

## E-Training using Virtual Reality based Three-Dimensional Web (In Outsourcing Industry of Manufacturing Structural Components)

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### ABSTRACT

Web based System has become an essential tool for coordinating with the Parent company and sub-contracting company in the Outsourcing of Engineering goods. This Paper explains a novel method of enhancing the web based communication facilities in the realm of Outsourcing for Fabricated Engineering components. Virtual Reality Modeling Language (VRML) is used for creating a three-dimensional web content. Customized delivery of the web content is realized by imparting dynamism to the conventional VR world. This enhanced method of using web based communication by the Parent Company to Outsourced firms is tested for the fabrication of two Engineering products namely Built up Beam and Built up Columns. It is found that there is a good improvement in performance parameters - time taken for comprehending the manufacturing process has reduced, depth of understanding the manufacturing operation has increased, cycle time of manufacture of the end product has reduced and chances for re-work/rectification are thinned down.

**Keywords:** Outsourcing, Parent Company, Outsourced Firm, Engineering Product, Fabrication sequence, VRML, 3-D Web content creation, Dynamism during content delivery

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Date of Submission: 20-11-2017

Date of acceptance: 30-11-2017  
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### I. INTRODUCTION

Outsourcing Scenario of Engineering Components basically involves making use of the resource and service of the Outsourced firms (OF) by the Parent company for meeting the production requirement of the Parent company, without compromising the Quality requirement of the Customers of the Parent company. In short OF act as extended arm to the Parent Company for production.

#### 1.1 Conventional Approach:

Outsourcing of engineering goods between the Parent Company and Outsourced Firms (OF) comprises the following sequence of activities:

Parent Company enters into contract with OF for a variety of Engineering goods depending on the requirement of the Parent Company and the skills and facilities available with Outsourced Firms. As and when jobs are assigned to OF, the following information regarding the manufacturing is provided (by the Parent company to OF) through the conventional web:

- Process document showing the Manufacturing sequence
- Quality control procedures
- Engineering Drawing
- Picture of End Product

Generally, all this information is communicated through the web as static web content. The main drawback of this existing method is the difficulty in comprehending the complex manufacturing process from the Process document text and the two-dimensional engineering drawings. This is more so in the case of workforce with lesser experience.

## **II. PROPOSED WORK**

In this research work the information is passed through the web (in three frames). In addition to the textual process document and two dimensional engineering drawing provided in the two frames; in the third frame, the entire product manufacture sequence is shown as a three-dimensional work in Virtual Reality (which creates a Virtual World as per the engineering drawing and manufacturing sequence). The conventional VR does not create dynamic 3-D web content; it is in static mode. For example, for a Beam or column, the same dimension (length, width, height, flange thickness etc.) is displayed for all users. Here in this research, dynamic 3-D web content is created as follows:

- For each job off loaded to the OF, the job parameters (length, width, thickness etc...) is stored in the data base
- CGI program are developed to cull out relevant data from these Data bases and create 3-D web using Virtual Reality Modeling Language (VRML) on the fly (as and when the information is communicated)
- This user- job specific VR world is displayed to the user (in one of the frames in the web)

## **III. FEATURES OF VRML**

The node is the basic entity and it represents an element. Collection of such nodes would create a scene. The element will have to be moved/transformed in order to create a perfect scene. Transform node performs that operation. For the elements, colors, shade, texture etc., can be specified in order to change the style.

Each node has four types of properties namely:

- Field
- Exposed field
- Event-in
- Event-out

The 3D format is called scene graph, which is hierarchical representation of all the objects in a virtual world and their positions relative to each other. A scene graph is made up of nodes, which contains the shapes and descriptions of the objects. Nodes are made up of fields, which hold values describing the individual characteristics of each node. A shape is made up of geometry, which makes up its form, and appearance, which gives the geometry its color.

VRML has many nodes with which one can create many interesting shapes. They are box, cylinder, sphere, cone, indexedfaceset, indexedlineset, elevation grid etc. VRML worlds can be enhanced through the use of lighting and sound effects. It mimics the real world as closely as possible. Three different nodes are available for lighting. They are

- Directional light
- Point light
- Spot light

### **3.1 Animation**

Animations are possible in VR with a concept of interpolation. VRML has a wide array of interpolators to directly manipulate objects. Combining several interpolators like position interpolators, orientation interpolator along with time sensor and touch sensor one can bring characters in the virtual worlds to life. Many navigation functions of the VRML browser can be controlled with the NavigationInfo node. This includes selection of the user interface and the size of the avatar, the user's embodiment in the VRML world. Viewpoints can be set to give users an interesting view on entry and also to give them a selection of interesting vistas of the virtual world. The Sound node is another means of enhancing the user experience by adding ambient or spatial sound in the world. Adding sound at the same location as an object makes even simple objects seem more lifelike.

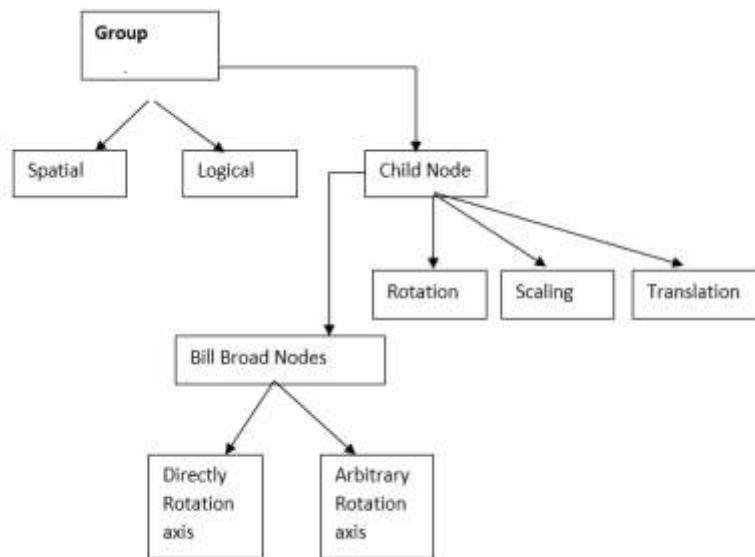
### **3.2 Grouping of Nodes**

Child nodes are grouped to form Parent node. Again, Parent nodes are grouped to form the desired Virtual world, which is represented in the figure1.

### **3.3 Scripting**

Scripting in VRML provides a powerful way to extend the capabilities of VRML. The Script node can be configured with an unlimited number of eventIns and eventOuts. When a Script node receives an event, a corresponding function is executed. This function can set fields internal to the Script node, perform complex algorithms, and send eventout to other nodes in the world.

Using the MovieTexture node, VRML allows users to use movies as texture, just like still images. These movies are controlled with time events, such as AudioClip node. The sound portion of a movie can be placed in the source field of a sound node to allow the audio to be positioned in the world.



**Fig 1 – Grouping of Nodes to create VR world**

### **3.4 Viewpoint**

Viewpoint animation is another powerful tool to make VRML worlds engaging. One can use it to take the user to interesting locations of Virtual world, or can create innovative transportation systems to help users get around. Binding can create a whole universe of relative coordinate spaces to make planets, stars, and entire galaxies for people to explore. VRML has nodes that enable users to achieve special effects, for example, a fog effect, background etc.

## **IV. VRML BASED COMMUNICATION SYSTEM FOR OUTSOURCING OF BEAM**

For the manufacture of the fabrication of the Engineering product namely Beam the information passed on by the Parent company to Outsourcing Firm (OF) is shown in Fig 2. The information regarding the job outsourced by the Parent company to the web screen is divided into three frames. For each of the job that is outsourced, the vendor- job details are stored in data base. The job-user specific information is retrieved and presented to the OF user in three frames.

In top frame the manufacturing processing sequence, along with quality control procedures are displayed. In the left side frame, the Engineering drawing of the job is displayed. In the right side frame, the Virtual Reality world of the job and the manufacturing process is displayed. The user can navigate through the VR world and can view the job with all VR effects (sound effect, light effect, proximity effect etc). The detailed processing sequence is also displayed. This ultimately helps in comprehending the job and the manufacturing process quickly and the depth of understanding is also enhanced. As a result, the chance of rework is reduced. All this helps in reducing the cycle time for manufacturing of the product. The benefit is realized even by the less experienced work force.

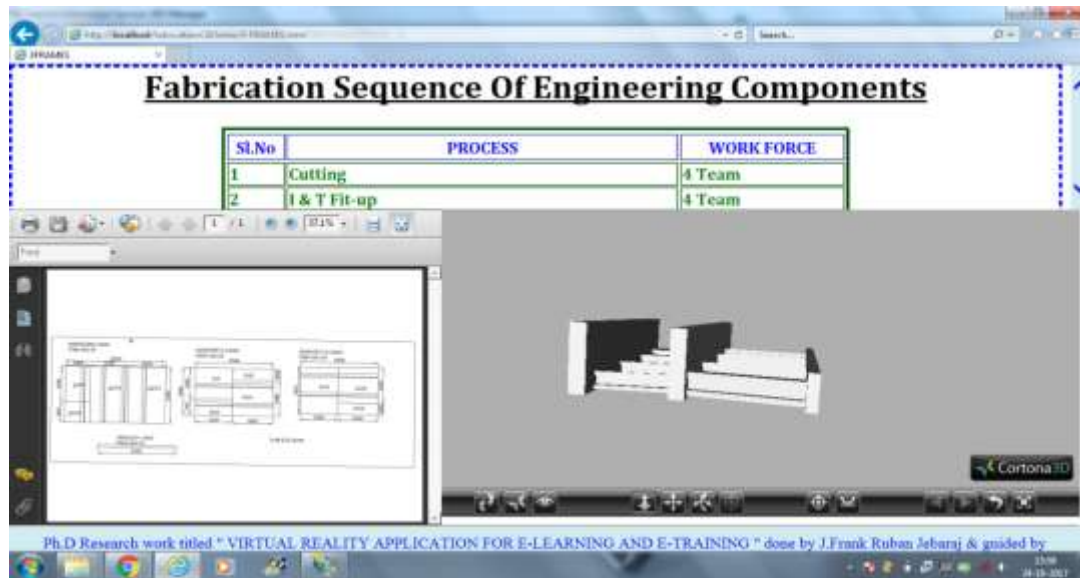


Fig -2 Information exchange for the manufacture of Beam

#### 4.1 Performance evaluation of the Product Beam

After implementing the proposed Virtual Reality, the following performance parameters (Before and after implementation) were obtained from the Outsourcing Firms from people of various experience groups.

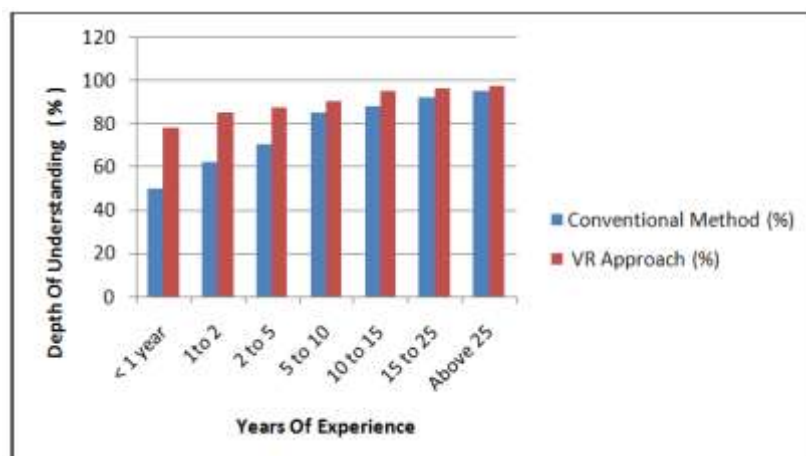
- Depth of understanding the Manufacturing Sequence
- Cycle Time of Operation of the end product
- Chances for re-work/rectification

##### 4.1.1 Depth of Understanding (for the product Beam)

The depth of understanding was studied among the work force with different years of experience. The depth of understanding in conventional method and VR method is compared and shown in table 1 and chart 1. It can be seen that the depth of understanding of the job is more in VR approach and also it is more pronounced in the group with lesser experience.

Years of experience	Conventional Method (%)	VR Approach (%)
< 1 year	50	78
1 to 2	62	85
2 to 5	70	87
5 to 10	85	90
10 to 15	88	95
15 to 25	92	96
Above 25	95	97

Table 1: Data input for the depth of understanding the manufacturing sequence.



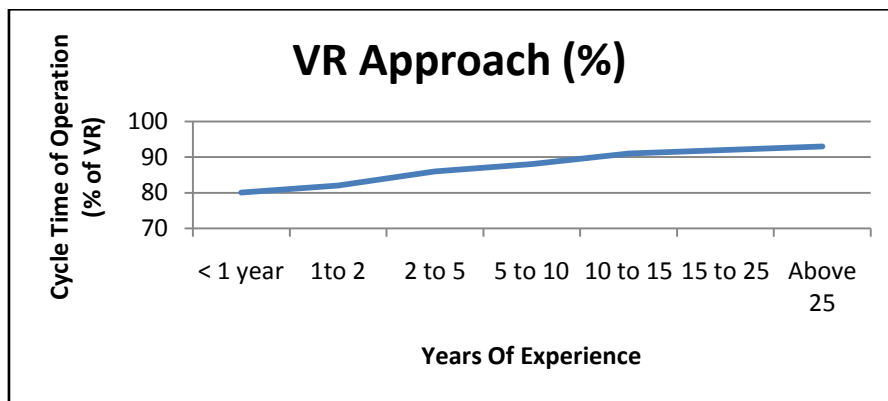
Graph 1: Analysis of depth of understanding the manufacturing sequence.

**4.1.2 Cycle Time of Operation of the end product**

If the time taken for manufacture of a product Beam is taken while exchanging information in the conventional manner is 100, then the time taken while exchanging information in proposed VR method is studied. The results are displayed in Table 2 and Chart 2.

Years of experience	VR Approach (% of time taken compared to normal method)
F < 1 year	80
1to 2	82
2 to 5	86
5 to 10	88
10 to 15	91
15 to 25	92
Above 25	93

**Table 2:** Input data for the Cycle Time of Operation.



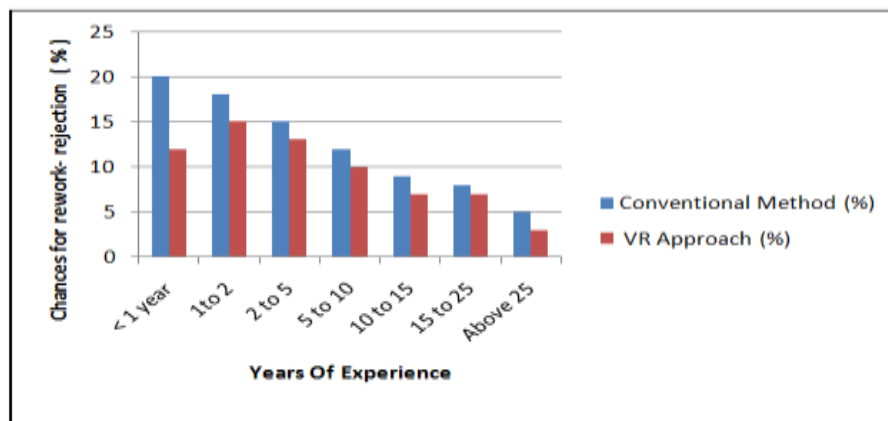
**Chart2:** Analysis of Cycle Time of Operation.

**4.1.3 Chances for rework- rejection**

After the product beam is manufactured, testing is done as per quality standards. If it is not adhering to the quality standards, rejection/ rework have to be done till the job complies with the quality standards. The chance for rework/ rejection is compared and shown in Table 3 and chart 3.

Years of experience	Conventional Method (%)	VR Approach (%)
< 1 year	20	12
1to 2	18	15
2 to 5	15	13
5 to 10	12	10
10 to 15	9	7
15 to 25	8	7
Above 25	5	3

**Table - 3:** Input data for Chances for rework-rejection.



**Chart 3:** Analysis of Chances for rework-rejection.

Here is the vivid portrayal of VR method outperforming the conventional methods which are widespread though.

## V. CONCLUSION

The manufacturing process is depicted as a three-dimensional web content using VRML. There is a substantial improvement in the effectiveness of this novel web based communication method. It can be seen that the advantage of the proposed method helps in reducing the cycle time of operation and minimizing the chance of rework/rejections. This ultimately results in cost reduction to the organization. The advantage of this method is more pronounced in the case of fresh technical force rather than in the case of experienced.

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