

# Chapter 97

## Augmented Reality for Collaborative Assembly Design in Manufacturing Sector

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### ABSTRACT

*Some speculations regarding the current issues existing in current assembly work have been brought out in this chapter. The theoretical basis behind the idea that Augmented Reality systems could provide cognitive support and augmentation is established. Hence, this chapter analyses the foundations for assembly feasibility evaluation and discusses possible innovative ways to provide an efficient and robust solution for these problems of realism and efficiency in design and assembly processes. The proposed platform considers the multiple dependencies in different manufacturing sectors that allow the work to be conducted in a simultaneous way, rather than sequential order.*

### INTRODUCTION

For a typical machine, one may look inside and find that it consists of accessories, modules and parts which have to be combined and integrated to fulfill its function. As the last step of mechanical manufacture to satisfy the technical requirements, assembly also includes the relative works such as

regulation of assembly accuracy, inspection of tolerance, test of integration, painting and package other than the pure combination of components. During the process, correctly guaranteeing the assembly precision of machine and components is one of the critical criteria determines the product quality. Before shaping the finished product, the traditional assembly of mechanical components is mainly on the basis of parameters deriving from assembly drawings or some business software

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such as CAD/CAM. Although being guaranteed a realization of strict assembly sequence and considerable assembly precision, such methods guided by assembly drawings or software also manifest their defects. Because of the lack of combination with the real environment, they can't provide a better understanding of different constraints and complicated plant environments in the real assembly circumstances while the after evaluation of assembly workload such as assembly cost, time consuming and hardship could not be easily commanded either. Moreover, concerning a large amount of components to be assembled, an obstacle to understand the assembly drawing between the designers and the assemblers has been introduced. Again, the repetitive assembly operation would also create a incorrect assembly because of the physical tiredness and the mental negligence. Accordingly, such a serious occlusion of information exchange greatly limits the development of the assembly level. To solve this problem, a concept of collaborative assembly design by using AR technology has been arisen, aiming at completing the interconnection of every character in the before-product period. This technology will allow designers, manufacturers and assemblers to collaborate in a distributed way.

This paper mainly focuses on a novel technology to evaluate mechanical assembly sequences, say, the Augmented Reality technology. Defined as the combination of the real and virtual scene, such a technology has been widely used in areas such as product maintenance (Feiner & MacIntyre & Seligmann, 1993), manufacturing (Curtis & Mizell & Gruenbaum & Janin, 1998; Sims, 1994), training (Back, 2001), battlefield (Urban, 1995; Metzger, 1993), medicine (Mellor, 1995; Ueno-hara & Kanade, 1995), and so on (Pope, 1994). Comparing with Virtual Reality (VR) which aims at totally mimicking the real world into the synthetic virtual perception according to the help of computer and separates the real and virtual environment, AR maintains a sense of presence in the real world and balances the perception of

real and virtual world. With the help of a see-through head-mounted device, a data glove and a tracking system, the virtual components can be placed in the real one which can be seen from the head-mounted device. Wearing eyeglasses which are also called the HMD, an operator manipulates the virtual components directly and superimposes them on the real ones with the whole process can be seen from the HMD. Besides, during the operation process of integrating the virtual objects, the operator will detect the real interferences coming from the real objects and the ambient environment that would delay the assembly schedule or need to be further modified. What is more, because of the feedback of other "non-situated" elements like recorded voice, animation, replayed video, short tips, arrows, it could simultaneously guide the operators through the whole assembly operation, release their tension and even notify an error assembly (Raghavan & Molineros & Sharma, 1999). This way, the reality being perceived is augmented. In AR, two noticeable key techniques have to be mentioned. They are the generation of assembly sequence and the superimposition of virtual objects.

The planner, a key component in the system for creating the assembly sequence and reducing the impractical or impossible subsequences while manipulating the real and virtual prototype components in an assembly environment, allows an operator to cooperate with using the assembly graph which is also called the liaison graph (Molineros, 2002). The generation and the decrease of assembly sequence are coming from the mutual behavior between the operator and the planner. With the help of the assembly graph (liaise graph) which serves as the underlying control structure, the planner utilizes precedence constraints along with the liaison graph to input all the possible assembly sequences by planner, say, a state from FFFFF to TTTTT, and then generates all the possible sequences. Following that, a mutual intercommunication between the planner and the operator is used to reduce the impracti-

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