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Potential Application of Concurrent Engineering in Video Production Process

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ABSTRACT

This study focuses on potential concurrent engineering applications in the video production process to increase productivity and efficiency. To ensure that the process of creating digital material is effective in the age of digitization, significant effort must be taken. One of the widely used digital content is video and it is regarded as the "raw material" in the digital world. Therefore, the ability to produce high-quality videos efficiently is the key to success in the digitalization era. The study goes into detail on concurrent engineering and how it might be used in the creation of videos. The initial model for embedding the concept of concurrent engineering into video production is also being proposed. Concurrent engineering in video production generally could improve the process' effectiveness, cost-effectiveness, and efficiency, leading to better outcomes for clients and higher levels of client satisfaction.

1. Introduction

The process of creating video material, known as video production, is intricate and multi-staged, involving everything from pre-production planning and scriptwriting to filming, editing, and post-production. Storytelling, cinematography, sound design, visual effects, and other creative and technical abilities are all necessary [55, 15]. Since the development of motion pictures in the late 19th century, there has been a long and rich history of video production. The 20th century saw the advent of video technology, which increased the accessibility and affordability of video production. Digital video's introduction in the 1990s and 2000s further democratised video production by making it simpler for people and businesses of all sizes to produce and share video content [28, 11].

Video creation is now more crucial than ever for companies and people trying to connect with their audiences and develop their brands, thanks to the growth of online video platforms like

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YouTube and social media. In many fields, including entertainment, advertising, marketing, education, journalism, and others, video production has become crucial [33, 3]. Video production has become an essential tool for enhancing student engagement and knowledge retention in the context of the ongoing digital transformation of education. It also enables personalised and flexible learning experiences, allowing educational institutions to adjust to the shifting needs and expectations of contemporary learners in a world that is becoming more digitised [37, 39].

The concept and artistic vision for the video are formed during the pre-production phase of video production. Planning, research, and scripting are required for this. The video is either animated or shot during the production stage, and the audio is recorded. Before the video is made available to its intended audience, post-production encompasses editing, colour correction, and sound design (refer Figure 1) [15, 28, 57].

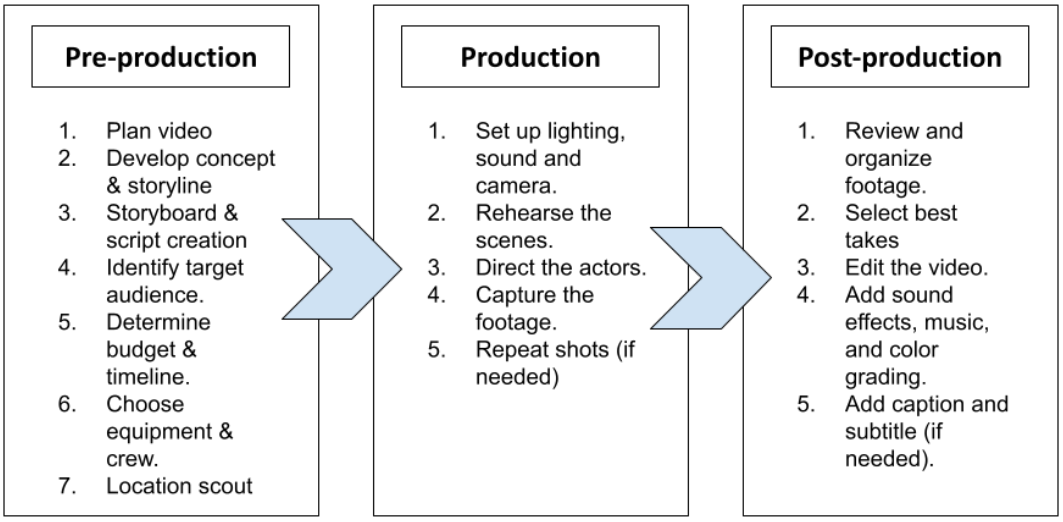

Fig. 1. Video production process [15, 28, 57]

Budget restrictions, schedule issues, and technological challenges are just a few of the potential challenges that may need to be overcome during the lengthy and tough process of producing a video. Therefore, those working in the sector are quite interested in finding ways to increase video production efficiency [21, 42].

Concurrent engineering is one technique that will be proposed to overcome these difficulties. A technique called concurrent engineering tries to speed up the production process by early collaboration and iterative work among all pertinent stakeholders [4]. Concurrent engineering can help to detect and address problems early on and reduce the need for expensive and time-consuming rework by working in parallel rather than in a linear, sequential process [22].

This study makes a significant contribution by addressing the pressing need to enhance productivity and efficiency in video production through the application of concurrent engineering. The research delves into the intricate and multi-staged process of video production, highlighting its historical evolution and current significance in various industries such as journalism, entertainment, advertising, and education. Recognizing the challenges faced by video production teams, including financial constraints, scheduling conflicts, and technological difficulties, the study proposes concurrent engineering as a viable technique to overcome these obstacles. By emphasizing early collaboration and iterative work among stakeholders, concurrent engineering aims to streamline the production process, detect and address problems early on, and ultimately improve efficiency, quality, and cost-effectiveness in delivering video content. The findings of this study provide valuable insights

and practical strategies for video production teams to navigate the complexities of the digital era and achieve high-quality outcomes that meet both client and audience demands.

2. Concurrent Engineering

In the process of concurrent engineering, various disciplines collaborate side by side to design, develop, and produce a product. By having all the disciplines involved in the design process collaborate at the same time, it is a type of integrated product development that aims to shorten the time and expense of product creation (refer Figure 2). Concurrent engineering seeks to shorten a product's time to market without sacrificing quality or client needs. Organizations should make sure that all disciplines are involved in the design process from the start and that they are cooperating to achieve concurrent engineering [56, 22]. Diagrams, charts, and algorithms are only a small component of concurrent engineering. It necessitates a multidisciplinary team effort, where communication and information exchange are essential to coming up with ideas [29, 59].

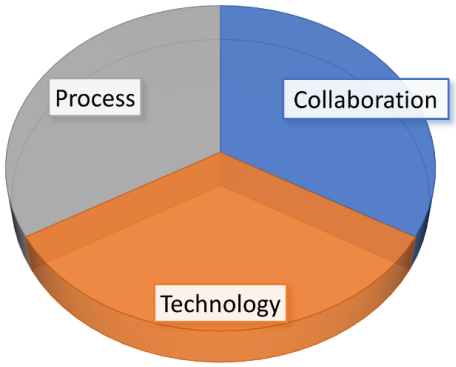

Fig. 2. The key elements of concurrent engineering [56]

Organizations should use computer-assisted technologies to encourage interdisciplinarity collaboration and communication. Additionally, organizations should make sure that all project stakeholders are cooperating to fulfil the project's goals and objectives [9, 20]. By working on several parts of a product simultaneously, concurrent engineering can speed up the development process. It is feasible to spot and address problems early in the development process by incorporating many disciplines, which results in a higher-quality finished product [53]. Additionally, diverse design and manufacturing processes can be integrated through concurrent engineering, which improves production efficiency. Concurrent engineering can cut down on the requirement for costly adjustments later in the development process by finding and fixing problems early on [43, 5].

Concurrent engineering also promotes the involvement of cross-functional teams and encourages communication and collaboration among different disciplines. Additionally, by working on multiple aspects of a product simultaneously, it is possible to identify potential risks and opportunities early in the development process (refer Figure 3), which can help in decision-making [2, 59, 54]. Concurrent engineering is employed in many different industries, including aerospace, defence, automotive engineering, manufacturing, construction, electronics, and software development [40, 29].

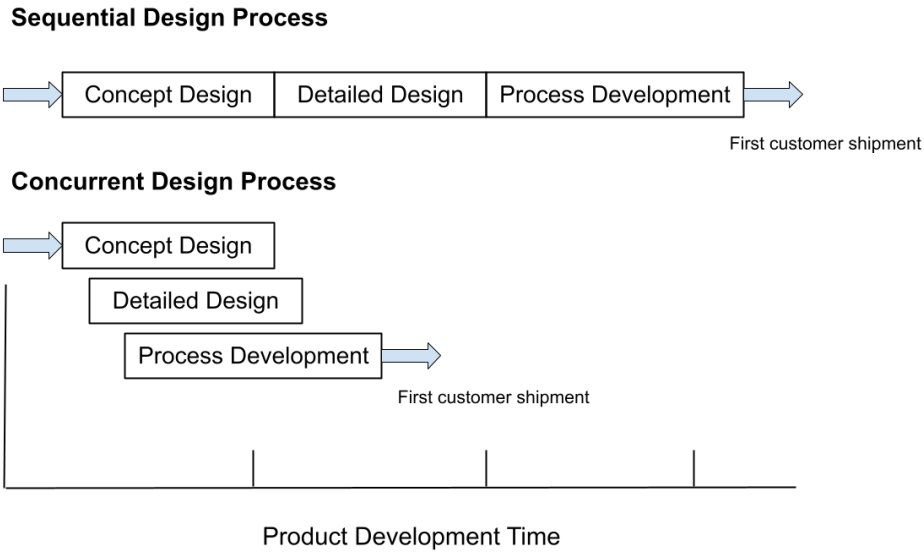

Fig. 3. Concurrent engineering is using parallel development technique so products can reach customers faster [16, 46]

3. Detailed Concept of Concurrent Engineering

Concurrent engineering is a method for developing products that stresses considering all facets of a product's life cycle simultaneously, including design, manufacturing, assembly, and maintenance. By assembling cross-functional teams to work on several project phases concurrently rather than sequentially or linearly, concurrent engineering aims to accelerate the product development process [43, 9, 49].

In response to the requirement for a quicker time to market and the growing complexity of products, concurrent engineering evolved in the 1980s. Sequential engineering, a conventional method of product development, followed a linear process where each stage of the cycle had to be finished before going on to the next [52]. This method was time-consuming and frequently resulted in design faults or manufacturing issues being discovered too late in the process, which could lead to expensive redesigns or delays [16, 46].

Concurrent engineering, on the other hand, entails the integration of numerous disciplines and departments to enable concurrent design and manufacturing activities. Concurrent engineering teams often include members from many functional areas, including design, engineering, production, marketing, and sales. Together, they can address any organisational, financial, and technical problems that come up when developing a product [4, 50, 27].

The ability to identify and address possible issues early is one of the main advantages of concurrent engineering. This is accomplished by creating virtual prototypes that can be tested and improved prior to actual manufacture using computer-aided design (CAD) software and other technologies [23, 54]. This method shortens the time to market while lowering costs and improving product quality [34, 18, 32].

Concurrent engineering can be difficult to implement because it involves fundamental adjustments to the traditional sequential method of product development. When implementing concurrent engineering, organisations may encounter several key difficulties, including communication, coordination, cultural change, training, cost control, complexity, and time pressure. To overcome these obstacles, companies must have a clearly defined strategy and plan for implementing concurrent engineering. They must also provide team members with sufficient resources and support to help them adapt to the new methodology [10, 31, 56].

The concurrent engineering approach is depicted in Figure 4 along with various product development processes, such as quality function deployment (QFD), concurrent product and process design (CPPD), rapid prototyping (RP), clean processes (CP), life-cycle design (LCD), and time to market (TTM) [59]. It lists some pertinent terminologies and approaches. The process begins with the market requirement before moving into the main activity of CPPD, where all tasks related to product and process design are carried out concurrently in parallel. The product requirements will be established using the QFD technique. The use of RP approaches will aid in confirming the product's functionality, manufacturability, and usability. The process design phase can use CP if environmental factors need to be considered [30, 47].

The product will be made and distributed following the CPPD procedure. By using a method known as LCD, all future requirements that the consumer creates because of using and discarding the product will be fed back into the design process. This methodology tries to consider every aspect of a product's whole life cycle throughout the design phase. The TTM is substantially shorter than with the conventional technique because most development tasks are completed concurrently. It suffices to say that the engineer will require the proper tools and procedures, such as design for assembly (DFA) and design for manufacture (DFM), to be able to complete all these design tasks simultaneously [30, 12].

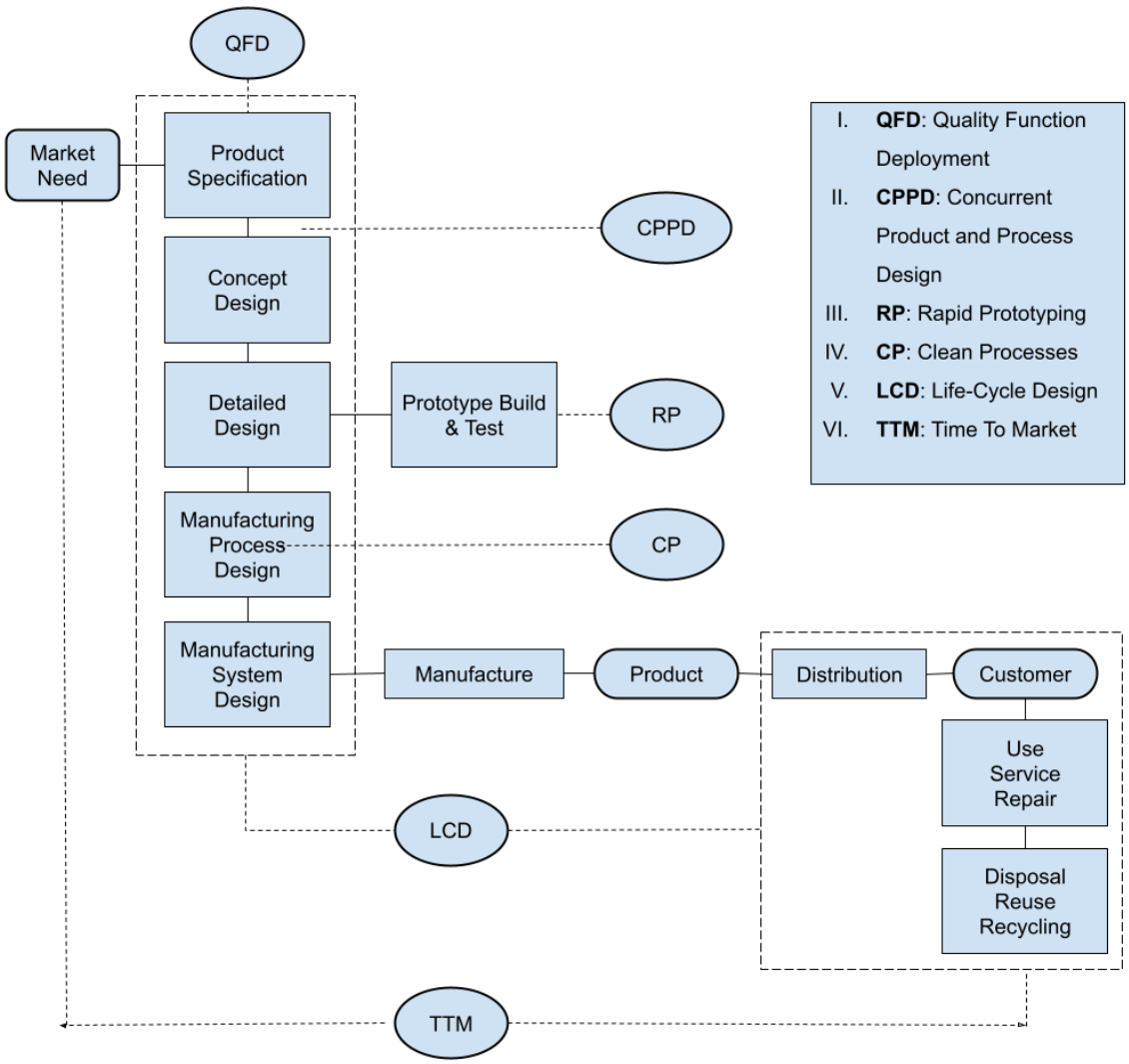

Fig. 4. Concurrent engineering in product development [26, 30]

Implementations of concurrent engineering will differ from firm to company. Individual businesses can create their own "best practice" for product development by utilizing essential actions that enhance the concurrent engineering implementation process. To speed up and enhance their concurrent engineering implementation, manufacturing businesses can employ the tool described [34], which is modelled after a workbook. Additionally, a three-level framework has been suggested by Gao *et al.,* [18], consisting of the suppliers' operating environment, a five-stage implementation process, and a portfolio of concurrent engineering tools.

Concurrent engineering was used in a textile plant by Gabrow [17]. Through the discovery of deployment issues, potential operator errors, and bottlenecks, the method was able to reduce production time. A multi-operation outdoor flexural creep test rig was created by Asyraf *et al.,* [5] using concurrent engineering techniques, including the morphological chart, the Analytic Network Process (ANP) method, and the theory of creative problem solving (TRIZ). Asyraf *et al.,* [6] explains the conceptual design of a portable fire extinguisher made of carbon fibre reinforced polymer composites. The conceptual designs were created by combining the analytic network process (ANP), morphological charts, and the theory of innovative problem solving (TRIZ).

Team-X was able to provide top-notch services for 25 years in, the concurrent engineering design team for a space mission. Through the revision of its review procedure and the addition of pre-design architecting capabilities, the value offered by Team-X has been further increased. Canciglieri *et al.,* [10] shows how the ideas of concurrent engineering and DFM/DFA (Design for Manufacturing and Assembly) can be used in the creation of components and products for the Brazilian White Goods industry. The methods succeeded in lowering costs and shortening delivery times.

In a two-stage R&D project selection process, Braukhane [8] discovered that the use of Set-Based Concurrent Engineering (SBCE) principles enabled the evaluation of technology paths and the identification of the most promising options. Bandecchi [7] explains the Concurrent Design process used in innovative capacity building and emphasised the advantages of three areas (education, interoperability, and system of systems (SoS) architecting). Swink *et al.,* [56] went over five examples of concurrent engineering applications case studies (Boeing 777 aircraft, heavy duty diesel engine at Cummins Engine Co., thermoplastic olefin automotive coating at Red Spot Paint and Varnish Co., airborne vehicle forward-looking infrared night vision system at Texas Instruments, and digital satellite system at Thomson Consumer Electronics). In addition, the research concluded that concurrent engineering is not a simple plug-and-play procedure, and that the effective application depends on a variety of elements, including product features, client needs, and technological requirements. Karningsih *et al.,* [31] managed to reassess how CE implementation is going in a high-tech firm in Indonesia. Simultaneous engineering gap analysis (SEGAPAN) and the analytical hierarchical process (AHP) are used to evaluate the company's concurrent engineering implementation achievement level.

Mabaso [36] highlighted that the absence of strategic communications is the root cause of a number of current concurrent engineering challenges, including poor project portfolio management, a lack of documented setting specific design standards, a lack of consideration for cost-effective designs and for designing products for ease of manufacture and assembly, poor planning of the production process, a lack of agility in the procurement processes, the use of dissimilar technological systems, and a lack of co-design collaboration. Braukhane [8] listed thirteen potential problems with cost prediction while employing concurrent engineering to develop spacecraft (expectation, culture, lack of tools, ROM cost, margin, complexity, lack of time and others). There were also suggestions about how to fix the issues.

3.1 Challenges in Implementing Concurrent Engineering

The method of concurrent engineering calls for an organised model with a predetermined set of tasks to be completed in a coordinated and cooperative way. But the lack of a clear and organised model is one of the main challenges to concurrent engineering implementation. This challenge is exacerbated by the scarcity of thorough recommendations and the dearth of case studies illustrating the effective application of concurrent engineering in industrial settings. The model is typically presented as a set of all-encompassing descriptive laws. Still necessary is a structured concurrent engineering model with a specified set of activities [1].

The second challenge is the lack of comprehensive guidelines for implementing concurrent engineering. To enable designers to move with sets of solutions throughout the video production process, a step-by-step handbook that details the tools to be utilised for each task is necessary [1]. The small quantity and variety of case studies where concurrent engineering is used in industry constitute another challenge. There is minimal research on concurrent engineering uses in the industrial setting outside of the original Toyota case study. Design experts in industry are hesitant to apply concurrent engineering due to the lack of real-world case studies, despite their support for the concept [32, 38].

4. Challenges in Video Production Process

There are several phases involved in producing a video, such as pre-production (planning and organising), production (shooting and recording), post-production (editing, compositing, and color-correcting), and distribution (sharing and releasing the video) [45]. Pre-production, when the project is planned, storyboarded, and facilitated, is the most important stage of video production. From setting up a shoot to creating the actual film, everything is done during this period. Choosing the location, the camera angles, the lighting, the time of day, the props, and the talent are all part of pre-production. Production involves filming the full video project on location or in a set, as appropriate. Post-production is the time when the video is edited and assembled for the final product. All necessary post-production adjustments, such as transitions, colour correction, and audio mixing, are made to produce the final product. Visual effects, motion graphics, animations, and a host of other elements can be used in this stage. After rendering out the project, the team receives it [13, 11, 28].

Although video production is a crucial aspect of modern media, creating high-quality content is still a difficult task. Despite technological developments, producing videos includes complex, interconnected procedures that take a lot of time, money, and knowledge. Professionals in the sector face additional hurdles due to the continuously changing digital environment and consumer tastes, which they must keep up with to remain relevant and competitive. This paper will look at the major problems with modern video production and how they affect the creation of high-quality, widely accessible, and long-lasting video material [51, 44].

4.1 Creative Differences

The collaborative process of video production involves multiple stakeholders with different perspectives and ideas. Conflicts over the direction of the project may arise from creative differences among team members. These discrepancies can lead to delays, more work, and lower quality of the final product. To solve this problem, video production teams must develop successful collaboration tactics that encourage creative input from all project participants while adhering to project goals [51, 58, 13].

4.2 Budget Constraints

Budget restrictions are a frequent problem that video production teams must deal with. Investments in talent, equipment, and post-production are often necessary for successful video production. Budget constraints may force quality trade-offs, which could harm the finished product. Video production teams may need to think about several strategies to solve this problem, such adopting less expensive equipment or coming up with ways to cut expenses without compromising quality [19, 48].

4.3 Time Constraints

Another greatest challenge in the production of videos is time constraints. The final product may suffer because of rushed or incomplete work caused by strict deadlines and extended manufacturing cycles. Teams producing videos must prioritise their work, set reasonable timelines, and always communicate clearly to overcome this difficulty [21, 55].

4.4 Technical Difficulties

Specialized tools and software are needed for video production, and they can occasionally experience technical issues. Technical difficulties may cause delays, rework, and extra expenditures. To overcome this difficulty, video production teams must make sure that hardware and software are kept in good working order and that team members possess the technical know-how to troubleshoot and repair problems as they emerge [45, 11, 48].

4.5 Changes in Technology

New technology and trends are continually emerging in the field of video production. It can be difficult to stay on top of these changes, and if users don't, the content might be out of date or irrelevant. To overcome this obstacle, video production teams must stay current with emerging trends and technology and be willing to modify their existing plans as needed to take advantage of new equipment and methods as they become available [14, 60, 25].

4.6 Distribution Challenges

Finally, distribution can be difficult for teams producing videos. It might be challenging to get the finished product in front of the target consumer, especially in the increasingly congested internet market. Even the best video content may not be seen if appropriate distribution methods are not used. To overcome this obstacle, video production teams must create efficient marketing and distribution plans that focus on the target market and make the most of the available distribution options [35, 61].

In conclusion, making videos is a difficult and complex process that calls for a blend of technical proficiency, artistic vision, and efficient project management abilities. Video production teams may create high-quality content that engages audiences and accomplishes project goals by addressing the problems they confront and adopting techniques for managing them.

5. Potential Application of Concurrent Engineering Concept in Video Production

Video production is considered a service industry. It involves the creation and delivery of a range of visual media products, including films, TV shows, commercials, and online videos, to customers such as production companies, marketing agencies, and individual clients. Video production services can include pre-production activities such as concept development, scripting, casting, location scouting, and storyboarding, as well as production activities such as filming, sound recording, lighting, and editing, and post-production activities such as visual effects, colour grading, and sound mixing [48]. Similar to other service-based sectors, video production can improve the design and delivery of video content by using concurrent engineering techniques. Concurrent service engineering, for instance, can assist video production companies in working together and integrating various aspects of the video production process, from concept development to post-production, to make sure that the final product satisfies the client's needs, is of the highest quality, and is delivered within the time and budget constraints [61, 41, 24, 51, 15].

Multiple stakeholders, including directors, producers, writers, cinematographers, editors, and sound designers, may work together to design, develop, and deliver the final video product when concurrent engineering is used in video production. Concurrent engineering can help to reduce rework, detect, and fix any issues early in the production process, and make sure that the video content satisfies the requirements of both the client and the target audience. Refer Figure 5 for the proposal of process flow to apply the concept of concurrent engineering in video production.

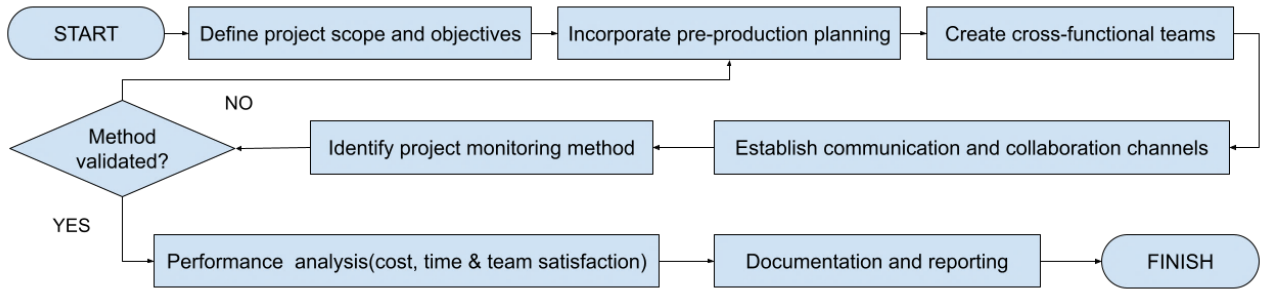

Fig. 5. Process flow for embedding concurrent engineering concept into video production

The initial step is to establish a comprehensive grasp of the project's goals, the work that must be done, and the desired results entail defining the project's scope and objectives. This makes it easier to establish expectations and boundaries for the project and to guarantee that everyone engaged is on the same page and working toward the same result.

Incorporating pre-production planning in video production refers to the process of preparing and organizing key elements of the video before actual production begins. Pre-production planning helps to identify and define key elements of the video such as the storyboard, location scouting, casting, budgeting, and scheduling. This step is crucial for ensuring that the production process runs smoothly, and that the final product meets the desired specifications.

In the context of video production, a cross-functional team might include individuals with expertise in scriptwriting, cinematography, editing, and sound design, who work together to create a high-quality final product. By collaborating and sharing ideas and expertise, cross-functional teams can bring a unique and comprehensive approach to the production process, which can help to ensure the success of the project. To create a high-quality video product, this can involve putting together a multidisciplinary team of experts from several industries, such as sound engineers, graphic designers, and video editors.

Communication and collaboration channels in the context of video production may include scheduled meetings, status updates, email or messaging platforms, or other technologies that enable team members to communicate information and work together efficiently. Team members can cooperate more effectively, reduce disruptions, and generate a higher-quality product by fostering open communication and teamwork.

Effective project management in the context of video production could involve developing a thorough production schedule, monitoring progress concerning the schedule, and using resources like budgeting and resource allocation software to make sure the project stays within budget. Video production teams may make sure that all project components are considered and that the finished result fulfils the required standards by employing effective project management techniques.

Three factors are considered during the performance analysis stage (cost, time, and team satisfaction). The costs of a project employing concurrent engineering will be compared to the costs of comparable projects using conventional sequential methods in the context of project cost. This can be used to assess how well concurrent engineering works to cut costs. The length of time required to finish a project utilising concurrent engineering will be compared to the length of time required to accomplish equivalent projects using conventional sequential methods. This can be used to assess the efficiency of concurrent engineering in cutting down on overall completion times. The team's satisfaction with the new method of working will then be evaluated and contrasted with the previous method.

Overall, the use of concurrent engineering in video production has the potential to increase the process' efficacy, cost-effectiveness, and efficiency, resulting in better results for clients and higher levels of client satisfaction.

6. Conclusions

The process of creating a video includes pre-production planning, scripting, filming, editing, and post-production, among other steps. It has a lengthy and rich history, and technical developments have increased accessibility and reduced cost. With the emergence of social media and online video platforms, video production is crucial in the current digital era. It has emerged as a key resource in several industries, including journalism, entertainment, advertising, and education. To overcome obstacles including financial constraints, scheduling conflicts, and technological difficulties, the video production process necessitates cooperation from all stakeholders. By encouraging early cooperation and iterative work, the technique of concurrent engineering can help to improve the efficiency of video production.

To create and build a product effectively and efficiently, concurrent engineering brings together professionals from many industries. Early in the development phase, this method can assist in identifying potential hazards and opportunities, leading to a high-quality finished product with enhanced manufacturing efficiency and lower costs. The key to overcoming the difficulties faced by production teams in the realm of video production is effective project management, technical competence, and artistic vision. Successful tactics can be used to create high-quality video content that engages audiences and achieves project goals, despite time and money restrictions, technological hurdles, creative disagreements, and distribution issues. Teams working on video production can produce compelling content and reach their goals by addressing these issues and using practical strategies.

Producing and distributing different visual media goods for customers is the process of video production. Through helping video production companies integrate various aspects of the production process, the use of concurrent engineering techniques can enhance the design and delivery of video

content. Concurrent engineering may minimise rework, find and address problems early, and make sure that the video content fits the demands of both the client and the target audience. Concurrent engineering is incorporated into video production through a process flow that includes setting project goals, planning, assembling a cross-functional team, communicating, and working together, efficient project management, and performance evaluation. Concurrent engineering can be used in video production to increase the process' efficiency, quality, and cost-effectiveness, which will benefit clients and boost their satisfaction levels.

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