

BravoMOST: Advanced Technology for Mechanism Design

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BravoMOST is a first-of-its-kind product aiding the development of complex mechanism designs. BravoMOST represents a technological advancement in automating the design cycle. With this product the engineer can work with a high level design representation rather than one that demands modeling details and interpretation of numeric results.

The "MOST" in the software name stands for Mechanism Optimal Synthesis Tool. This tool specifically addresses the modification phase of the typical design cycle process.

Figure 1 illustrates the traditional approach to mechanism design. As shown, a design is created, a model is made of the design, analysis is performed on the model, and then modifications are made to the design. Typically, the modifications are made manually by the engineer through manipulation of the model.

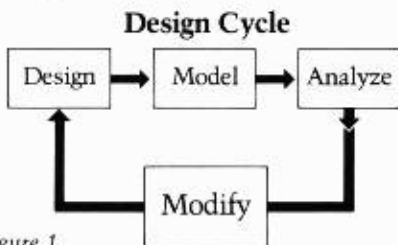


Figure 1

BravoMOST, on the other hand, eliminates the need for the engineer to modify the design by using optimization and synthesis to automatically perform design modifications (Figure 2).

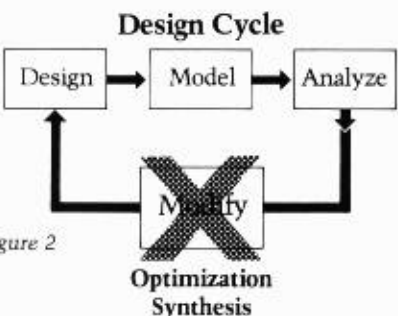


Figure 2

BravoMOST provides the ability to perform kinematic "dimensional synthesis" of both planar and spatial

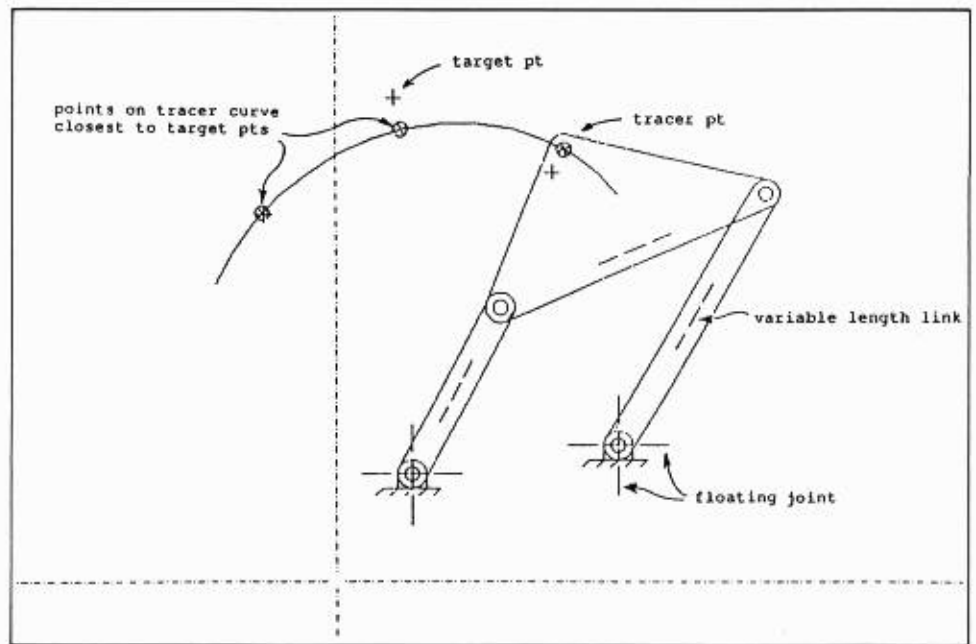


Figure 3

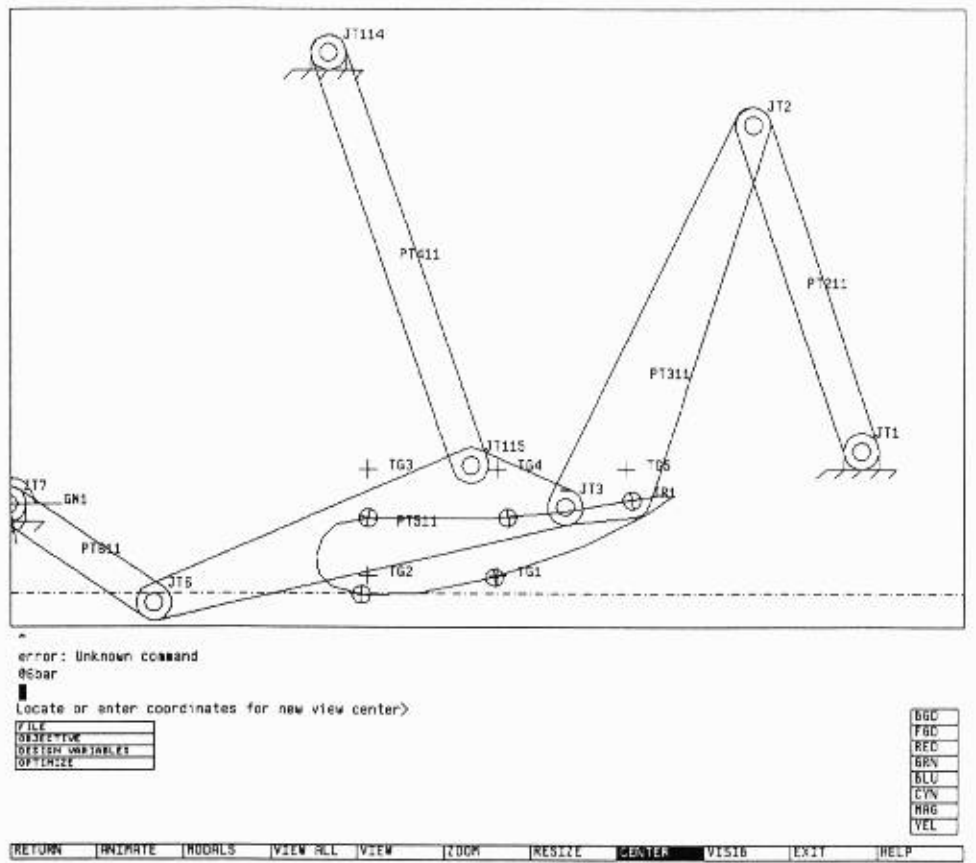


Figure 4

mechanisms. This means that the system will change the dimensions of the mechanism to satisfy some design objective. The system will not change the topology of the mechanism (a six bar Watt type mechanism will remain a six bar Watt type, etc.). The "dimensional synthesis" system for

mechanisms is described below and seen in Figure 3.

A graphic display and user interface assist in describing the design problem. The engineer first reads the starting mechanism from a file. This file is in an industry format that can be created by the

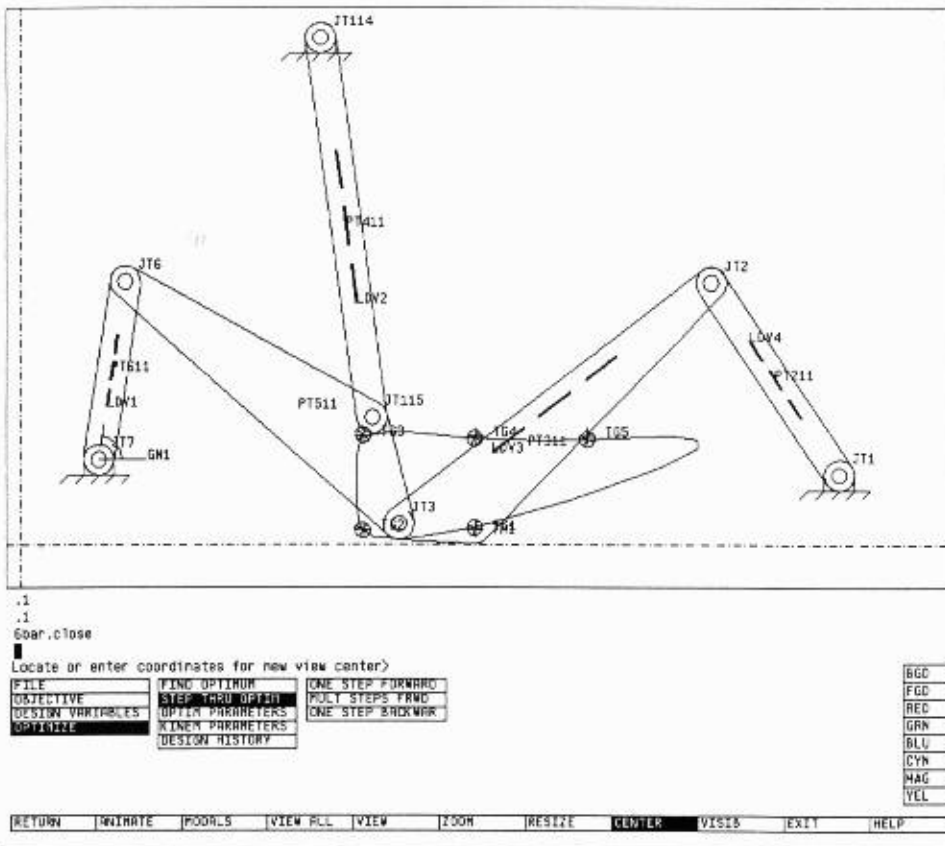


Figure 5

Bravo MECHANISMS application.

Next, the engineer specifies the design intent by defining a new path that the mechanism should trace. The new path is represented by a series of "target points" which defines a "path objective". The engineer also creates a "tracer point" (shown on the mechanism as the circled cross) on the mechanism which must pass through the target points.

The engineer controls what BravoMOST is allowed to modify in the design by creating "design variables". "Design variables" are links with variable length, joints on a single part that can move in relation to each other, etc. (shown as the triple dashed lines). These design variables are modified by the optimizer until the closest approximation of the new path is achieved.

An optimization algorithm is used to determine how the design variables must change in order for the tracer point to come closer to the "objective", i.e., the desired new path. The optimization

calculation requires an analysis to determine gradients (slopes) so the design variables can be changed in the best way. These changes are made to the mechanism (design variables) and the analysis is repeated to determine if the objective has been met.

A proprietary kinematic analysis package is provided as an integral part of the system. This analysis program is used to solve for the positions of the mechanism parts as the path is traced. The kinematic analysis provides feedback to the user and generates information for the optimization.

BravoMOST is a mechanism design system, giving the engineer full control of problem definition and solution strategy. Then, BravoMOST has the power to make the needed changes. BravoMOST changes the mechanism, making a new design model, that traces the new desired path. The optimization part of the software guides BravoMOST's attempts at synthesizing this new design, completely automating the modification phase of the design cycle. Figures 4 and 5 show a six bar cassette tape threader before

and after the synthesis. Notice how the new path conforms to the target points!

Previously, engineers working with any more than a basic mechanism had to simplify the design model to fit the capabilities of available software. Other current software products use what is known as Burmester Theory to solve the mechanism synthesis problem. It's very limited in scope and can only be applied to simple planar mechanisms, such as 4-bar and a few 6-bar. But BravoMOST handles complex 2D and 3D designs by applying optimization to the mechanism synthesis problem. This is a first!

The optimization algorithm (particularly well-suited for solving mechanism synthesis) was developed at the Schlumberger Research facility now based in Austin, Texas. This algorithm is superior to the optimization algorithms commonly developed for general problems, and patents are being proposed to protect it.

In addition to its advanced design capabilities, BravoMOST is an extremely productive tool. It uses a programmable graphic interface called FIT (Flexible Interface Tool). FIT provides an easy-to-use customization capability that allows changes to menus and other interface attributes. The interface may be altered to conform to standard terminology for a specific industry, or, to make the interface more specific to a given design situation or engineer preference. The command language allows the use of extensive macros or procedures to automate a specific command sequence or specify parametric operations. The FIT interface also makes use of the patented tablet stroke recognition capability to execute command strings or macros with a simple free-hand symbol.

Since its creation, BravoMOST has generated a great deal of technical interest. A paper entitled "Optimization and Synthesis for Mechanism Design" was presented at a technical session during AUTOFACT '88 and published in the AUTOFACT '88 Conference Proceedings publication (see pages 16-38 of the Proceedings). We fully expect that BravoMOST will play a significant role in keeping Schlumberger CAD/CAM at the forefront of computer aided engineering.