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A Dosimeter Charger Unit

Each year since 1977 we have entered two projects in the Cornwall Schools Technology Project. This scheme is for teams of Secondary School Students who present 20-25 projects at the exhibition in July. This is the history of one such project, which was subsequently entered for The Design Council's School Design Prize.

At St. Austell Sixth Form College Science Projects is one of the options in the general studies programme. In September one group of about ten students and two staff meet to discuss various suggested projects. It is an anxious time because most of the students are fresh from their 11-16 comprehensive and a little lost in their new environment; they are not known to the staff or in many cases to each other. However, in about two weeks teams are formed and projects selected and by the end of a month all have settled down into a routine.

A dosimeter is an instrument to be carried by a person to measure the amount of radio-activity to which the wearer has been exposed. It is about the length of a pen but twice the diameter. At one end there is a window with a cross piece and when viewed from the other end a scale with a hair line can be seen through an eye piece. It is charged up to about 220 volts and discharged by radiation proportionately to the dose received. Although it is charged to a potential of over 200 volts it is not dangerous to the wearer as the charge of electricity is small and could not deliver a large current.

A dosimeter would be used by the emergency services in the event of a nuclear attack. In previous designs charging has been powered either by mains electricity or by dry batteries. Here then is a weak point. Mains supply may not be available and dry batteries can deteriorate. The team after some involvement with the emergency services quickly

A cross-section of the dosimeter charging unit.

Seen here is Ian Grainger-Allen, with the dosimeter recharging unit he designed with Philip Dover and Alan Varco from St Austell Sixth Form College, Cornwall.

appreciated the problem and were quick to suggest a solution, the Peizoelectric effect.

In the peizoelectric effect a crystal of a substance such as quartz is distorted, which results in an electric charge being generated. The resultant voltage can be high enough to cause a spark to jump an air gap. This phenomenon is used in the modern gas lighter and in fact a gas lighter was dismantled for this project in order to use the crystal and trigger mechanism. The unit using the peizoelectric effect would be independent of mains supply and dry batteries, the energy supply being generated by the operator squeezing the trigger. It would also be cheaper, lighter and more mobile than other designs.

This particular project had the advantage of Ian in the team, as he was a bright second-year student who consequently knew the equipment available, and with one year of his 'A' level course behind him he was the obvious team leader.

Alan soon realised that three people could not usefully crowd round one set of instruments, so he detached himself to concentrate on construction work. We have no workshop facilities of our own and Alan had had no special training in handicraft skills but soon showed initiative by borrowing tools, learning about materials and even becoming skilled in the use of a lathe. This of course would not have been possible without the willing co-operation of the handicraft teacher, who often broke off from his own class to help him.

Ian and Philip meanwhile were discovering the problems of making electrical measurements when dealing with small quantities of electricity. They had instrument problems, as there was no electrostatic volt meter to measure the output from the crystal. They also learnt how easy it is to be deceived into thinking a problem has been solved. When they tried to measure the voltage output from the crystal using a potentiometer arrangement in conjunction with a cathode ray oscilloscope, different results were obtained with different C.R.O's.

After a while they concentrated on the size of the charge rather than on the voltage generated. The charge necessary for a dosimeter is only 500 p.F. It was eventually decided that a suitably chosen capacitor would be charged up and this charge shared with the dosimeter. The charging of the dosimeter is monitored by viewing through the eye piece, and as the charge slowly leaked into the dosimeter from the capacitor the circuit was broken at the appropriate moment. The production of the charge from the crystal, the charging of the capacitor, the connecting of the capacitor to the dosimeter and the final isolation of the dosimeter is effected by a single operation of the trigger and electrical contacts. It is therefore possible to allow for variations in the capacitance of the dosimeter from one instrument to another.

The design of the shape of the unit and the mounting of the dosimeter presented no real problems. A pistol grip was thought best, with the dosimeter lying along the top. The result was rather like a revolver, but the trigger was at the back of the handle as it was easier to use the unit if the user pointed the 'muzzle' towards himself. If it had been a revolver it would have been very suitable for playing Russian Roulette. Before the actual charger was constructed a cardboard model was made to check how convenient it was to hold and operate.

The final problem was to mount the dosimeter on to the unit in such a way as to make it easy to use. The dosimeter had to be positively located and to compress a contact which is behind the cross piece on the window. It had to be idiot proof. At the same time the view through the window had to remain unobscured.

By the time of the Cornwall Schools Technology Project Exhibition the students had devised a method which located the dosimeter accurately, but it was awkward to put in and take out of the unit. Then came the end of term and Philip took the instrument home to try to improve this aspect of the design.

At the end of August all the team were called together to be interviewed by representatives of The Design Council. The interview started early and Philip arrived last but not late. No-one knew if he had done anything to the design. As it stood at the end of term the mounting arrangement was not very good, and I secretly thought it would be the team's undoing. Philip presented a much-improved version without comment. None of them said a word, as if it had always been that way. The final solution was awarded a prize by The Design Council and there has been interest in the charging unit from industry. We are hopeful that it will be developed commercially.