Development of Product Assembly Instructional Video for training purpose

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Development of Product Assembly Instructional Video for training purpose

P BalaSeshan[1] and Dr K Janardhan Reddy[1, 2]

[1]School of Mechanical engineering, Vellore Institute of Technology, Chennai.

[2]kjanardhanreddy@vit.ac.in

Abstract— This work is focused on the development of effective Product Assembly Instructional Videos. Product assembly instructional video is an important element for training, and boost the skills of employees by laying virtual information of any complex assembly. The instructional video is aimed to train employees on "How the product is assembled" with detailed steps to be followed during assembly and with instructional voice-over n a rendered video. It is found from the literature that traditional training often consumes more time and resource for any organization and frequent changes in manpower makes it more difficult for them to spend adequate time to train. So, the instructional videos are helpful to overcome such problems. The method used in this research paper is to develop a framework for product assembly instructional videos. The research s extended via a case study where n these videos are used for training and discuss with the practitioners regarding how they review this model. This paper concludes with a framework for product assembly instructional videos and describing various factors to consider in the creation of industrial training videos. The work also used various software which includes CAD tools, voice recording, impending, and video editing tools to create a training video manual.

Keywords: Industrial training videos, product assembly, instructional voice-over, multimedia.

1. Introduction

Training video manuals are audio-visual files that are distributed in a digital format [1]. There are different types of videos that are used from lecture-based and worked examples [2]. The current work is focused on industrial training video manuals which provide explanation videos on "How the assembly is done" and with a detailed view of components that are assembled along with the step by step procedure. instructional videos provide a potentially effective training method for addressing gaps in employee knowledge [3]. Limited research had been available on identifying characteristics that maximize the effectiveness of these tools [2]. The purpose of this study is to develop a framework to create an efficient product assembly instructional videos to train employees.

1.1 Role of Instructional Videos

Since 2006, research on the use of instructional video in the industry has grown remarkably [6]. Employees have reported that the audio-visual medium is motivating [5], and effective with respect to learning [4]. In addition, researchers have observed that the use of video manuals has resulted in significant increases in skill sets [9]. While previous research suggests that video manuals have had a positive impact on employees' attitudes and learning performance, the format of presentation has been predominantly passive.[11]

1.2 Product Assembly Based Videos

As stated earlier, assembly video manuals are relatively short (e.g., under 10 minutes) video explanations of how to complete sequential assembly procedure in work areas. The reports suggest that employees had a positive attitude towards the use of video manuals in the training class and that there was a significant correlation between the use of problem understanding and how to solve it easily. In spite of the limited research, the use of training videos has increased rapidly since 2005.iOften used for entertainment purposes, YouTube is also a free source of numerous training videos. However, limited attention has been directed towards improving the effectiveness of these industrial training video manuals. If employees are going to use these tools, it is critical to identify characteristics that influence their quality and impact on learning.

1.3 Criteria for Making Efficient Instructional Videos

In order to identify key features that might alter the effectiveness and impact of product assembly videos, three tangential areas of research were consulted: product assembly examples [5], multimedia, and learning approach. Based on an extensive review of the research, sixteen features were identified as potentially important in designing effective video. These features were organized under four main categories including establishing context, creating effective explanations, minimizing or reducing cognitive load, and engaging employees. Each category and its sub-components will be discussed in turn.

1.4 Establishing Context

To establish the context of product assembly instructional videos, a review of research indicates that the following are key issues to be addressed: problem type, appropriate problem labels, background information, and identification of key problem elements.

Creating a well-designed problem is a critical step to establishing an effective learning context. The requisite knowledge for understanding how to create effective problems is extremely challenging and elusive for many trainers. Robin Holding Kay [12] noted that not enough detail or context is provided in complex assembly problems for employees to establish a connection to what is to be done or how s to be done, an extensive review of how people learn, well-structured, organized knowledge, leads to better problem solving and retention than memorizing a series of facts or procedures. Clear, meaningful labels for problems within a larger organized framework are an important aspect of setting the context for employees' training with these videos. Adds that careful labeling of problems and sub-goals are influential in guiding effective problem-solving.

Eliciting pre-existing knowledge and conceptions related to concepts being taught is an important aspect of training employees to solve problems because it provides opportunities to build on or challenge current understanding. Robin Holding Kay [5] suggests that it is also important to establish why a specific task is important in order to engage and motivate employees in the problem-solving process.

Robin Holding Kay [5] advocates that enough time needs to be spent on explaining what a problem is asking before delving into a solution. If the employee does not understand the structure of the problem, what is being needed, and the necessary key elements required to solve the problem, he/she will have difficulty proceeding. Robin Holding Kay [5] maintain that it is essential that the employee understands key pre-concepts before solving a problem so that he/she is not cognitively overwhelmed. They refer to this guideline as to the pretraining principle.

1.5 Research Questions

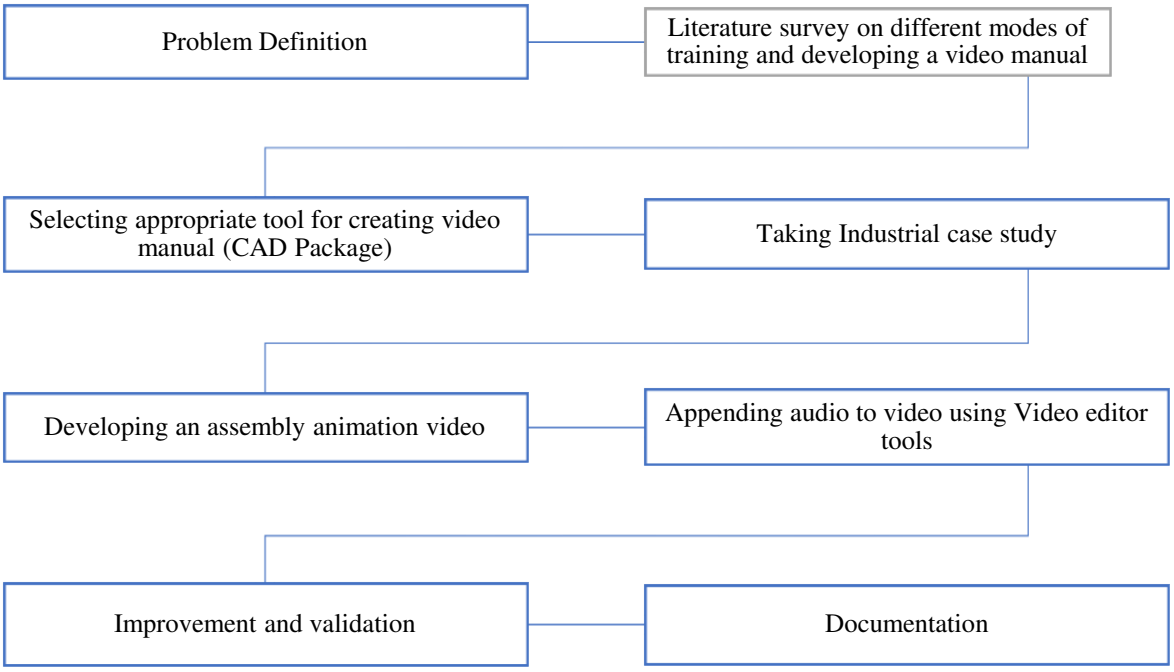
The preliminary framework for creating instructional video, Table 1 was used to develop and deliver 4 pre-calculus problems to an automobile company for training in Assembly. Two primary research

questions were used to assess the effectiveness of the proposed instructional video manual design framework:

1. What were trainees' attitudes toward product assembly instructional videos? (survey data and comments)
2. How did company knowledge change as a result of using instructional video for training?

2. Methodology and Implementation

A brainstorming session is used to sequential the procedure to be followed, the sequence followed is:



2.1 Selection of appropriate tools for the preparation of Video Manual and Appending Audio:

The CAD package used for developing the Assembly video is Solidworks [Institutional] and Composer module for rendering and camera angle and other adjustments. The mobile phone microphone is used for recording the audio and then VSDC video editor s used to integrate both audio and video files. The assembly files were taken from an organization as part of the case study in improving the training through Assembly instructional videos. The project was carried out for 3 months and subsequent results are awaiting.

The organization has given some assemblies based on the complexity of the assembly and to make it easy to understand and with clear explanation and popup instructions at each step. The video has covered all the complexities of assemblies given.

An effort was made to provide high quality, effective explanations that were less than 10 minutes in length, as prescribed by Robin Holding Kay [5]. The length of the video does not compromise on content and explanation n order follows the Suggestion given in reference. Every training video reveals all features of the component and orientation in assembly.

Each instructional video had the following design features based on the schema outlined Table 1: clear problem label (Table 1, item 2), a coherent exposition of the key elements and context of each problem (Table 1, items 3 and 4), step-by-step explanations (Table 1, items 5 & 6), clear writing of important elements in an easy-to-follow layout (Table 1, items 8, 9 and 10), effective use of visuals and highlighting when appropriate, (Table 1, items 7 & 11), a steady pace (Table 1, item 13), and an engaging tone of voice (Table 1, item 12).

Each video includes the assembly first and then exploded view of all components and sequence of assembly to be followed. The Video would start by explaining about the assembly and then individual parts so that it's easy to understand the procedure efficiently. The employees could also control the video with a pause, stop, or play buttons. The process of explaining a step and pausing the clip would allow the employee to complete the corresponding work from his assigned work and it can also verify whether the assembly made by employee right or not at that instance itself.

2.2 Problem Definition

The major concerns with the technical training and development of video manuals in any company/organization are:

1. lack of availability of trainers or instructors and
2. Time or duration of the training, due to which the training is often hurried which may lead to low efficient work output, and this is not desirable.

To overcome such problems a proactive framework is developed which can: improve visual guidance by overlaying virtual information and can also be an efficient training tool for the employee in a short period.

2.3 Selection of appropriate tools for the preparation of Video Manual and Appending Audio

There are many Video editing packages available both online and offline which are used for developing the Assembly videos. Out of which the software used s VSDC video editor, to integrate both audio and video files. The assembly files which were taken for this study also contained current Printed instructions to guide us to follow the industrial procedure and sequence.

Table 1. Key components of model for developing training videos

Creating Effective Explanations
1. Meaningful Steps: The problem is broken down into meaningful chunks. [4]
2. Explain all steps: The reason for conducting each step is explained (so students can understand why a procedure/step is being used) [5]
3. Use of Visuals: Pictures/tables used in the clips helped organize /clarify / illustrate key aspects of the problem. [5]
Minimizing Cognitive Load
1. Readability: The writing in the clips is easy to read. [2]
2. Write down key information: The important elements (terms/definitions /formulas/ procedures) are written down as needed (not all at once). [2]
3. Layout: The layout of the clips is easy to follow (e.g., well organized, not crowded, even horizontal lines) [4]
4. Highlighting: Key areas of problem are visually emphasized (e.g., different color, highlighting, circled) [5]
Engagement
1. Engaging Voice: The tone of the voice is engaging (e.g., was not flat or monotone). [3]
2. Pace: The pace of the clip is good for learning. [3]
3. Length of Clip: The clip is an appropriate length (5 minutes s about right).
4. Distractions: There were no behaviors/habits that would distract a trainee.
5. Trainee problem: Trainees worked on their problem while listening to the explanation of a trainer problem [7]

2.4 Implementation

A case study was performed to find out the key factors of the research work and in this section, a brief justification of all the factors considered during the time of work is given. An example is taken in the Next

section (Results) to show how the exact Softwares are used. in this section, an overview of all the software is given. The model which was taken for this study was in **.stp** format as it is one of the standard formats across all mechanical and manufacturing industries.

2.4.1 Choice of Selection of CAD package:

As there are several CAD packages available in the market, we identified the most used software in the industry and took one such software to demonstrate the work based on the selection matrix with criterion as n Table 2.

***Table 2** Selection Matrix for CAD Package.*

	Catia	*Solidworks*	*ProE*	*Inventor*
Ease of making Assembly Animation Video	*4*	*5*	*4*	*4*
Attachability n Assembly Video [both audio and video]	*4*	*4*	*3*	*4*
Compatibility to convert into the instructional video	*4*	*4*	*4*	*4*
Video frame rate Adjustability	*5*	*5*	*4*	*5*

5- Excellent Working Knowledge. *1- least Working Knowledge*

Note- the above table is not the comparison between Softwares but availability and Accessibility and knowledge of working and it may vary from person to person.

From Table 2, we selected Solidworks for assembly and motion analysis and rendering and developing animation video. The following Figure 1 shows the Solidworks 19(Educational) software interface Table 3 shows some basic features, their icons, and function it does. Figure 2 shows the rendering toolbox.

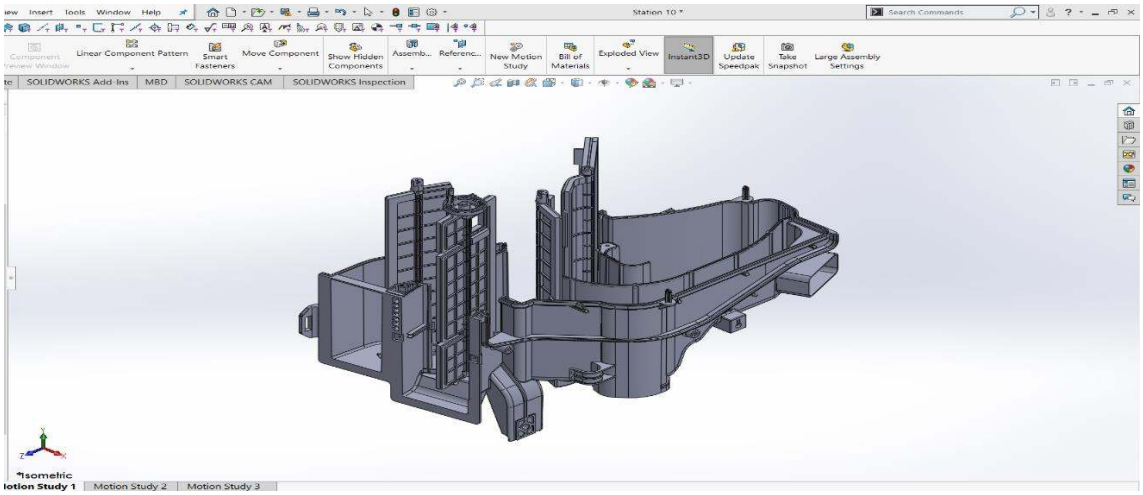


***Figure 1.** Solidworks 19 (Educational)*

Table 3. Solidworks basic Features to create assembly animation videos

Feature Icon	Use of Feature
Insert Components	**Used to insert components in Solidworks**
Mates	**Used to give mates to imported components and constrain them**

Exploded View	**used to generate the components' sequence of assembly in steps**
New Motion Study	**Used for Motion Study of the components in that assembly**
Move Component	**Used to move the components with respect to constraints**
	used to save the animation

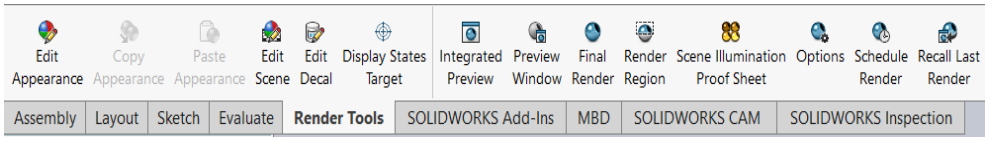


Figure 2 *Rendering toolbox used in this work*

2.4.2 Choice of Selection of Video Editor package:

Similar to CAD packages there are many numbers of video and audio editor packages available. So, it is important to select a package based on a criterion and a decision matrix is developed for this also, Table 4. Describes it,

Table 4 *Selection Matrix for Video Editor Package*

	VSDC	*Windows Movie Maker*	*Adobe Movie Editor*
Ease of impending Audio files	*5*	*4*	*4*
Attachability of subtitles n Video	*4*	*4*	*3*
Attachability of mages at time of editing	*4*	*3*	*4*
Video Contract and Brightness Adjustability	*5*	*5*	*4*
Availability of license	*Trail*	*Trail*	*Trail*

5- Excellent Working Knowledge. 1- least Working Knowledge

Note- the above table is not the comparison between Software, may vary from person to person usage.

From table 3, we selected VSDC Video Editor(trail) for impending audio and other video frame adjustments. The following Figure 2, shows the various tools used n VSDC for completing research work. Figure 3. Shows the VSDC software usage in impending audio and subtitles and other mages to the instructional video.

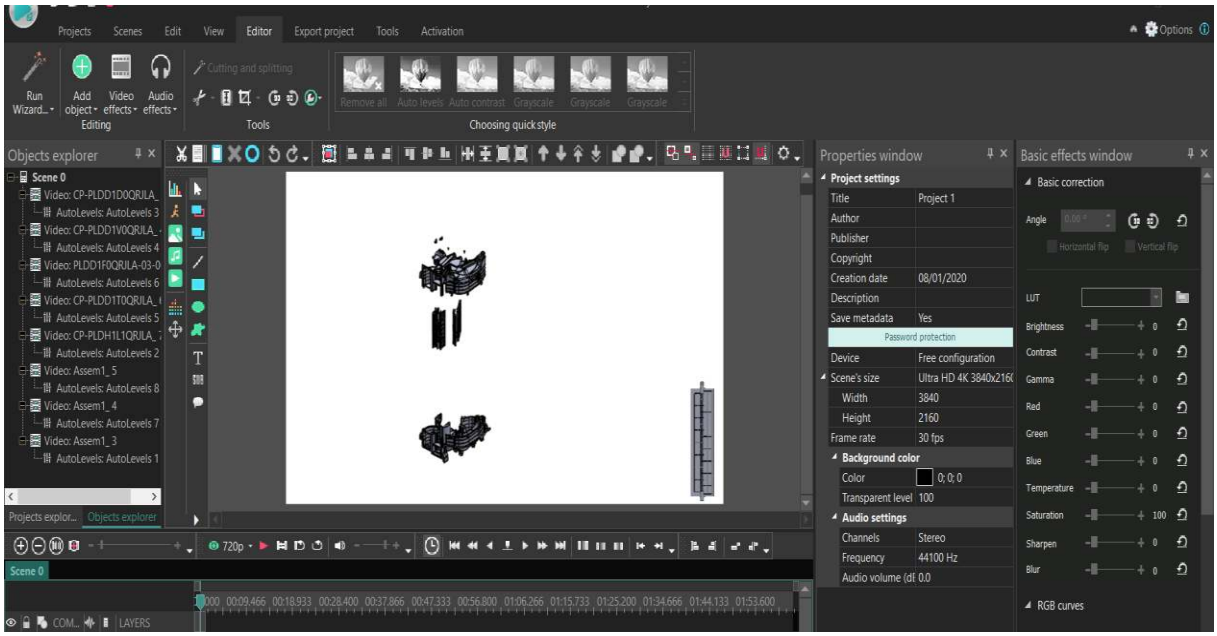


Figure 3 *VSDC Editor interface to edit the video*

3. Results

As a part of research work and to conduct a case study we took the automobile components assembly to develop Assembly instructional Video, the following are the data we adapted to complete the work.

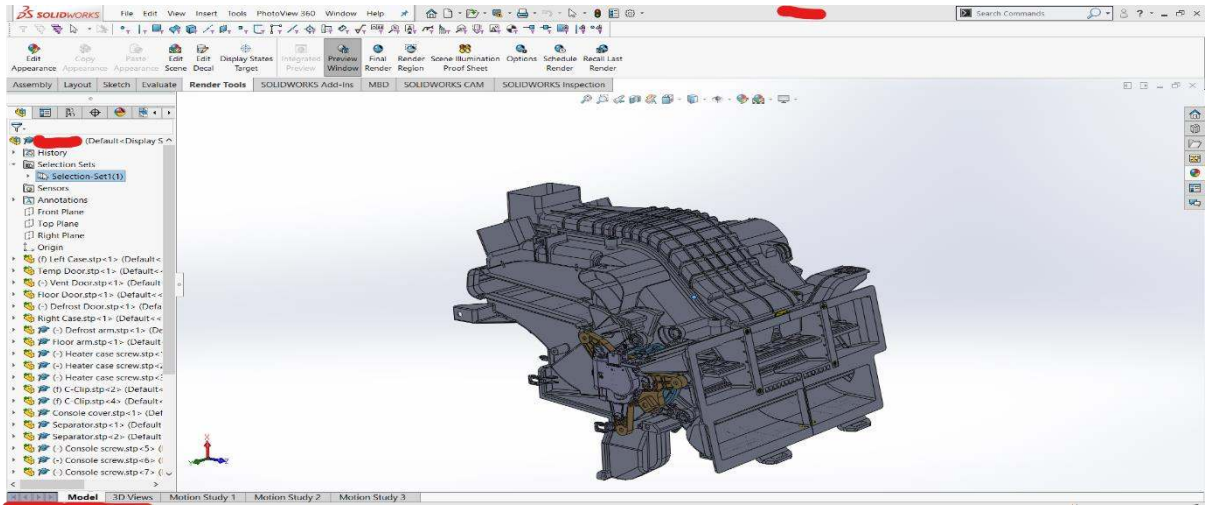


Figure 4 *Case study assembly selected to prepare the video manual*

The component selected has 35 components and the assembly is carried out in 3 different work stations, the instructional video made is into 3 parts with each having steps to be followed and audio instructions and details of how the assembly is done.

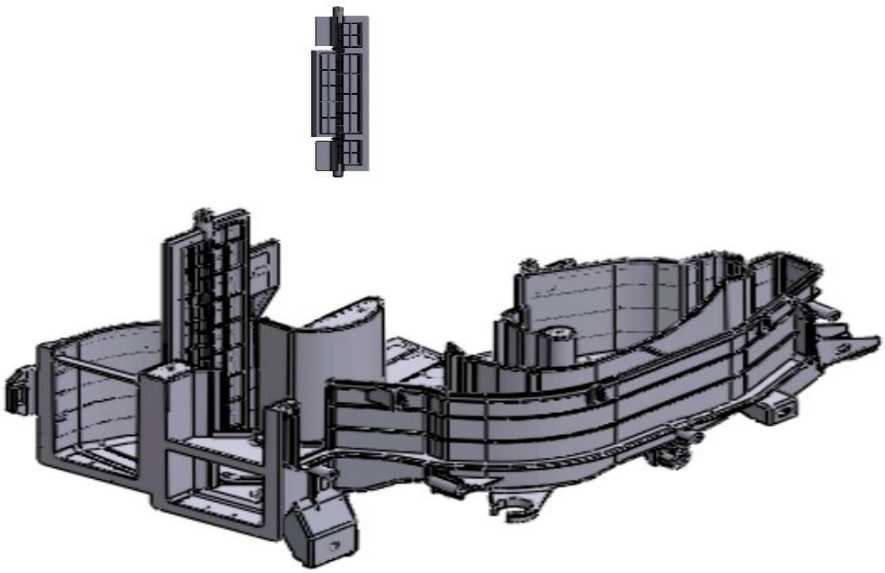


Figure 5. *Illustration clip showing part along with assembly so that there is no difficulty in understanding and identifying the part and location to assemble. It is cropped screen of VSDC Free Video Editor.*

4. Conclusion

Based on a thorough review of the literature written on "How humans learn", a criterion for designing instructional video was proposed and organized under four main categories: establishing context, explaining the problem, cognitive load, and engagement. A holistic, as opposed to an experimental approach, was used to evaluate the general impact of the proposed design characteristics. This study is a first attempt to examine and evaluate a research-based framework for designing and creating an instructional video. A deliberate effort was made to ensure the quality of the analysis by conducting a thorough review of video design principles, providing a detailed description of the assembly used, collecting data from a representative sample, and then using various data collection tools. Furthermore, data collection tools on the attitudes of trainees towards instructional videos could be further refined to target specific design components of the proposed framework. Finally, formal pre- and post-tests on precalculus would provide more persuasive data regarding the impact of instructional videos on learning performance.

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