DESIGN AND DEVELOPMENT OF TECHNICAL SKILL TEST AND TRAINING EQUIPMENT FOR LINEAR AXIS TABLE MOVEMENT

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Abstract- **In Skill Test, every individual must possess necessary skills required to perform the job. A wide variety of recognition is used to determine or confirm the skill set proposed. Here in this project, the skill test of every individual is tested by the linear movement of Stylus in X and Y axis following through the different profiles in Easy, Medium and Difficult profiles. The directions of Stylus are controlled by the spindle and to be moved simultaneously by both the hands.**

The handle wheel is connected to threaded rod with fine pitch such that back slash between one pitch to another pitch of the thread will be avoided. The Stylus travel from "START" position to "END" position will go through different shapes of curves. The skill behind taking the Stylus from one position to another position is to not to touch/hit the walls of profile. The skill of the operator is evaluated by taking the Stylus between close tolerances. The operator's skill is measured by less or no number of hit to the surface of the wall which will be displayed in the board. Less the number of mistakes will be considered for high accuracy and more mistakes mean need more practice and concentration.

Index Terms-Technical Skill device, Training equipment, linear axis table,

I. INTRODUCTION

The process of teaching or improving skills, knowledge, or fitness in oneself or others in relation to certain desirable competencies is known as training. Training is intended to improve one's capability, capacity, productivity, and performance. It is the cornerstone of apprenticeships and the backbone of content in technological institutes (also known as technical colleges or polytechnics). In addition to the fundamental training necessary for a trade, occupation, or profession, training may continue beyond initial proficiency to retain, enhance, and update skills throughout one's working life. Professional development is a term used by people in certain professions and occupations to describe this type of training.

On job training takes place in a typical working environment, with trainees using the same tools, equipment, papers, or materials that they will use after completely trained. For vocational work, on job training is widely regarded as the most effective method. It entails individuals receiving training on the job while performing their duties. The instructor is usually a professional trainer (or maybe an experienced and skilled employee) who uses hands-on practical experience supplemented by formal classroom presentations.
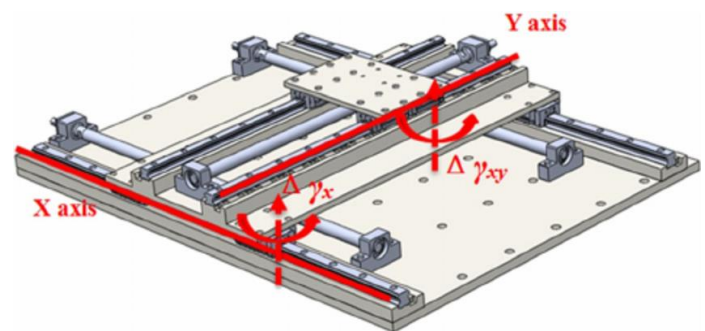
Fig (1) Diagram of Training Equipment

It aids in the advancement of an individual's career as well as the organization's continued success. On job training is considered when actual training takes place on particular job. Employees may be familiarized with the working are where they play a part during training. Employees obtain hands on experience with equipment's, tools, materials and machines. The candidate needs to face the problems that occurred during performing the work, which is a part of on job training. An experienced employee or manager plays the role of mentor, passing on his or her knowledge and company-specific

abilities to the new employee through written or verbal instructions and demonstrations.

Employees are less stressed when training takes place on the job rather than in a classroom. On job training is the most common form of education not only in the United States, but also in most developed countries such as the United Kingdom, China, and Russia. Its efficiency is based on the use of existing workplace tools, machinery, records, and equipment, as well as the expertise of experts in the subject. On job training is simple to set up and maintain, and it makes the transition to a new job easier. For practical work, on job training is very popular. It is affordable, and it does not necessitate the employment of specialized equipment for a given task. The firm is required to keep participants as regular employees after they have completed the training. [1][2]

Training equipment is a device that is used to increase the strength of a physical activity. Training is the process of improving one's skills and knowledge in order to build meaningful competences. The purpose of training is to improve capability, productivity, and performance. The On job training approach takes place in a typical working environment, with actual tools, equipment, or materials that the trainees will use once they have completed their training.

In technical skill test/training equipment variety of training are available. There are various ways to develop skills, some of the symmetrical skills are In house industrial training, Improve Students Employability skills, CNC Machine operator Training, Reality training, Improve training & Development of workers, multi-level training of skilled workers, Position control of XY Table, Modeling and control of a XY positioning table, Measure students machining skill, micro positioning of two dimensional table with long travel and others.

They underline that rather than focusing on a single subject or course for students, the goal of training should be to teach them how to use a variety of technologies.[3] By providing instruction on numerous technologies, it supported students in honing their efforts for their regular lectures. They offered mechanical engineering students with industry training in order to teach them crucial technical and soft skills. Due to effective training, students were able to compete in a variety of contests. With the assistance of the lecturers, students were taught how to complete their projects within the limits of time, money, and facility.

Talked about how important internships are for teachers in terms of strengthening their abilities and increasing their employability. [4] A vocational high school has been formed to provide employment to workers with the basic minimum of industrial expertise. As a result, educational practices should reflect and relate to industry circumstances.

To give students a sense of what is going on in the workplace, industrial classes are taught utilising a work-based approach. It was necessary to train effective teachers for learning activities, which can be done through internships in the industry. It is critical to increase the quality and quantity of teaching resources, which will help to ensure that learning in the industrial class runs smoothly.

Learning environment creates for CNC machine operators to learn about machining simulation and component-linked elements. [5] Expert systems and web courses will be used to create a virtual machining environment in which information and skills may be obtained in an efficient, safe, flexible, and low-cost manner. The machining task includes sub-tasks such as part inspection, tool condition selection, tool operation, programme input, and edit tools. This virtual training allows the trainee to practise machining under various operating conditions and observe the results. Physical impacts such as cutting force, distortion, and temperature, on the other hand, were left out of this instruction.

Many sectors, they argue, require skill training for technicians in maintenance and assembly. As a result, they began training on an [6] Augmented Reality platform, which is an excellent industrial training technology that connects instructions to complete tasks on machine parts service. Such training leads to the development and testing of Augmented Reality-based maintenance and assembly skill training. The fragmentation of skills into sub-skills, as well as approaches to skill training and ability evaluation, were among these features.

Requirement for a training and development programme for employees are necessary. Technical knowledge as what workers should present, and operating competence as what workers should develop. It had an impact on the way the work was done, as well as the inspection and control procedures that were discovered. The study found that excellent performance improved the efficiency of the production line in a short period of time by reducing task completion time and increasing the quantity produced.

Created table modelling and control in XY positioning. A double axis positioning system's instrumentation and construction have been detailed. A generic electromechanical model has been established, which includes the identification of control models. The apparatus comprises of two axes, referred to as X and Y, that may be independently positioned. The shaft's linear movement is achieved by rotating it using a DC motor coupled to a gearbox, which is supported by numerous systems that convert rotational motion to linear motion. The equipment moves 380mm in each axis, with the end switches for displacement limits being fixed. The axis employs electromechanical components and sensors of varying sizes. The microcontroller

board, which includes electromechanical and sensor parts, is connected to the computer through USB.

Investigates the advantages of arranging course work in such a way that knowledge shared with students is beneficial. [9] Being technicians and technologists distinguishes Diploma students from engineering students in terms of expertise. Contribution to the design process should be considered, as should necessary knowledge, and students should be prepared for the abilities that will be required in the future. Both pupils were given a hand skills drawing as an example of how their comprehension of reading and drawing might be assessed. Engineering students had a considerably higher comprehension level than diploma students, according to the findings.

They presented a method for decreasing table error caused by the ball screw's limited rigidity [10]. Typically, the XY axis bed is connected to a motor through a ball screw. The ball screw's rigidity is restricted. There is a distinction between table and motor positioning. To track the torsional displacement feedback algorithm, the technique was used. Tables, servo motors, servo packs, and velocity and position controllers are all part of the CNC machining position control system. The position control loop is controlled by a PI controller.The performance was evaluated in terms of the spring constant estimation error.

They explained how a 3D printer using FDM technology may be developed and built using a regular 3D printer. The joining or adding of material layer by layer to produce a 3D object is described by 3D printers. 3D printers are examples of machines that enable this procedure. It is made up of various parts, including a frame with an XY axis linear movement arrangement, motors, a print head, and software. The head movement mechanics must be able to respond to the 3D Model. The XY Axis is used for horizontal movement while the Z Axis is used for vertical movement.

II. CAD MODEL, AND COMPONENTS
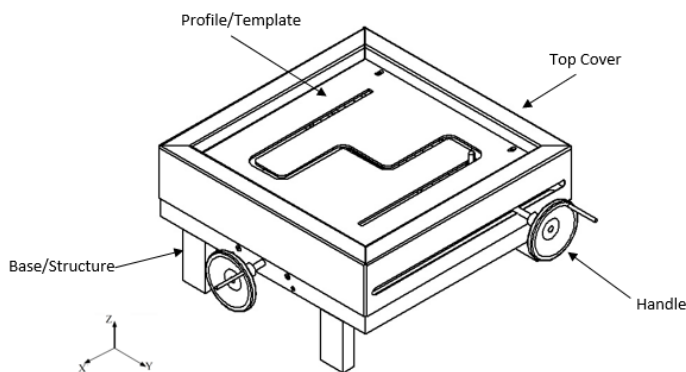
Fig (2) Diagram of Training Equipment

Rectangular Frame: Rectangular sections are widely utilised for welding frameworks with different orientations of load distribution. Because they feature consistent geometry along two or more cross-sectional axes, uniform strength, and resistance to torsion, rectangular, square, and circular cross sections are particularly effective geometries for multiple axis loading.
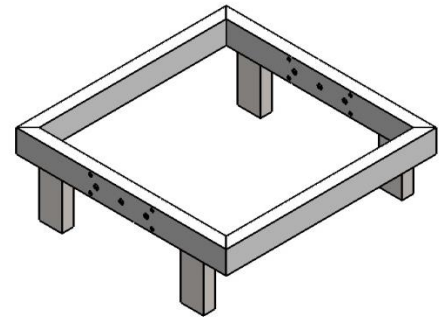

Fig (3) 3D view of Base Structure

The linear assembly and top assembly are firmly held in place by the robust foundation construction. The basic construction is made up of Rectangular tubes that were welded together. Welding is a fabrication method that involves welding two pieces together by heat, pressure, or both, and then cooling the parts to form a join. The arc welding procedure, which is widely utilised, is used in the below base structure.

X & Y Axis Linear Movement: In this application, linear guides are utilised to guide each table in the X, Y, or Z directions. The use of linear guides allows for easy maintenance and long-term accuracy. The linear is divided into the following sections:

- **Carriage**: Stylus/Probe is mounted on carriage for application.
- **Support Blocks**:Support blocks are mounted on either side support plate. It holds linear shaft guided with carriage and threaded rod with fine pitch for fine movement of carriage assembly.
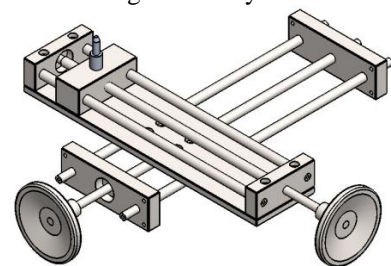

Fig (4) Linear Axis Assembly

- **Support plate**: Above mentioned parts are assembled on support plate for better alignment and high accuracy.
- **Guide Rod**: Linear shafts are highly grounded surface with smooth finish for ease of movement of carriage assembly. The linear shaft takes a load of carriage assembly and distributed evenly from one end to another.
- **Threaded rod**: The carriage is moved forward and backward with the help of threaded rod. It consists of fine pitch for controlling and accuracy of the movement.

Template/Profile: The template/profile is manufactured in three different modes for better performance of candidate. The three modes of training are Easy, Medium and Difficult. For additional practise, several profiles are utilised for training.

- **Easy Mode**:Candidates in Easy mode are expected to practice by independently moving the table's X and Y linear axes. The candidateunderstands the clockwise and anti-clockwise rotation of the Handwheel, as well as table movement in the X and Y axes, in the simple mode of instruction.
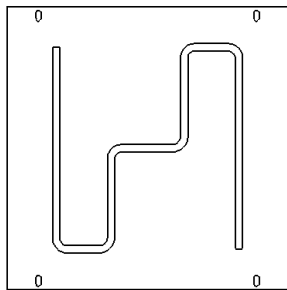

Fig (5) Profile for Easy Mode

- **Medium:** Candidates in medium level of training, are expected to practisein X and Y linear axis movement individually for a short distance and concurrently for a longer distance.
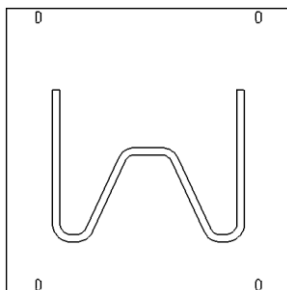

Fig 4.2 Profile for Medium Mode

- **Difficult:** Candidates are expected to practise X and Y linear axis movement concurrently from the beginning to the conclusion of the profile at the final level of training.
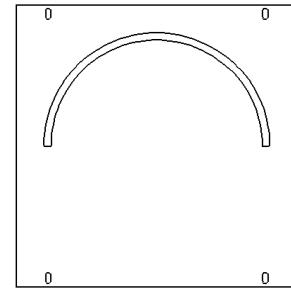
Fig 4.3 Profile for Difficult Mode

III.   WORKING PRINCIPLE

The model of technical skill test and training equipment is shown in above figure. The main components are Base Structure, Linear Axis Assembly, Template and Handle. The sub-assemblies are attached to a sturdy base / frame that allow the stylus / probe to move freely. The stylus/probe movement is controlled by a worm screw with a low height to make movement easier. The tally counter is used to track any mistakes or omissions. If an error is detected, a thin steel wire is wrapped around the inner wall of the channel, sending a signal to the information counter sensor if the stylus / probe comes out of the channel / path (LDR). The light emission concept is used by the LDR sensor. When the light turns on, the sensor recognises it, and the counter starts counting in 1-digit increments. The time duration for completing the profiles in different mode, Stopwatch is used.
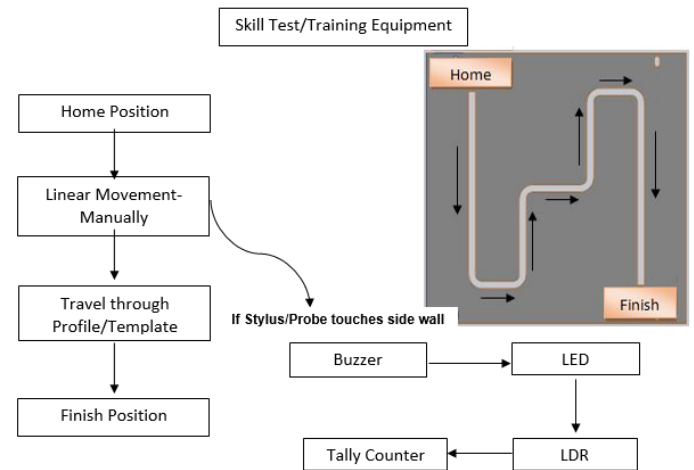
Fig (2.2) Flow Chart

IV.   MATERIAL SELECTION

Structure/Base: The fundamental portion of the assembly, the structure/base, must be rigid enough to support the entire assembly. For the most part, hollow parts are employed in the construction of structures and bases. Hollow sections can be circular, square, or rectangular and are commonly utilised in

industry. Rectangular hollow sections are widely employed in welded steel frames where loading in several directions is possible, but square and circular hollow sections, with their homogeneous geometry, are more effective geometries for multiple axis loading. Mild steel, such as A500 grade B or C, is available in rectangular hollow sections. The frame is fabricated with 25x50mm and welded across the corner

Linear Axis assembly A one-dimensional motion along a straight line is known as a linear axis. The linear axis assembly is similar to that of a linear guide and is made up of the following components:

- o **Lead screw -** M12 x 1.25 x 500mm.
- o **Guide Rod-** Ø12 x 500mm made of hardened EN8 material for 52-54Hrc.
- o **Carriage block-** 140x 40x30 mmmadeof Mild steel ST-42 material zinc coated to resist from rusting.
- o **Side block-**100x 40x 20mm made of Mild steel ST-42 material zinc coated to resist from rusting.
- o **Handle-** Ø100x50mm made of Polyamide material for better grip.

Top Cover: Sheet metal is used for the top cover. Sheet metal is a type of metal that can be cut and bent into a variety of shapes based on the use. Metals such as aluminium, brass, copper, steel, tin, nickel, and titanium are just a few examples. We chose Grade 304 steel because it is readily available, inexpensive, easy to form, and weldability.

Template/ Profile: For template the material should be light weight and should be non-ferrous metals. For such mechanical property ABS (acrylonitrile butadiene styrene) suits best for purpose. This is a thermoplastic sheet material are lightweight and can be used in a variety of applications. ABS sheets come in thicknesses ranging from 0.5mm to 10mm. The template of this product should be made of plastic to avoid thermal conductivity. The template is made up 6mm sheet to overcome stiffness, and a thin wire of Ø1mmrun across the profile on the inner side walls of the template.

V.   CAD MODELING

SOLIDWORKS CAD is a mechanical design automation software that allows designers to swiftly sketch out concepts, experiment with features and measurements, and create models and detailed drawings. SOLIDWORKS employs a three-dimensional design approach. A 3D model is created as you design a part, from the first sketch to the final outcome. You can use this model to make 2D drawings or to join components made up of parts or subassemblies to make 3D assemblies. You may also produce two-dimensional drawings of three-dimensional assemblies. When you use SOLIDWORKS to design a model, you can see it in three dimensions, as it will be once it is manufactured.
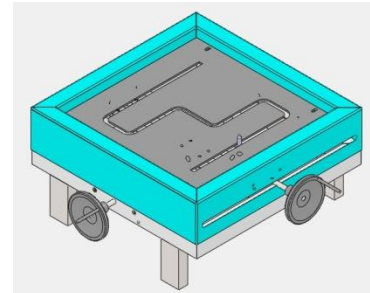
Fig (3.1) CAD Model Training machine

Physical Model of Equipment

VI.   ASSESSMENT

The outcome of the skill test/training equipment is determined by the candidate's performance. To analyze the result, the number of errors produced across all Stylus/passage Probes across the profile assigned is used. The test/training has three difficulty levels: easy, medium, and challenging. In easy mode, the X and Y axis are straight, in medium mode, the angular and curve paths are somewhat modified, and in tough mode, the angular and curve paths are continuous.

Different sets of grade points may be recognized for different modes for evaluation reasons. In those cases, the evaluation can be finished.

Following are the procedure of Assessment to check the performance of the candidate
- Mode of training
- Tracking of mistakes
- Time taken

➢ *Mode of training*
The training is conducted in three different modes; Easy,

Medium & Difficult

Easy: Candidates in the first level of training are expected to practise independently moving the table's X and Y linear axes. The applicant knows the clockwise and anti-clockwise rotation of the Handwheel, as well as table movement in the X and Y axes, in the simple mode of instruction. For additional practise, several profiles are utilised for training. If the applicant completes the course satisfactorily, the next form of instruction will be provided.

Medium: Candidates in the second level of training are expected to practise X and Y linear axis movement individually for a short distance and concurrently for a longer distance. The candidate knows the clockwise and anti-clockwise rotation of the Handwheel, as well as table movement in the X and Y axes, in the Medium mode of instruction. For additional practise, several profiles are utilised for training. If the applicant completes the course satisfactorily, the next form of instruction will be provided.

Difficult:

- Candidates are expected to practise X and Y linear axis movement concurrently from the beginning to the conclusion of the profile at the final level of training.
- The candidate knows the clockwise and anti-clockwise rotation of the Handwheel and table movement in the X and Y directions in the Difficult mode of training.
- For additional practise, several profiles are utilised for training.
- The final evaluation is completed if the candidate successfully completes the training.

➢ *Tracking of mistakes*
- These machines are unfamiliar to the candidates who will be using them, and they frequently make mistakes.
- A tracking device is linked to make an alarm for the applicant to conduct training with fewer errors.

- On the inside wall of each profile is a tiny wire that is connected to a tally counter using LDR sensors to count the number of mistakes made by the applicant during training.
- The teacher sets a number of errors for each level of training when performing training. The table below lists the allowed errors for flawless training.
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Table 12 – Number of Mistakes for different mode

Mode of training	Number of mistakes	
	Min	Max
Easy	10	15
Medium	07	12
Difficult	02	05

➢ **Time taken**

Depending on the candidate's commitment and sincerity, training might take anywhere from 50 to 60 hours. Different durations for competency of level are specified for different levels of mode. The table below displays the amount of time necessary for each level. The applicant is trained in such a way that they should be able to complete the profile in the time allotted. Candidates with varying degrees of learning ability have various timetables established for them.The time duration for completing the profiles in different mode, Stopwatch is used.

Table 13 – Time taken for different mode

Mode of training	Time taken in min	
	Min	Max
Easy	8	16
Medium	8	17
Difficult	4	7

➢ *Training Result*

Finally, upon the completion of training, an assessment is made based on the factors described above, such as the mode of training, mistakes made, and time spent to complete the profile. Only if the candidate completes the "Difficult mode" level without making any mistakes or exceeding the time limit is the candidate certified. For assessing a candidate's performance in several modes, an assessment is completed and documented for each mode, and a final evaluation is completed while keeping track of prior

assessments. The table below indicates the candidate's degree of competency.

Table 14 – Expert level of Candidate

Description	Remarks
Excellent	Understood the concept and can work on this machine and on various profiles in different mode.
Good	The timings and mistakes done reached on average level.
Satisfactory	The timings and mistakes done reached upto maximum level
Poor	More training required

VII.   CONCLUSION AND FUTURE SCOPE

Conclusion:

With the rapid growing of various training activities for different streams technical skill training becomes more important. In this project work, the working of table is studied and assessed. The bed of the machine acts as a base on which the different fixed and moving parts are mounted. The base of the machine is made up of rigid Rectangular hollow pipe welded across the corners. The advantage of rectangular hollow steel is that they are stronger in bending and widely used in manufacturing of base of machines.

The machine comprises of various Mechanical, Electrical & Electronics components. The candidate understands the need and application of each component used in manufacturing of training machine. The linear axis assembly is used for movement of Stylus/probe in linear motion. The linear motion in X-Y Axis is carried by rotating the handwheelin clockwise and anticlockwise directions. For angular and circular movements the candidate needs to rotate the both X-Y linear axis assembly simultaneously.

To make the candidate perfect in control and movement of the linear axis assembly the training is carried out in three various modes Easy, Medium and Difficult. In three different modes each mode has several shapes of profiles which suits with training mode. By getting trained in various modes the candidate becomes perfect in machine operation performed on various traditional machines like Milling and Turning.

At the end of training, the candidate will be perfect in operating traditional machines like milling, turning and can be able to perform machining operations.

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