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Alternative Sewing Machine Control

The introduction of 'A' level Craft, Design and Technology examinations emphasising a much wider area of study than the traditional material based craft examinations has brought the problem of choosing projects which fulfil the requirements of the examination and are sufficiently stimulating for the 'A' level student to maintain interest in what must be an in-depth study. A well organised 'A' level C.D.T. course should include working through practical problems involving research, synthesis, practical construction, testing and evaluation, and probably most important a critical appraisal of what has been achieved. The very nature of any project must be intellectually demanding and draw on other skills and knowledge. The recent Design Council report 'Design Education at Secondary Level' emphasises the value of these skills by saying – 'In design, examinations must also test their aptitudes and abilities in applying their knowledge including skills of analysis and synthesis in the one hand and flair and imagination on the other'.

The essence of any good design project at 'A' level must be that it has:–
(a) a realistic element of research within the constraints of an 'A' level course,
(b) provide new learning experience for the student including craft skills,
(c) sufficient scope for original thinking,
(d) be capable of producing a variety of valid solutions,
(e) the solution must enable the student to demonstrate his/her ability as a craftsman,
(f) produce a final solution which can be tested and evaluated in a positive way.
All are unknowns until the project is underway.

This account of David Parkins 'Alternative Sewing Machine Controller' project demonstrates how the project developed and serves to illustrate how its designer overcame the 'unknowns' and brought the project to a satisfactory conclusion. It also illustrates that even though we try to break down the design process into units such as design brief, analysis of the problem and research, very often the solving of one problem can create another requiring further research and development. An important factor proved to be that as the project proceeded David always had his aim clearly defined so ultimately he produced a good solution to the problem.

The Design Brief and Research

The project started with discussion about how his aunt, injured in a car accident and now paralysed from the waist down, could control her sewing machine unused since the accident. Correspondence with sewing machine manufacturers showed that they had adapted machines in the past for individual disabled people after studying their particular disability and at considerable cost. The brief was eventually built up into the design of a more universal controller suitable for anyone who has limited or no use of the legs and feet. After testing several different types of sewing machine with the normal foot control it was found that in most cases control of the on/off and slow speed running required considerable expertise on the part of an operator with full use of his/her limbs. Also the cost of replacement foot controllers is as much as £40, which was thought to be excessive.
The original area of research therefore developed into two lines of inquiry:–
1) How to enable the disabled person to effect control over the sewing machine?
2) How to control the machines on/off and speed accurately?

David also decided that any device produced would have to be of reasonable cost and certainly no more than the cost of foot controls.

The construction of several non-working mock-ups enabled David to discover that his aunt could best control a machine by moving her body forward slightly against a spring loaded sliding mechanism. Other possibilities considered and tested were pneumatic control from the mouth, a spring loaded biting mechanism, movement of the elbow and side to side movement of the body but these proved tiring for the operator or interfered with the handling of the material being sewn. Tests also showed that it was difficult to incorporate the mechanism of the foot controller into any alternative design.

The answer was electronic control. Further information from sewing machine manufacturers indicated that at present the normal resistance control was universally used for domestic machines as it was cheaper to produce than electronic control. One manufacturer was particularly helpful saying that they were looking into electronic control for domestic sewing machines but it would be some time before it appeared in the market. So David started exploring electronics. A crash course in circuit building using S – Dec. to make him familiar with components and techniques plus instruction in soldering electronic components proved adequate before David returned to the design problem. He learned quickly as there was a real need to be able to use electronics.

The problem was to control A.C. motors of 80 to 120 watts with precision and enable the motor to develop adequate torque at low R.P.M. A published lamp dimmer circuit proved capable of controlling a sewing machine motor at medium and high speeds, but initial control at slow speeds was erratic. Further research and a little maths produced a circuit which used the back E.M.F. of the motor to prevent low speed hunting. At this point the fun started, the circuit controlled the sewing machine reasonably well, but destroyed the thyristor used each time it was turned off at the mains. Despondency crept into the project. Advice from the Head of Physics did not cure the fault but produced new ideas for an improved circuit. The faulty circuit was scrapped and a new circuit

devised using information from an electronics handbook. Circuit three was made as a 'lash up' and, with the help of an oscilloscope, modified until it worked as required. Fortunately the Physics Laboratory is virtually next door to the workshops.

Design of the Solution

The rotary potentiometer controlling the electronic circuit required 320° of movement to give complete control of the sewing machine. The first prototype was designed and constructed using a pulley system to convert the 80mm of linear movement decided on in the early research programme into the 320° of rotary movement required. It worked. For a short time, then cables stretched, pulleys slipped so the application of a screwdriver in the right places was required at regular intervals. Prototype 2 incorporated a friction device and number 3 a rack and pinion. All worked but were hopelessly unreliable. The design was suffering from the common fault of becoming over complicated but this was solved one morning by a copy of an electronics catalogue and the question 'Why don't I use a linear potentiometer like this?' Out to the component shop, liinear potentiometer purchased and incorporated into the prototype by lunch time. By now the staff of the Dress and Design department had become involved loaning a sewing machine and being first in line when it came to trying out each solution before it was tried by a disabled person.

Homework quickly produced the design sketches for a mechanism using the linear potentiometer, micro switch and a plate came together with return mechanism to control the electronic circuit which had been developed. Each stage of the project had been carefully recorded which was particularly valuable in ensuring that any ideas were not forgotten when work started on the final design.

David's aunt using the Mark 1 Controller during tests on different types of foam padding for the control bar.

The Final Design

Six months after starting the project David had everything needed to produce a solution to his design brief. In this project the research and development had taken up more time than expected but this is often the case with 'A' level problems.
The final design problem was to put the bits and pieces together in a form which was attractive in appearance and be of a reasonably priced reliable construction. It was decided to use a padded cover for the bar on which the user presses his/her body but this introduced a new problem. The spring in the foam used, reduced the sensitivity of control which had taken so much time developing in the electronic control circuit. Research into foam densities produced one with the correct degree of firmness to give satisfactory control.

Construction and Evaluation

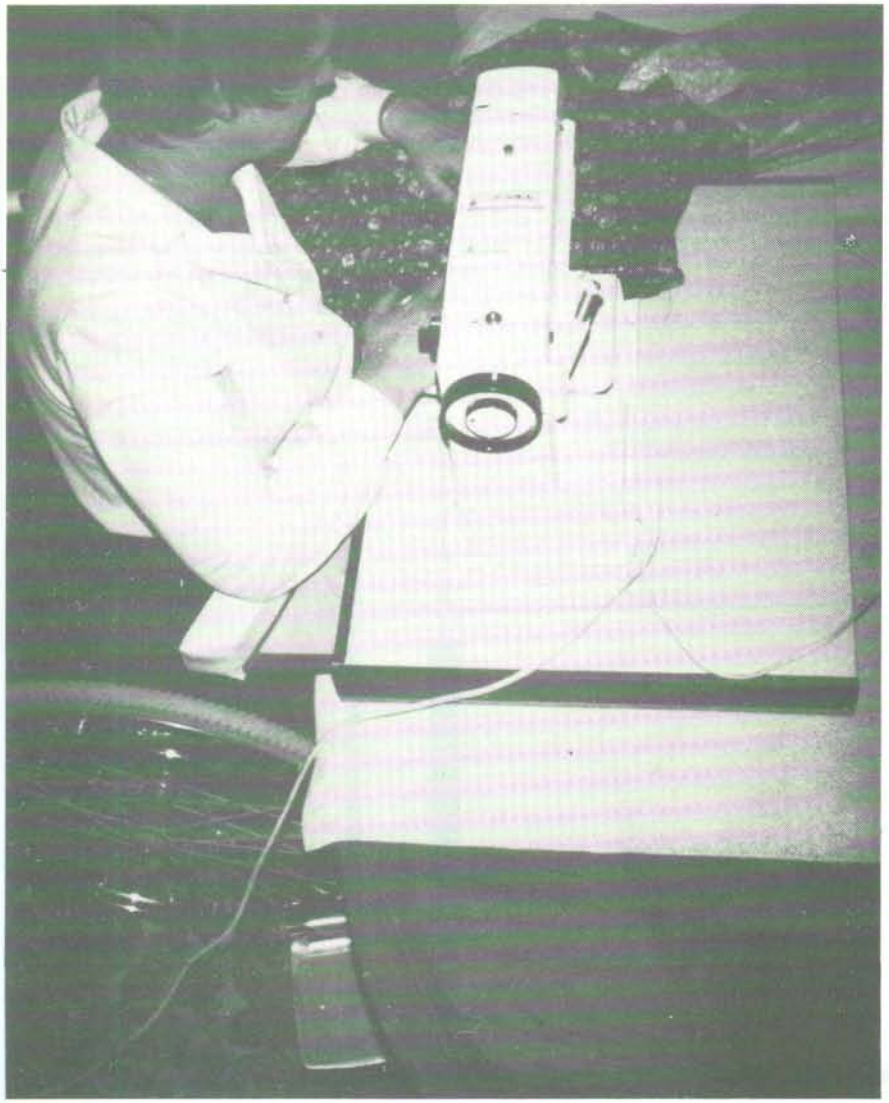
The successful circuit was made up into printed circuit form, more homework for David doing the layout and a new aspect of practical work for him etching the circuit in ferric chloride solution.
The rest of the controller was designed and made using wood and plastic as the main materials making the design entirely safe electrically.

As can be seen from the illustration the final controller consists of a shallow box with a leather cloth covered working surface on which the machine rests. The sewing machine can be placed on the controller in the most suitable position for the operator, mains and connection leads to the machine form an integral part of the design.
To start the machine the operator moves forward against the padded bar to turn the machine on and further movement increases the speed of the sewing machine. The control bar is spring loaded to return the controller to the off position.

A programme of testing for reliability and versatility continued what was becoming a long and involved project. Volunteers were not difficult to find in school but they were not disabled, however,

they did find the controller easy to operate particularly when starting the sewing machine and running at low speeds. In fact when used with several types of sewing machine the slow speed is lower than normally obtained with a conventional foot controller. David's aunt, for whom the controller was designed, had suffered many 'tryout' sessions but, she was delighted to have her sewing machine back in use. The Leeds Polio centre provided more willing testers to try the controller so when it returned to school it was thoroughly tested and had proved entirely reliable, the only faults being a small amount of wear in the sliding mechanism and an irritating squeak. The first fault was easily rectified by a change of material for the slides and as a result the second disappeared. A strip of hardwood was fitted to the upper surface of the controller as a safe guard against pins inadvertently finding their way into the mechanism.

A successful project – David's disabled aunt making clothes again.



The Schools Design Prize

The completed sewing machine controller, by now well used, was entered in the Design Council/Rolls Royce School Design Competition and was awarded a prize. A minor concern was that if the operator using the controller were to fall forward then the machine would continue to run at full speed and therefore be a hazard. Recently more design work by David has produced a further electrical modification in the form of a cut out and no-voltage release so the sewing machine is stopped should such an emergency arise. This has been incorporated into the Mark 2 version of the controller now under construction. Material costs for the Mark 1 controller were surprisingly low, slightly more than the £6.00, but the safety modifications included in the Mark 2 Version adds a further £5.00 to the cost. The final cost was considerably less than expected but of course labour costs were impossible to assess, however consideration was given to ease of construction in the final stages to keep this factor to a minimum.

Conclusion

This project proved to have all the elements of a good design project particularly in research and new learning experiences. The final product is relatively simple but the path to the final solution is littered with now useless mock-ups and scrap circuits, but what is interesting is that David continues to develop his product even though he has moved on into Further Education. At present he returns to school in his spare time and has produced sketches of a more compact model with an easier construction. As yet this has not been made but no doubt it will be.

Finally the real success of the project is that his disabled aunt can once again enjoy using her sewing machine.