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Computer Aided Design of Power Transmission System

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ABSTRACT -It is widely recognized that today's demands in mechanical power transmission systems, (MPTS), are characterized on the world wide basis by an increasing variety of system combinations . This calls for the development and use of computer programs for designing such systems quickly and accuratelly .

An important reason for using computer - aided design, (CAD) of integrated in the design of MPTS is that, offers the opportunity to develop components, units and drives, constructing the MPTS. It is goal of the CAD of MPTS, not only to automated the design of these components and drive units individually, but also to automated the design of the integrated MPTS as a whole. This work porposed expert system of CAD of MPTS should be designed in a modular way in order to make it applicable both in an integrated form as in a stand alone mode . which is capable to choose the suitable units and drives constructing the MPTS according to the prespecified design data and design them .

KEY WORDS

Computer - aided design (CAD), computer - aided manufacturing (CAM), integrated systems (IS), computer integrated design, (CID), computer – aided construction (CACON), computer - aided calculation (CACAL) , computer - aided data program (CADA), speed ratio (SR), machine design, and mechanical power transmission system, (MPTS).

INTRODUCTION

In general, the Mechanical Power Transmission System, MPTS, is used in many fields to fulfill the requirements offered by the industrial as well as civilian or military applications as to transmit the mechanical power from the prime mover (PM), as the power source to the load, as the power consumer, see Fig . (1).

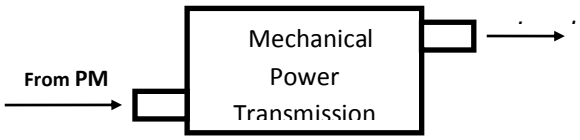

Fig . (1) Functional location of the mechanical power transmission system

The mechanical power transmission system may be a single unit; Belt, Chain, Gear Drive, or as a combination from these different types of drives and others . Gears are the essential components in the general area of power transmission in spite of using Belts, Chains or sometimes Couplings to transmit the power according to the prespecified design data, namely the center distance, the speed ratio and the angle between the input and output shafts . One should carefully evaluate the merits and disadvantages of gear drives as compared to belt and chain drives before incorporating either into a mechanical power transmission system .

Design work is a process of translating the original description of yet non - existing equipment into a form defining how this can be built. The design process involving man - machine interaction is referred to as Computer - Aided Design. CAD/CAM has been uitilized in engineering practice in many ways including drafting, design, simulation, analysis and manufacturig [1]. Generally, CAD is the use of the computer to do the following jobs :

- Designing of machine and structural elements,

- Optimizing the design and modifying it in a relatively very small time with an easy way, and

- Modeling and simulation of a system.

For many people, the words " Computer - Aided Design " confuse up an image of an engineer sitting at a graphic display terminal creating and analyzing the physical behaviour of new designs, or performing their corresponding calculations, while this is certainly an important or even indespensible application, this type of activity represents a relatively small fraction of all computer related work in mechanical design and in fact does little to impact the most critical problem facing most designers; namely the synthesis, analysis, construction and design of the MPTS feeding multi - loads with mechanical power from a PM. It has been asserted that engineering systems may be modeled as modular subsystems with identifiable inputs and outputs to be interconnected in network fashion. Mathematical concepts of this type are studied as graph - theory . It is not surprising therefore, to see substantial use of graph - theoretical concepts as computer aided design of integrated systems, CAD of IS, and it seems natural to use graph - theoretical concepts as basis for understanding the data structure of any MPTS. It is the goal of the CAD of MPTS not only to automate the design of these components and drive units individually, but also to automate the design of the integrated MPTS.

This system should not only enable the user to solve special design problems, but also include data and algorithms necessary for different purposes . CAD of MPTS should, therefore, be designed in a modular way in order to make it applicable both in an integrated form as in a stand alone mode .

For this reason, a CAD program has been developed as an expert system, ES. The developed expert system to design mechanical power transmission systems is capable to choose the suitable units or drives, which are necessary to be used in a mechanical power transmission system according to the prespecified design data, namely the power to be transmitted, single, or multi speed ratios, center distance and the angle between the input and output shafts in the drive, see Fig. (2). Also, the presented expert system solves the design problem of gear boxes through power - pathes, speed stage analysis and finally through geometrical analysis and check calculations for tooth root and surface strength against bending and wear failure respectively for each gear stage in the gear box under investigation .

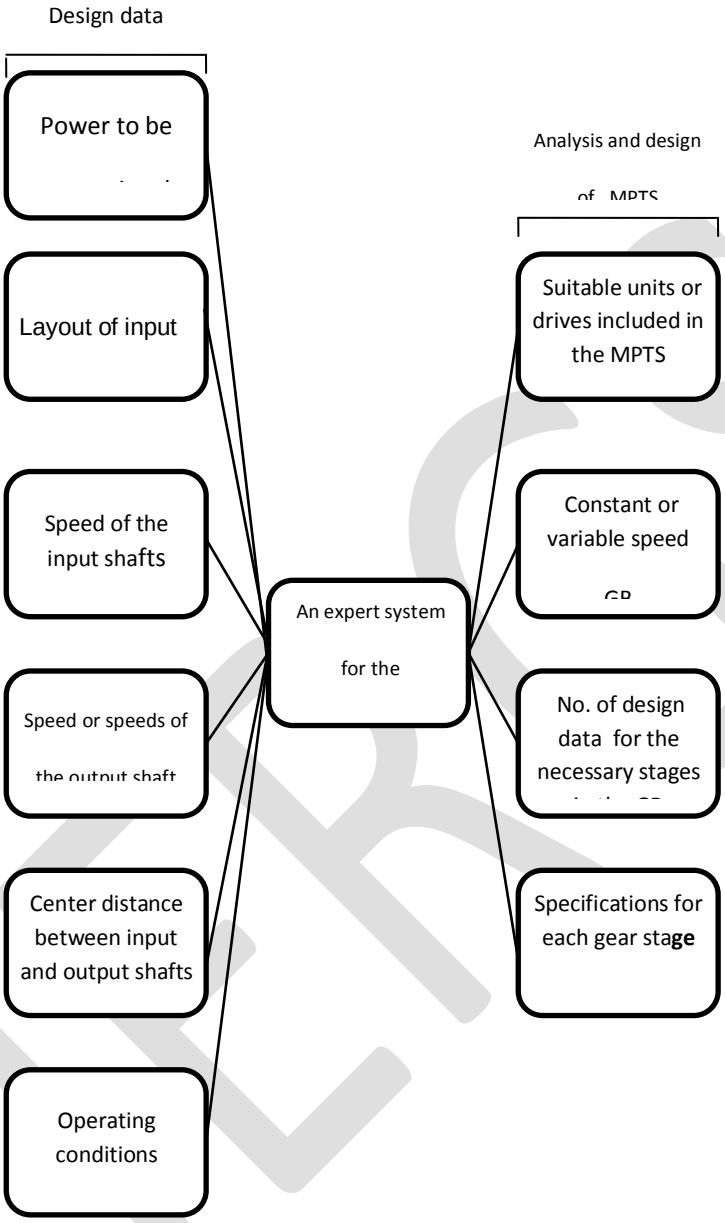

Fig . (2) An Expert System for Design of Mechanical Power Transmission System ES-D-MPTS

AUTOMATION OF THE DESIGN PROCESS

An important reason for using CAD of multi - loads MPTS is that it offers the opportunity to develop the components, units, and drives necessary for this respective MPTS . In the conventional design of such transmission systems, the synthesis and analysis as well as the MPTS construction were carried out by the designer . And as we know, this was both time consuming and involved duplication of effort by design personnel . The most effective way to improve the synthesis, analysis, construction and design of the suitable components particularly for the multi - loads MPTS is to completely eliminate the interactive component-selection from the CAD of the multi - loads MPTS by selecting these components suitably and entirely by the computer using an overall program aimed at atomizing the requisition cycle of the multi - loads MPTS. The maximum benefit of CAD of multi - loads MPTS is only possible by an integration of the synthesis,

analysis, construction and design of the suitable components necessary for this MPTS . This work presents a methodology for automatically performing the complete design process for multi - loads MPTS from the loads data Matrix, which can select, construct and design the suitable mechanical components in this MPTS satisfying both loads layout and speed requirements without any human intervention . Computer Integrated Design, CID, systems have emerged as a means of upgrading the complete design process; synthesis, analysis, construction and design calculations, to assist the design personnel to improve the overall design process . CACON / CACAL implies an integrated process where the computer technology is incorporated in the construction and design of multi - loads MPTS .

The system should not only enable the user to solve special design, but also include data and algorithms for different purposes . CAD of IS should therefore be designed in a modular way in order to make it applicable both in an integrated form as in a stand alone one . Any component should be programmed as an independent unit and used whenever it is required . In an integrated CAD system, direct links are established between the different components and drive units constructing the transmission system as well as between the different design phases . It is the goal of CAD of IS not only to automate the design of the components and drive units individually, but also to automate the design of the integrated system as a whole .

Expert systems are software abilities used to display the modules-modular subsystems with identifiable inputs and outputs-interconnected in a network fashion describing the engineering system. MPTS, by virtue of such nature, are good candidates for Expert System applications . An Expert System combines the designer experience-gained in selection and design of MPTS, with the computer facilities (speed) memory and computational ability, which reduces the required skill, improves the overall efficiency as compared to manual or even semi-automated design process, eliminate the duplication of data and save a great effort and cost.

DESCRIPTION OF COMPUTER PROGRAM

The strategy for automated design of MPTS, or Computer Integrated Design CID systems, illustrated in Fig . (3), shows the following three systems :

-The first system is a computer aided construction, CACON, which is aimed at developing subprograms for the selection of the mechanical components in the MPTS,

-The intermediate system is a computer aided data program, CADA, which proposes a technique aimed to fill the gap between the foregoing CACON and the next CACAL .

-The last system is a computer aided calculation system, CACAL, which proposes a technique aimed at providing computed aided calculation sequence planning applied to the components in the MPTS, which reduces the skill, hence improves the overall efficiency as compared to the human activity .

Such selection procedure is repeated if multi-loads are to be fed with power from a prime mover, using the same setup . This work is incorporated within a computer program .

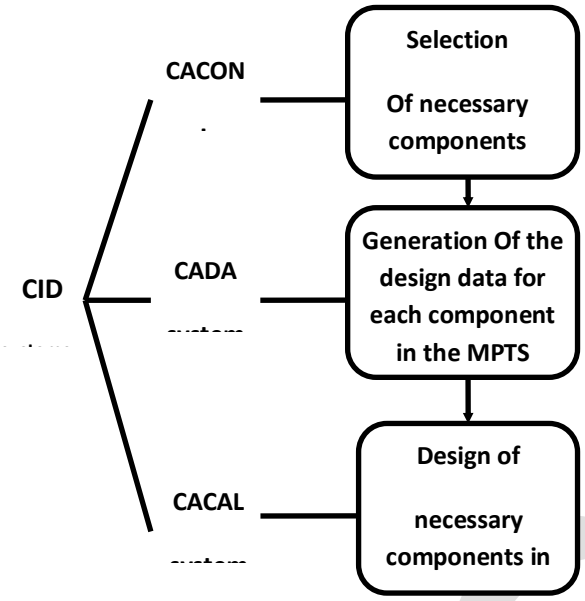

Fig . (3) Computer Integrated Design, CID, systems for MPTS

CASE STUDY

Based on the input data given for MPTS, output speeds 500, 200, 20, rpm and 3000 rpm as an input one, as shown in table 1 .

Table 1. Iutput data

Center distance (m)	Angle between input &output shafts	Number of out put speed
0	0	1

The speed ratio for the power pathes, SR(J) and these for the gear stages in each path U(I,J) as well as the input speed for each stage are displayed in table 2..

Table 2. Output data from the program

Pathes, J		1	2	3
Speed ratio, SR		6	15	150
Stage No.=1	Speed ratio	6	4.9	4.9
	Max. Speed	3000	3000	3000

Stage No.=2	Speed ratio	3.06	7.5
	Max. Speed	612.2	612.24
Stage No.=3	Speed ratio		4.08
	Max. Speed		81.6

CONCLUSIONS

An important reason for using CAD of integrated systems in the design of MPTS is that, it offers the opportunity to develop components, units and drives etc. constructing the MPTS . It is the goal of the CAD of MPTS, not only to automate the design of these components and drive units individually, but also to automate the design of the integrated MPTS as a whole . CAD of MPTS should, therefore, be designed in a modular way in order to make it applicable both in an integrated form as in a stand alone mode . For this reason, a CAD program has been developed as an Expert system, which is capable to choose the suitable units and drives constructing the MPTS according to the prespecified design data as well as to design them .

The structure of the problem under investigation; the design of the MPTS feeding multi-loads with mechanical power from a prime mover, could be now thought to be formulated and then treated in 3-dimensions :

-One dimension would contain the necessary components, units and drives constructing the MPTS for a certain load - arranged in the power flow direction.

-2nd dimension is introduced to spread those for the rest of the loads fed from the same prime mover.

-The 3rd dimension would be dealing with the depth of the design process to include the synthesis, analysis and construction as well as the calculations as applied to the multi-loads MPTS as a whole.

This work presents a methodology for automatically performing the complete design process for multi-loads MPTS, which can select, construct and design the suitable mechanical components in the MPTS satisfying both load layout and speed requirements without any human intervention . Computer Integrated Design, CID, systems have emerged as a means of upgrading the complete design process; synthesis, analysis, construction and design calculations . CACON/CACAL implies an integrated process, where the computer technology is incorporated in the construction and calculations of multi-loads MPTS.

The strategy for automated design of MPTS or computer Integrated Design, CID, systems contains 3-system as :

-The 1st system is a computer aided construction, CACON, which is aimed at developing two subprograms for the selection of the mechanical components in the MPTS,

-The intermediate system is a computer aided data program, CADA, which proposes a technique aimed to fill the gap between the foregoing CACON system and the next CACAL one .

-The 3rd system is a computer aided calculation, CACAL, system which proposes a technique aimed at providing a computer aided calculations sequence planning applied to the components in the MPTS, which reduces the skill, hence improves the overall efficiency as compared to the human activity .

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