# LITERATURE REVIEW ON SYNTHESIS OF MECHANISM FOR STUDY CUM COMPUTER TABLE

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**ABSTRACT**

*This article is dedicated to study of different types models cum study chair that are available in the market. Here we focused our attention to solve the problems faced by the user. This paper addressed the various methods available to construct the types of table. While studying the literature our aim to improve the specially these issue that are quite frequently faced by the user. After surveying many researches article author has noticed that these are common problem faced by the people like TFT screen takes space and very less space is left for books. When PC is not in use, dust settles on the monitor Space available on top is used for the monitor resulting into overcrowded top surface. The focused is concentrated to optimize the proposed design, and the detail calculation is made for each component used in design.*

**Keyword: -** *TFT screens1, Kinematics Literature2, Traditional Monitors3, and Optimization4.*

## 1. INTRODUCTION

In today's life every working professional, students, even kids use computers and they also need it for study purpose in their schools and colleges. To solve both these purpose they need a computer as well as a study table. But this requires a lot of space and as discussed before space constraint is a problem. Generally flats are small and have small or medium sized rooms where we have to keep all our belongings suitably and also safely but this requires a large amount of space which many a times becomes difficult to be arranged. That is why monitors of the decade have now been changed to TFT screens. In spite of being quite expensive and sensitive in comparison to traditional monitors, rate of monitor sales is negligible as compared to that of the TFT screens.

Here we are discussing about the different types of models of study cum computer table available in the market. For this we went to different showrooms of furnishings in Delhi and NCR region. The models available in market do not provide separate space for TFT screens hence either the space has to be shared for these purposes or the table top becomes congested. Following are the problem, if we use the current design of table for both the purpose:

- TFT screen takes space and very less space is left for books.
- When PC is not in use, dust settles on the monitor
- Space available on top is used for the monitor resulting into overcrowded top surface.
- The safety of TFT has to be compromised with due to external disturbance.
- The TFT monitor is not fixed in its position.
- Some existing cases have been presented as follows:

## 2. LITERATURE REVIEW

The very first step in machine design is kinematic synthesis of mechanisms that is followed by analysis. Analysis and synthesis tasks should be done together to obtain an acceptable optimum design. Analysis can be in many forms like dynamic analysis, kinematic analysis, force analysis and finite element analysis which consider different matters of the design. However synthesis task, deals with two main problems; to determine the type (Type Synthesis) and to find the dimensions (Dimension Synthesis) of the mechanism which suits best to the desired motion characteristics.

There are several approaches for the dimensional synthesis of mechanisms. Usually two of them find general use: Prescribed Position Synthesis and Optimization Synthesis [1].There are mainly three types of multiply separated position synthesis methods which are: Motion Generation, Path Generation with Prescribed Timing and Function Generation.

In kinematic synthesis of mechanisms, intuition and experience of the designer play a major role compared to other design stages. However, just like in every engineering problem, synthesis problems require the solution of mathematical and/or geometrical systems as well. Even though calculation procedure can be carried out in many programs easily, without a user interface the synthesis task becomes a cumbersome and time consuming problem. Computer programs with user interface not only take over the duty of solving the mathematics and/or geometry of the problem from the designer but also help the user visualize the design. At the end, the designer will have to use his intuition and experience for the selection of the most suitable mechanism out of the possible combinations.

As a whole the necessity of using computer programs for synthesis become abundant in our time with the arising development in computer technology. The computer programs are capable of reaching the best solutions with user interaction at every design stage both in analysis and synthesis.

**2.1 Background**

H. Zhou & Edmund H.M. Cheung [1] adjusted the position of a driven side-link fixed pivot and generates multi-phase motion by the same 4-bar linkage. An optimal synthesis method of adjustable four-bar linkages for multi-phase motion generation is put forward and the closed-form synthesis procedures of driving and driven side-links are presented.

Chi-Feng Chang [2] proposes synthesis methods to design the mechanism that is adjustable for tracing variable circular arcs with prescribed velocities. The constraint equations and useful properties of the desired mechanism are derived by using the concept of cross-ratio. The desired mechanism can be a crank-rocker or a slider-crank mechanism.

Kevin Russell & Raj S. Sodhi [3] proposes a method for designing slider-crank mechanisms to achieve multi-phase motion generation applications typically accomplished by adjustable planar four-bar motion generators. The benefit of this method is twofold. First, multiple phases of prescribed rigid body positions are achievable using a mechanism with fewer moving parts than the planar four-bar mechanism. Second, the slider-crank motion generator can achieve phases of prescribed rigid body positions without any physical or automated adjustments of its moving pivots between phases.

A set of Burmester curves can represent an infinite number of planar four-bar motion generator solutions for a given series of prescribed rigid-body poses. Unfortunately, given such a vast number of possible mechanical solutions, it is difficult for designers to arbitrarily select a Burmester curve solution that ensures full link rotatability, produces feasible transmission angles and is as compact as possible.

Peter J. Martin, Kevin Russell, Raj S. Sodhi [4] presents an algorithm for selecting planar four-bar motion generators with respect to Grashof conditions, transmission angle conditions and having the minimal perimeter value.

Tao and Krishnamurthy [5] developed graphical synthesis procedures of adjustable mechanisms to generate variable coupler curves with cusps and symmetrical coupler curves with a double point. Shoup [6] presented a technique for the design of an adjustable spatial slider-crank mechanism used as a variable displacement pump or compressor. Velocity fluctuation, force transmission effectiveness and mechanism geometric proportions were considered in the design method.

The Precision Point Synthesis which was first solved by Burmester graphically. G.N.Sandor, R.E. Kaufman & A.G. Erdman [7] worked on Planar geared linkages readily lend themselves to function, path and motion generation. Function generation includes any problems in which rotations or sliding motion of input and output elements (either links or gears) must be correlated. In some cases, the designer may want to produce a formal functional relationship between the input and output. In these cases, the input and output rotations can be used as the linear analogs of the independent and dependent variables. Freudenstein [10] contributed to this theory by formulating the problem analytically. Erdman and Sandor introduced the dyadic approach which is easy to implement to numerical solutions.

Gordon R. Pennock, Ali Israr [8] investigates the kinematics of an adjustable six-bar linkage where the rotation of the input crank is converted into the oscillation of the output link. This single-degree-of freedom planar linkage will be used as a variable-speed transmission mechanism where the input crank rotates at a constant speed and the output link consists of an overrunning clutch mounted on the output shaft. The analysis uses a novel technique in which kinematic coefficients are obtained with respect to an independent variable. Then kinematic inversion is used to express the kinematic coefficients with respect to the input variable of the linkage.

The theory mentioned, forms the base of the many of the software packages on the market. Some of the software on the other hand, uses optimization routines to generate the desired motion or path.

Many computer programs are written for kinematic synthesis of mechanisms. In addition to the literature presented Ulushan and Sezen, WATT® [20] is a good reference for synthesis of mechanisms. The software interacts with other common programs like Excel® and AutoCAD® that the user can import or export data. In the present study commercially available CAD software like solid works, Auto CAD used to synthesis of planer mechanism to solve the problem of art.

**2.2 Synthesis of Mechanisms**

Although in general a designer's inventiveness and intuition play a significant role in the synthesis of mechanism there are three fundamental problems of synthesis which can be solved in systematic manner. They are as follows:

**2.2.1 Function Generation**

A frequent requirement in design is that of causing an output member to rotate, oscillate, or reciprocate according to a specified function of time or function of the input motion. This is called function generation. That is correlation of an input motion with an output motion in a linkage. A simple example is that of synthesizing a four-bar linkage to generate the function the function y=f(x). In this case, x would represent the motion (crank angle) of the input crank, and the linkage would be designed so that the motion (angle) of the output rocker would approximate the function y. Other examples of function generation are as follows: In a conveyor line the output member of a mechanism 9 must move at the constant velocity of the conveyor while performing some operation for example, bottle capping, return, pick up the cap, and repeat the operation. The output member must pause or stop during its motion cycle to provide time for another event. The second event might be a sealing, stapling, or fastening operation of some kind. The output member must rotate at a specified no uniform velocity function because it is geared to another mechanism that requires such a rotating motion.

**2.2.2 Path generation**

A second type of synthesis problem is called path generation. This refers to a problem in which a coupler point is to generate a path having a prescribed shape that is controlling a point in a plane such that it follows some prescribed path. Common requirements are that a portion of the path be a circular arc, elliptical, or a straight line. Sometimes it is required that the path cross over itself. For this minimum 4-bar linkage are needed. It is commonly to arrive a point at a particular location along the path without/with prescribed times.

**2.2.3 Motion Generation**

The third general class of synthesis problem is called body guidance. Here we are interested in moving an object from one position to another. The problem may call for a simple translation or a combination of translation and rotation. In the construction industry, for example, heavy parts such as a scoops and bulldozer blades must be moved through a series of prescribed positions.

The four-bar linkage has a long history in kinematics literature. In the following articles we are discussing two different methods available for the synthesis of four bar mechanism.

**2.3 Three Position Synthesis of Four bar Mechanism**

There are various graphical methods for the synthesis of mechanisms like two point synthesis, three point synthesis, and four point syntheses for motion generation [9]. Here we are discussing three point analysis of four bar mechanism. The graphical procedure employed for two point synthesis can be extended to three point synthesis. In figure 2.1 the input crank 2 drives the output crank 4 through three specified positions. The input crank angle is $Ø_0$ and the displacement angles $Ø_{12}$, $Ø_{23}$ and $Ø_{13}$ respectively, corresponding to the design positions 1 and 2.2 and 3, and 1 and 3. The corresponding desired output crank displacement angles are $\psi_{12}$, $\psi_{23}$ and $\psi_{13}$. It is required to determine the length of output link 4 and the initial output crank angle $\psi_0$.

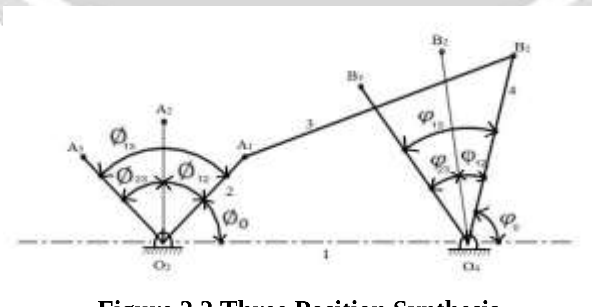

**Figure 2.2 Three Position Synthesis**

Figure 2.2 illustrates the solution to the three position synthesis problem which is based on inverting the linkage on the output link 4. First the input crank O2A is drawn in three specified positions and the desired position for O4 is located. Since the procedure is based on inverting on link 4 in the first design position, draw a line from O4 to A2 and rotate it backward through the displacement angles 13 locates A3'. Since A1 and A1' are coincident (due to inversions on the first design position) mid normal to the lines A1'A2' and A2'A3' intersects at B1 which establish the length of the coupler link 3 and the initial position and length of the output link 4.

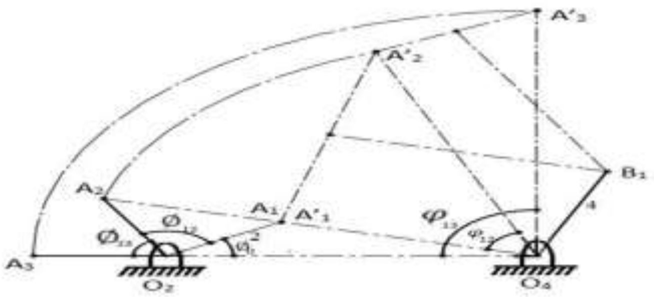


**Figure 2.1: Four bar Mechanism**

**2.4 Freudenstein Equation**

Freudenstein's Equation**,** uses a simple algebraic method to determine the position of an output lever in a linkage mechanism. This revolutionary equation has been developed by Ferdinand Freudenstein in his PhD dissertation.

**2.4.1 Freudenstein Method**

Freudenstein method [19] is an analytical method for synthesizing four-bar linkage. For three-position synthesis, except the three link length ratio, all other parameters were chosen arbitrarily. In the case of four-position synthesis no parameters, except the three link length parameters, can be chosen arbitrarily, as four positions are to be satisfied. Either one more parameter is to be left out as unknown, or a compatibility condition must be satisfied by these chosen parameters. In any case, the resulting equations turn out to be non-linear and, with arbitrary values of the chosen parameters, there may exist zero, one or two solutions.


**Figure 2.3 Four Bar Linkages**

These resulting non-linear equations in four unknowns are solved using the technique of linear superposition. Figure 2.3 shows a four-bar linkage with link lengths as $r_1$, $r_2$, $r_3$ and $r_4$. All the angles are measured counter clockwise from the X-axis, which is along the fixed vector l1. Thus q1 = 0.Considering the closed loop O2ABO4O2,

r1 + r2 + r3 + r4 =0 (a)

$r_1\, e^{j\theta}{}_{1} + r_2 e^{j\theta}{}_{2} + r_3 e^{j\theta}{}_{3} + r_4 e^{j\theta}{}_{4} = 0$ (b)

If the equation (b) of the preceding section is transformed into complex rectangular form, and if the real and imaginary components are separated, we obtain the two algebraic equations

$r_1 \cos\theta_1 + r_2 \cos\theta_2 + r_3 \cos\theta_3 + r_4 \cos\theta_4 = 0$ (a1)

$r_1 \sin\theta_1 + r_2 \sin\theta_2 + r_3 \sin\theta_3 + r_4 \sin\theta_4 = 0$ (b1)

From the fig 2.3 $\sin\theta_1 = 0$ and $\cos\theta_1 = -1$;

Therefore $-r_1 + r_2 \cos\theta_2 + r_3 \cos\theta_3 + r_4 \cos\theta_4 = 0$ (c)

$r_1 \sin\theta_1 + r_2 \sin\theta_2 + r_3 \sin\theta_3 + r_4 \sin\theta_4 = 0$ (d)

In order to eliminate the coupler angle $\theta_3$ from the equations, move all terms except those involving $r_3$ to the right – hand side and square both sides. This gives

$$(r_3 \cos \theta_3)^2 = ( r_1 - r_2 \cos\theta_2 - r_4 \cos \theta_4 )^2$$

$$(r_3 \sin \theta_3)^2 = ( C \sin\theta_2 - r_4 \sin \theta_4 )^2$$

Now expand the right hand side of both equations and add them together,

$$((r32 - r_1^2 - r_1^2 - r_4^2) / 2 r_4 r_2)) + (r1/ r_4) \cos \theta_2 + (r_1/ r_2) \cos \theta_4 = \cos (\theta_2 - \theta_4)$$

Freudenstein writes Eq. in the form

$$K_1 \cos \theta_2 + K_2 \cos \theta_2 + K_3 = \cos (\theta_2 - \theta_4)$$

With $K_1 = ((r_3^2 - r_1^2 - r_1^2 - r_4^2 ) / 2 r_4 r_2))$

$K_2 = (r_1/ r_4)$

$K_3 = (r_1/ r_2)$

**2.5 Optimization**

In the design of technical systems and components it is of crucial importance to reduce costs, improve performances and system reliability and shorten time to market. The use of rigorous methods of decision-making, such as optimization methods, coupled with modern tools of computer-aided design may be effective in this. Especially for large and complex systems these Structured and advanced methods may become necessary. Furthermore, they lead to better solutions and enhance the creative process of conceptual and detailed design of technical systems. The course 'Engineering Optimization' covers several topics that are important for the design and optimization of mechanical systems and products, especially when finite element methods, numerical integration methods, or discrete-event simulation techniques are used for analysis. Engineering is trade of creating products which fulfill a given task with minimum input and maximum output. Therefore, optimization is an art of reducing input in such a manner that the output is increased.

**2.5.1 Optimization of Four-Bar Linkage**

Kinematic synthesis with the precision point approach contains certain number of precision points. These precision points are limited by the number of available design parameters in the linkage. The desired motion characteristics are achieved at these precision points in the entire range of movement of the linkage and there will be inherent structural errors at all other points. In the optimization approach, however, the desired motion characteristic is not attempted to be exactly satisfied at any point in the range of movement. Rather, any number of design positions is chosen and some error quantity, suitably defined using these chosen positions, is minimized. The number of such design positions is not limited by the number of available design parameters. Here, least-square technique is used as the optimization approach for mechanism synthesis.

From synthesis equations, the equation for qth design position can be written as,

$$D_1 \cos\left(\theta_2^q - \theta_4^{1q}\right) - D_2 \sin\theta_4^{1q} - D_3 \cos\theta_2^q - D_4 + \lambda_1 \sin\left(\theta_2^q - \theta_4^{1q}\right) + \cos\theta_4^{1q} = 0$$

where

$$\left.\begin{aligned} D_1 &= \frac{l_2}{l_1} \\ D_2 &= \frac{l}{s_1}\sqrt{1-s_1^2} \\ D_3 &= \frac{l_2}{l_4 s_1} \\ D_4 &= \frac{l_1^2 + l_2^2 - l_3^2 + l_4^2}{2 l_1 l_4 s_1} \\ \lambda_1 &= \frac{l_2}{l_1 s_1}\sqrt{1-s_1^2} = D_1 D_2 \end{aligned}\right\}$$

Here D1, D2, D3 and D4 are the design parameters and l1 is the non-linearity coefficient. At this stage, it must be appreciated that equation (14) is not satisfied exactly at the design positions since the values of q2 and q4 have already been co-ordinated according to the prescribed function. It is assumed that the left hand- side of equation (14) will turn out e when the values of q2 and q4 are substituted. The value of represents the error in the loop-closure equation at a design position. The objective is to determine the design parameters so as to minimize the overall error, considering all the design parameters, in the least square sense. The expression for e for the qth design position can generally be written in the form:

Equation

$$\varepsilon_q = \sum_{p=1}^{M} D_p \mu_{pq} - \nu_q - \lambda_1 \rho_q - \lambda_2 \delta_q$$

Thereafter, the design parameter D is obtained from equation (17), once the non-linearity coefficients are obtained from the comparability conditions. Comparing equations (14) and (15),

$$\mu_{1q} = \cos\left(\theta_2^q - \theta_4^{1q}\right), \quad \mu_{2q} = -\sin\left(\theta_4^{1q}\right), \quad \mu_{3q} = -\cos\theta_2^q,$$

$$\mu_{4q} = -1\ , \ \rho_q = -\sin\left(\theta_2^q - \theta_4^{1q}\right), \lambda_2 = 0\ .$$

From equation (17) and using $\lambda_1 = D_1 D_2$,

$$\beta_1 \beta_2 \lambda_1^2 + (\alpha_1 \beta_2 + \alpha_2 \beta_1 - 1)\lambda_1 + \alpha_1 \alpha_2 = 0$$

Each real root of this equation results a possible design and one of these designs will be optimum design.

**2.5.2 Results**

**Table 1. The results of synthesis for log x, exp x, sin x and tan x functions at four accuracy points are summarized**

| **Function** | | **log x** | **$e^x$** | **sin x** | **tan x** |
|---|---|---|---|---|---|
| Interval of x | - | 1*2 | 0*1 | 0*90 | 0*45 |
| Range of θ 2 , deg | - | 60 | 90 | 90 | 90 |
| Range of θ 4 , deg | - | 60 | 90 | 90 | 90 |
| Crank angle θ 2i , deg | - | 50 | 265 | -65 | 213 |
| Accuracy points | $X_1$ | 1.0381 | 0.0381 | 3.4254 | 1.7127 |
| | $X_2$ | 1.3087 | 0.3087 | 27.7792 | 13.8896 |
| | $X_3$ | 1.6913 | 0.6913 | 62.2208 | 31.1104 |
| | $X_4$ | 1.9619 | 0.9619 | 86.5746 | 43.2873 |
| Follower angle, $\theta_1$ , deg 4 | - | 86.3058 | 31.9547 | 70.2382 | 11.5262 |
| Link length ratios | $L_2/ L_1$ | -2.9264 | -2.8907 | 1.3367 | -3.7217 |
| | $L_3/L_1$ | -3.1110 | 1.7907 | 1.8831 | 1.1871 |
| | $L_4/ L_1$ | 1.0844 | 2.3977 | -0.5582 | 4.4618 |
| Maximum output error,% | - | 0.4104 | -0. 1889 | -2.1929 | -0.6742 |

## 3. CONCLUSION

For this we went to different showrooms of furnishings in Delhi and NCR region. Many research article being surveyed successfully and based on these survey report author calculated result of synthesis for log x, exp x, sin x and tan x functions at s four accuracy points are summarized. Apart from theses optimization technique used which is an art to reduce the input in all terms with improved output**.** Many types of computer models of study cum computer table available in the market but author intended to provide the best one that can overcome the most of the problem discussed in the literature.

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