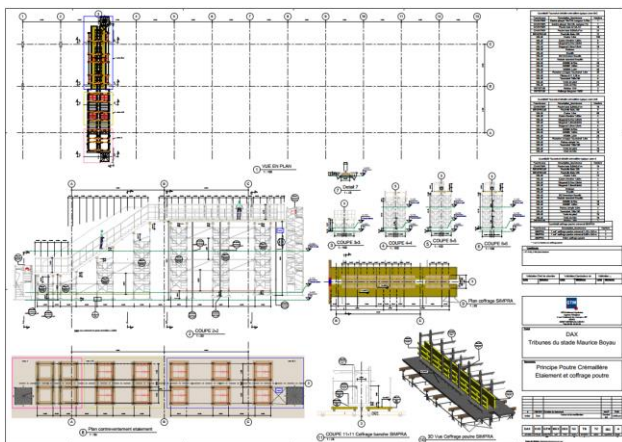


Fig. 3. A drawing from the set of execution method document, sent to construction site, show step by step and required materials, equipment. All the model has been built in Revit.

With the existing model from Revit software, BIM or method engineer will take advantage of animation function from the other software to conduct the 4D model or just an animation (depending on the urgency). There is some software for like Naviswork, Synchro, 3DsMax, ... with its powerful and simple functions for animation.

In this study case, we conduct this work with Unity, a game engine requires more complex in user interface (UI). Nevertheless, after working with animation and render, Unity allows user export it to be an VR application (as a video game or mobile game) which adapt this project's difficulty rapidly, suitable with our urgent situation and team's basement. After assign the necessary equipment with the approximated time following by tasks, the link and movement by construction equipment will happen. Usually the 4D definition of BIM says that it is actions reference to time in a 3D model containing information, but the main purpose in here is support and solve the difficulty of execution tasks provided by method execution department, therefore the time assignment is not necessary.

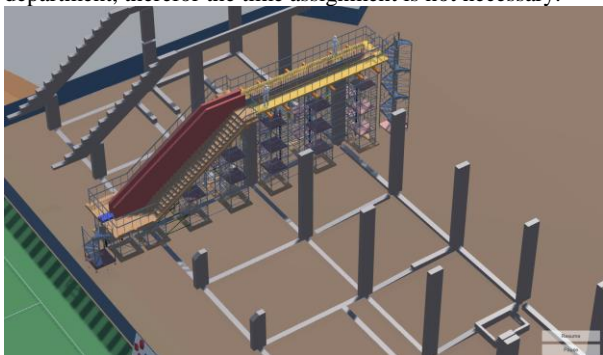


Fig. 4. An application made by Unity with VR simulated environment shows the execution method in animation helping the site engineer, other department understand better procedure.

2.3 Site experience

After conducting execution method in animation by Unity. With the support for VR, it can produce VR from the existing animation into a small application. We used it to explain about all the execution steps and brought it to the construction site for engineers and workers test it. The discussion became more interesting, after some modification, the image of "how to do" and "when to do" was in everyone's mind. We continued to give the VR test for other people to have more optimistic point of view and conducted surveys following that to collect information about user experience.



Fig. 6. The first test on construction site at stade Maurice Boyau project, DAX, France.

3. SURVEY AND RESULT

The participants took part are mainly from final year engineering students, fresh engineer, senior engineer, manager, engineering professor and construction deputy. The purpose of selecting variety of participant to value the effectiveness of VR application on execution method.

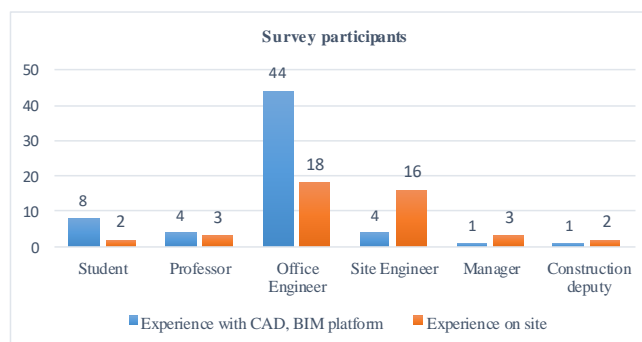


Fig. 5. Graphic show the user's experience based on site or on CAD, BIM platform.

The purpose of survey is to collect data from user experience based on graphics, images, recognition of materials and equipment on the site. The navigation survey is very important because user will step into a virtual environment where maybe it will be completely different with real life. Also that there maybe have some inconvenience for user called cyber sickness defined as a sub-type of motion sickness because it does not involve the vestibular system and is triggered only by visual stimuli causing symptoms like nausea, sweating, dizziness and fatigue [8]. The survey will take data from users after reading, seeing, understanding information from conventional way (drawings,

technical documents, 3D photos) and in immersive VR environment. Depends on own experience, user will have different feeling and understanding, even the inconvenience if it is the first time entering this virtual environment. All the questions from this survey are valued by the scale from 1 to 10 (at 1 is “Uncomfortable”, 5 is “Neutral” and 10 is “Excellent”).

	List of questions	Convention		With VR	
		Mean	SD +/-	Mean	SD +/-
Navigation	Easy to navigate in the VR environment	x	x	7.58	1.8
	Feeling fatigue because of the blue light	x	x	7.1	1.113
Recognition	1.The site scale, direction	7.56	0.55	7.53	0.68
	2.The project in general	7.98	0.95	8.03	0.32
	3.Different type of structure	7.76	1.23	7.97	0.65
	4.Different type of material	7.2	1.68	7.93	0.62
Installation Understand	5.Getting the list of tasks have been conducted	7.25	1.2	7.19	1.74
	6.Understanding the sort of tasks have been conducted	7.12	2.87	7.85	1.35
	7.Type of material/supplier brand/component used for each type of structure	7.05	1.98	7.88	1.85
	8.Understanding the guided technical information assigned in the model/drawing	7.66	2.21	8.1	1.3
	9.Understanding the following works prepared after.	6.56	3.01	7.52	0.85
	10.Having any idea or suggestion?	5.61	3.65	6.99	2.89

Table 1. Table of collected data from survey

The responses from questions listed from number 1 to number 10 in table 2 are used to analyse data collection.

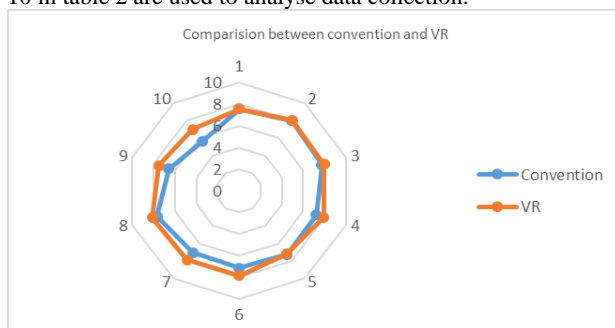


Fig. 7. Comparison from each response for each division in table 1.

As the result, it can be observed quickly that the array between question 1, 2, 3, 5, 8 is very slightly which means construction site team is working in the current full procedure effectively, projects are described as a variety parameters from design to management even if it they are the same type with similar scale approximately. However, the point has a big difference between the Mean value of questions number 4, 9 and especially 10. After receive the result, the author asked some participants about these big differences. The most answers are about there are many layers of information needed to know or it requires a certain experience to understand the step fluently before going for this survey. The engineers working in office have more confidence with VR environment and guided information inside while the site engineers felt themselves more satisfy beyond the discussion before when seeing steps in detailing, the structure was installed. The standard deviation (SD) difference, which was caused almost by the lack of experience from student. With more practice in simulated tasks by VR, they defined the scope of work easily and more fluently.

The first two question with listed any number used to have user experience when using headgear to enter VR environment. These 2 questions are not used to compare between the comparison but it plays a very important role for VR engineer to develop the next projects for user feel more comfortable.

The question number 10 had a very low level: Do you have any other ideas? Usually the site engineers have more ideas in execution tasks related to their job on site. Positive things have been seen after applying VR, the Mean value has been increase significantly. More and new ideas will give any teams have more opportunities to develop and increase their performance at work.

4. CONCLUSION

The study has indicated that it will be an advantage for any construction company to build a virtual construction site using VR technology integrating with any execution method and it can be used effectively for information exchanging between disciplines, departments. Participants take part in the test regardless of their experience would perceive well the virtual construction site environment to be sufficiently adapt the virtual environment first, then will be learnt and experience the steps and procedures takes place inside this built construction virtual environment, which has been assigned by the guided information inside and will be updated by post-feedback after interaction. Mostly, it can be found that interaction through images, sense, and sound is more effective than reading and looking at a set of document.

The VR technology nowadays is still underestimated because of rates in scenarios of the reality in depiction from different situations and applications in construction sites. There are some reasons like the preparation of VR scenarios is time consuming task, also it requires the fines in details, an easy user interface (UI). However, in the approach of digital technology where the inevitability is coming, it can have enhancement likelihood of adaptability from new technology.

Overall, the aim of using VR technology in BIM model should be taken into account in which stage it should or should not use to avoid the time consuming for it. People feels amazing when they start entering to the VR environment, but for our final target is dealing with engineering and solution to moving forward in construction industry or in any field it can apply. Further research is proposed with Artificial Intelligent in VR

like detecting encoded component, material, and information inside. Human is always the center of technology development. This study has shown that the use and need of VR is crucial in execution method that gave out the result having distinct advantages over conventional work. It also can be used with BIM technology suitably and in other near future applications is coming.

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