Blue File No. 9

ELECTRONIC TOYS FOR THE SEVERELY DISABLED

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SECTION ONE

Background and Overview

INTRODUCTION

Over the last few years, the toy market has been increasingly flooded with "chip" based toys so that now they are a part of everyday life for most children and many adults. Initially, most of the electronic games were packages utilising the home television set but now all kinds of toys are appearing including mobile toys and learning games. With such a growth industry, one wonders what the next few years will produce but there is no doubt that it will be more "chip" based entertainment.

Wandering round the toy shops, one feels very sorry for the parents of today's children although what goes on after the kids have gone to bed is another story. The parent of a severely disabled child, however, is faced with a very different scene, their children are also tempted by the new and colourful toys that technology has produced but little attention has been given by the manufacturers to the problems of the severely disabled. It is not really as bleak as it at first looks, the disabled child is not being put further and further behind; some of these toys can be adapted for the severely handicapped child but, more important, the flexibility of the technology could allow independent play.

This project set out to find out what the current toy situation is for severely disabled children and, more important, to find out what teacher and parents would like. A further aim was to adapt some toys, preferably cheap ones, and get some reaction from teachers to this approach. From the initial survey work, and through the experiments carried out, it was hoped that there would be some clear indications of where to go next. The conclusions and recommendations at the end of this report show that the work has been successful in isolating where more needs doing.

Play and the Disabled Child

Appendix A is a short discussion of the general importance of play. The disabled child has, somehow, to achieve normal development with, frequently, few of the normal channels of playing available. Obviously, the degree and type of handicap has a direct bearing on the ability to have a normal life. The situation is, only too often, complicated by the guilt or rejection of the parent. Some parents manage to integrate their disabled child into the family achieving normal relationships between themselves and other brothers and sisters, but often it is left for the school to both carry out the task of education and provide good recreation.

The disabled child has to have the normal education of any other child but also has to learn how to deal with disability. This frequently means that learning must begin as early as possible. Many severely physically disabled children, particularly those that cannot speak also, learn to read at a very early age - there is very little else they can do except watch television. There are a limited number of toys around but these, on the whole, do not help much with developing the understanding of the senses that are missing. For example, invariably, blind children at senior school have great difficulty in learning solid geometry from diagrams because they have built up no appreciation of the flat form of a solid shape from drawing as a child. A physically disabled child understands little about space because they have been unable to explore freely at an early age. The schools try very hard to compensate for this missed development but there is only a certain number of hours in the day and there are a number of children all needing attention at any one time. It is in these areas that the new toy technology should be able to play a very large part.

Some Notes on Disability

Many disabled children are able to play with ordinary toys; all do so up to a point. Deaf, blind or speech disabled children have no manipulation problems although the blind child may need some special markings on switches. It is the severely physically disabled child, particularly if speech is also affected, who is at the greatest play disadvantage. Such normal play things as sand, paint, water and construction are often not available, leaving parents and teachers few options but to give a great deal of individual attention. The work carried out under this project has concentrated on the play needs of the severely physically disabled child although comments have been included where appropriate, on the suitability of electronic toys for other handicaps. The problems of severe mental disability have not been studied as the assessment of toys for this group is a highly skilled job.

Physical disability, in this context, means someone with severe movement problems. The child used for many of the experiments carried out under this project, is unable to move and cannot talk. When starting with this type of child, the movement available has to be assessed so that a switch can be found. This assessment is an ongoing thing as the child develops. Once the child has a switch that can be used, the long process of teaching how to use matrix selection using this input starts. It is in this early teaching of control that some of the new toys could contribute. A severely physically disabled child frequently has to put a great deal of effort and concentration in to achieving very little, one is after using every motivating factor possible to reward the child suitably. Control of moving toys is also very important as, for many, no other free movement can be under personal will.

Matrix Selection

For over twenty years now, severely disabled people who are unable to use a keyboard, have used matrix selection to perform simple tasks like writing and environmental control (opening doors, switching on lights, etc). The method relys on isolating a movement that can be used to control a switch; this can be breath, blinking, movement of the head, etc.

Conventionally, an electromechanical display grid was used with the disabled user able to move along the grid with one switch and down the grid with the other. Now, the visual display screen is often used but adding some intelligence to the selection process can assist a great deal especially for the children. Using conventional equipment like the possum typewriter, disabled people were, for the first time, able to write, selecting words letter by letter. No drawing or colour was available nor was correction of mistakes. Now, simple word processing is becoming available allowing the disabled person to select whole words and phrases from the matrix, on some systems pictures and colours can also be used. The matrix method of selection, with a screen based system, was used for control in some of the experiments discussed here.

OUTLINE OF THE PROJECT PLAN AND EQUIPMENT

The Electronic Toys for the Severely Disabled project was planned to be an overview of the area giving, as its results, clear indications of what the current situation was and where further work was needed. Six months, July to December, 1981, was set aside for carrying out this study. As part of the plan some existing toys would be purchased, some would be adapted others would be evaluated to find out why they were not suitable. An experiment of attaching a moving toy to a computer would also be mounted to see if this could give a serverly disabled child some independent play. While the study was being carried out, the educational benefits of the new breed of toys would be looked at specifically for the young disabled child.

The work fell in to three stages:

1. Survey of toys (this is discussed in the next section)
2. Discussions with representative schools and parents
3. Experimental work with toys and computer equipment

The toy survey was really an ongoing phase which, in fact, yeilded its most useful results at the end of the project when christmas toys appeared. This could probably be usefully continued as new electronic toys are constantly appearing some of which must be suitable for disabled Children. The discussions with schools were brief with those that were

local to London being involved. The point of the discussions was to establish what was available and where it was used, again an ongoing process as further toys emerge or are adapted. Within the time scale it was only possible to set up the experiments and get a few general comments. It is difficult to involve the ILEA based schools in the direct running of these experiments as it takes far longer than six months to clear any equipment through the safety committee's. This was a big problem, so it was decided to set up experiments with one child at home and then consult the Council for Educational Technology on what they wanted to do about the use of equipment in schools. Some toys, however, were sent to a school for the blind towards the end of the Christmas term; comments and details are given in section four.

The main experimental work was on drawing and running a train remotely controlled from a matrix on a computer. Other games were played and some toys tried out, details will be given in the following three sections.

Equipment

Throughout the project the MAVIS computer system was used for mounting experiments. The reasons for this choice were that the equipment was available and also had been designed with the disabled user in mind. The short time scale did not allow for new software to be written for a computer like the APPLE although it would be easy to use most of the existing machines that have been allocated to schools. Certain features offered by a machine are very desirable for working with severely disabled young children so as to increase motivation. These features include full colour, the ability to play tunes, the ability to interface at least three-preferably four-devices to the machine as well as the screen, an easy command language that teachers and parents can understand (not everyone wants to become computer experts) and matrix software that can handle system commands as well as electrical control for remote devices and text. MAVIS already uses the ordinary colour television as its display with the teletex character set which allows for limited but satisfactory graphics. A configuration of keyboard for an adult, special switches for the child and environmental (electrical) control box for running track-based toys was used, a printer was also attached. MAVIS already had software that would run these devices in parallel. Cassettes were used for storage.

Various toys were purchased that were thought suitable for various disabilities. Some toys were borrowed for initial experiments and purchased later if the work was successful. Two pieces of special heardware had to be made, a new set of switches for a child and a controller for a tram or train, both of these will be discussed later.

Toys Survey

A proportion of the work time has been spent on looking at electronic toys. There is an ever increasing range varying from the conventional television games set to small musical intruments. At present the electronic toys can be grouped as follows:

1. TV games
2. Other electronic games
3. Computer games
4. Moving toys
5. Musical toys

Various of the the construction sets, for example Lego and Meccano, have electronic sets but these were not included as they had a futher different function. However, some of these construction toys could be very valuable to some disabled children and no doubt, they will develop.

The survey was carried out by looking in department stores, toy shops, model shops and watching the computer magazines. Often it was difficult to assess a toy fully as most toy shops were reluctant to demonstrate or or demonstration models had just run out of batteries. The model shops were the most helpful, particularly Hadley Hobbie, Middlesex Street, (near Liverpool Street Station, London). These type of shops were used to enthusiasts and often has useful suggestions to make, occasionally they offered to make minor modifications but generally they were a mine of information.

More detail on the findings of this small survey will be given in the next three sections under the relevant sub-sections. Most of the information can be found in section two.

SECTION TWO

Screen Based Games and Toys

Introduction

This section deals with the largest group of electronic toys, those that are screen based. A few years ago, this section would have been exclusively TV games but now toys are available with their own mini screen built in; also included are games for the personal computer. So this section deals with the groups of TV games, computer games and other electronic games, this last classification being toys that have a great deal in common with the screen based games but have moved away from having a discrete screen as a display, for example the SIMON games set.

The remainder of this section has three main headings;

1. Toys and games on the market
2. Computer games and software simulation
3. Drawing and electronic construction

In the first section some general comments are made about the screen based toys on the market. The second subsection is closely linked to the first but discusses an alternative and the third deals with the very important development tool drawing. However, there is one general comment that should probably be made here; not enough attention to the needs of the disabled child has been given to many of these toys, frequently they are items that a handicapped child would find invaluable but the switches are not strong enough or inaccessible. Perhaps as more of these toys appear, the situation will improve.

Electronic Toys on the Market

There can be hardly any houses in the UK with children that do not have some kind of screen based electronic toy. Many of them will be TV games while others will have small units that will play one game, say space

invaders. One only has to go round a couple of toy shops to see how many of these games and toys there are for the ordinary child to choose from. It is not only children who play with these games, Steve Davis, one of the top class snooker players is well known for saying he relaxes between matches with a set of TV games, and there must be many others.

Television Games

The conventional television game has now been on the market, in various sophistications, for three or four years. Most of the current models are cassette driven allowing a number of games to be played with the same piece of basic equipment. However, the games played are often very similar in the skills they need from the user. In principle, these toys could be great fun for a number of disabled children and adults but at present there are few that could be used.

One factor that applies to most of the "games centres" is the fragile nature of the equipment. Often this is built of fragile plastic with levers and cassette holders that can be easily broken. One has to consider the disabled in their individual groups to be able to see the different problems; the result is very disappointing.

Children with good manual dexterity but who are in a wheelchair will normally, have no problem with using TV games; sometimes they have to be set up by someone else. A deaf child can also frequently enjoy the games although, obviously, the noise is lost and perhaps, this can affect the motivation towards the toy. Problems for the blind child will be dealt with in section four but the nature of the games is often unsuitable for someone without sight. Finally, those with manual dexterity problems, even if it is not severe, often have trouble with the levers and buttons. For those with very little movement, the games are impossible to play as they are usually shooting at a target, very difficult with slow and inaccurate control.

These comments also apply to many of the screen based games that do not use a television. They are not built for people with poor movement or bad sight and because they are boxed units, they are next to impossible to adapt. (See Recommendation R-3 and the Conclusions).

Other Games and Toys

Although this subtitle sounds very general, it refers to toys like the SIMON game, i.e electronic boxes, not using a screen or target shooting, on which some given games can be played. To find suitable toys of this kind a good understanding of the problems of the particular disability is needed. In the following paragraph, the SIMON game (MB toys) will be used to illustrate this point.

SIMON is a common electronic game that has been around for two years. It now comes in various packages, here we are looking at the original version made by MB toys. On the MB version, three games are offered - one for one player, one for two players and one for two or four players. The principle of the games is very similar and that is to follow a pattern of lights, with tones for assistance, up to a present skill level. There are four skill levels which increase the pattern length, the speed of presenting the pattern gets faster as the length increases. The patterns are generated randomly on four lights with human thinking time unlimited.

This game, in this form, is not suitable for those with no movement because the large buttons cannot be operated. Deaf children often find it a little more difficult than others because they only have the lights to copy and not the tune. For a severely visually handicapped child adding a little texture on the buttons can be helpful, tone deafness here makes the game very difficult. However, the point to be made is that this version is well designed. It has very large playing buttons which allows people with gross movements to use the toy. The switches for changing skill and game, however are small and difficult. Here, if the skill level had been changed automatically by the computer then the toy would be greatly improved. The brightly coloured lights are motivating which make children with bad movement try amazingly hard to play. Currently at £19 it is worth trying out with a number of disabled children.

There will be an increasing number of this type of toy around. For the disabled child one is looking for ease of operation, a simple way to add texture, easy to use buttons and switches, a toy that is not too small so

it is easy to handle, good motivation factors like tones and brightly coloured lights and something that is relatively cheap but reasonably well made. Obviously, these factors change a little depending on the disability.

Surprisingly, the existing toy market produced very little in the way of screen based electronic toys suitable for use by the severely disabled. There is a great need for disabled children to be able to have toys around that they can just pick up and enjoy like other children do. The electronic toy should be able to fill this gap but, as yet, very little has appeared.

Computer Games and Software Simulation

Many of the home computer systems have sets of games that can be played by their users. Some of these are unsuitable for the disabled person as they require fast movement or controlled movement within a certain time limit. However, because these machines can be adapted for operation by switches using matrix selection, sets of pages do become accessible. In the following paragraphs the comments mainly refer to those disabled children who have virtually no motor skill at all; they may also not be able to talk. For this group of people, some home computers are already in use, the commonest is the APPLE. Further information about the use of the APPLE with severely disabled children can be obtained from Patrick Poon, Charlton Park School, Woolwich (further contacts are given in the references).

Again, there are various human factors that are, if not essential, very important in motivating severely disabled children. Full colour is very important, as is sound, and being able to produce something quickly. Where a machine is to be used both at home and at school, it must be easy to operate so that parents feel at home with the equipment as well as their child. Safety cannot be overlooked nor can the versatility of the equipment along with maintenance offered and updating. Some of the home computers are easier to alter than others, it cannot always be assumed that there will be an enthusiast among the qualified staff in a school or as a parent.

During this project, a representative set of games were tried on MAVIS. These covered both simulations and conventional computer games. Other packages were not tried out as they are all very similar and time was short. It is accepted that there is a great deal of very useful "toy" material available for the personal computer market.

Games on MAVIS

Three specific games were tried out during this project as a representative sample. These were;

1. Target (a target shooting game)
2. Hang man
3. Simon

One of the principles of MAVIS is that everything that can be carried out using the keyboard can be produced with switches and the matrix. Having to use a matrix to play games very quickly shows the advantages and disadvantages of a particular simulation or package. If someone can use a keyboard then a packaged game can often be adapted, provided the right one is chosen in the first place, but it is those who have very limited movement who are at the greatest disadvantage with playing and it is here that software simulations and packages are the most useful.

Target

One of the games examined during this work was a target shooting game. This is very typical of many of the packaged electronic and TV games - the aim is to amass of score by hitting a target. This was relatively easy to implement with various sounds added to improve motivation. Shooting, and starting the moving target, was quickly achieved by any character selection from the matrix; however, most matrix users do not have enough control to carry out a selection accurately within a short time.

There is a further point that should be made about implementing games that are not really suitable. Disabled children like to be able to do

the same things as their brothers and sisters. This game was entertaining to watch others play and could, at least, be tried by the handicapped. Games like this have two important factors to be taken into account, firstly a child likes to win or be able to amass a large score. Secondly, it is sometimes fun, for short periods of time, to be able to do things that others do, even if you are going to be bad at them. A game of this kind may not yield good playing results but it might improve selection from a matrix in that a score is amassed and something happens on each selection. There is an area of further development that could be carried out around these types of games.

Hang Man

Hang man was implemented and tried out because it is a commonly played game. Full colour was used for the picture with a set of built in words. This type of game has been widely used in other work.

This is an easy game to use from a matrix and assists with letter selection by using a game. However, very young children with poor coordination and movement may not be taught to spell first but to sequence words; this is particularly so for those that cannot talk. Apart from the spelling factor for some (see Recommendations R-4) the game was very successful and enjoyed.

Simulation of SIMON

The pattern matching game of SIMON was simulated purely as a means of entertainment. For the simulation six colour patterns were used and a matrix with the colours and answers to the question "do you want another game" was built. This game proved very useful as a tool for those running the work rather than as a useful toy. Although the SIMON game is very easy using a normal game set, it is very difficult from a matrix. While remembering the pattern to be copied one has to do the matrix selection, i.e. moving to the correct column and row for the next item of the sequence. This matrix selection operation is distracting often making it far more difficult to remember the pattern. The SIMON game, as a simulation used in this way with a matrix, is really not very useful

although it is one of those things that looks as though it should be just the right kind of thing. Colour and sound are very motivating but two types of concentration are needed which tend to interfere with each other.

Drawing

Drawing and colouring are enjoyed by most children, even those who cannot see. Again it is the child with severe motor problems who cannot draw and colour unless it is all done by someone else under instruction from the child, a very different concept. There are various mechanical machines that have been built for disabled children for drawing but these tend not to be entirely successful.

There are various drawing packages available for computers and some that have been built for the disabled. These packages are similar but have different interfaces, they can be seen by contacting manufacturers. Some packages for disabled can be seen on the MAVIS system and on MACAPPLE (Charlton Park School). Again these packages are similar so the MAVIS system is described here.

Full colour in drawing is very important for motivation especially if a child has all the bother of having to do everything from a matrix. Very good resolution is not essential as the children very much enjoy the colour and being able to express themselves independently. A full colour graphics package for disabled children using a matrix still needs further research but the drawing facilities that have been implemented have been very successful. (see Recommendations R-5 and R-6).

Drawing on MAVIS

MAVIS uses a system of drawing where commands are given in compass directions, to a cursor which is, initially, in the centre of the screen. The length of line drawn at any one go is changeable, there are simple commands for filling in a closed area and colouring. This package of implemented as an experiment and demonstration; most able bodied users find it very difficult to get on with but, surprisingly, not so the

disabled. So an experimental system has remained with the acknowledgement that some people have found it difficult.

The problem with very young users of any system is generating motivation to continue at every step. We felt that our six year old user was ready to draw but not sufficiently motivated to fiddle with positioning the cursor and carrying out expression completing one line at a time. The solution we found is described in the next paragraph. The drawing package has been very successfully used by other users, in fact, it is easier to operate from the matrix than from the keyboard as the visual representation of the directions of movement appearing at the bottom of the screen, are helpful. Even with this limited package - the system uses the teletext character set - a number of disabled students have had a great deal of enjoyment.

Because of the general way that the MAVIS matrix handling program has been constructed, we were able to draw chunks of a picture and present the words for these pieces in the matrix. For example, the matrix for house contains wall, roof, window, door, chimney, etc. When these items are selected they are drawn but door cannot be drawn before wall. This, in away, is a first step to an electronic construction kit based on the screen. The drawing, as it stands, has been very successful but the idea of construction did not occur until the end of the work so, as yet, few comments except for the enjoyment of one child, have been gathered.

Drawing, and electronic construction toys based on a screen, are an area where more work could very usefully be carried out. It is not just getting the correct human interface for a child to be able to draw easily on a computer; it is providing a means by which those pictures can be printed, in colour. Recently, the first reasonably priced colour printers appeared on the market. Unfortunately, we were not able to include them in this project but have recognised their obvious use for making picture talks at school normal (i.e. a child can take it home to Mum at the end of the day). (See Recommendations R-5 and R-6).

SECTION THREE

Moving Toys

Introduction

Most children start using moving toys almost before they can walk. There is a gradual progression in the larger items from toys to be sat on and pushed with the feet through three wheel tricycles and pedal cars to the two wheel bicycle. Smaller moving toys are also in regular use acting as a simulation of adult life and enabling a child to explore the environment safely. The range of these toys is numerous with a few electronic moving toys, notably Big Track, recently on the market.

Many disabled children are able to use the moving toys very successfully given few or no adaptations. Severe motor disability needs the most study for the moving toy area as it is these children who have greatest problems. Eventually, the severely motor disabled child may have a large moving toy known as an electric wheelchair but this is moving towards teaching skills for living not developing play. When talking to the infant teachers at schools for the disabled they always request a large moving toy. It is something that a child can sit in, (sitting on is often impossible because there is no support), preferably a programmable module is desirable so that the child or the teacher can send it round the playground in, say a square, with the child experiencing independent movement. This request is being examined (see recommendations R-7). Small moving toys are also important. Toy Aids Projects (see References) do adapt some moving toys and carry out limited work in this field but comments from teachers are that there is not enough interaction from the child especially when the infant is intelligent. However, the project uses is limited finance providing a service without which there would be virtually no toys available, perhaps further finance and some good guidance would produce further toys from this range specialising on the electronic moving items that could be so rewarding to disabled children.

Moving Toys on the Market

There are numerous moving toys on the market but only certain categories will be discussed here. Moving toys can be approximately grouped as follows:

1. Toys without motors
2. Battery driven or clockwork toys with repetitive movement
3. Toys on rails or tracks
4. Electronic programmable toys

Some of these groups are more relevant to this project than others.

The following discussion relates mainly to children who have severe motor problems unless otherwise indicated.

Toys Without Motors

Most children have a range of small cars and models that will move around the floor when given a push. As yet there is little indication of electronics in this type of toy except for perhaps the odd light that come on. Although the severely motor impaired child often enjoys watching others play with these toys there is frequently no reward for them with independent play.

Battery Driven or Clockwork Toys with Repetitive Movement

These toys, for example, jumping dogs etc., provide great entertainment value but are easily tired of , especially for the brighter child. Toy Aids Projects (see addresses and references) have adapted a number of these toys adding large button activators. The toys have been widely used and greatly appreciated both by teachers and parents but these limitations are a problem for the very severely handicapped child, as again, there can be little independent interaction.

Within this set of toys, however, there are a number, which is increasing, of remote controlled toys. Considerable time was given to

looking at the remote controlled toys and one car (see appendix two) was purchased. The remote control box already had very large buttons that could be operated by a severe spastic and was used without charges. As a cheap toy (£9.95 in September, 1981), it was a great success as it did allow some independent play but there were some problems.

The car, being fairly cheap, was not very robust meaning that it would not really stand up to use in a special school. A more serious problem was that it moved too quickly for the very severely disabled child to control it really satisfactorily even though the buttons could be operated. The final problem was that, because it was very simple, its operations were few so, coupled with the rather fast movement, it could not be played with independently for very long. A severely disabled child could gain a great deal from this type of toy but the following factors are needed:

1. A robust controller and sturdy toy.

2. A controller that can either be easily adapted or can be used directly.

3. Slow speed of operation. This again can be altered within some of the toys.

4. A reasonable number of operations so that the child can independently retrieve the toy from behind furniture.

5. A toy that will work on carpet and hard floors is needed, some are a little fussy about their surface.

6. Items like a horn or moving noise are desirable to increase interest.

In our search through the various cars, planes, boats and moving robots, we found that the model shops were, by far, the most helpful. In fact, with very little alteration, some of the more expensive remote control units could be adapted, this often means making the levers larger and

loosening the springs. Hadley Hobbies (see addresses) was only too pleased to help and make suggestions but the equipment sold by these shops is not really toys, not for children anyway, so it is more expensive.

Remote control can, obviously, be applied to other items than cars, but boats and planes seemed unsuitable for a young severely disabled child. The parent of a small girl remarked that all toys that were at all suitable seemed to be geared conventionally to boys. This seems to bother the parents rather than the children but it is an important remark in that the fact of having to have little girls play with boy's toys is one more aspect of guilt. Parents frequently blame themselves for a child's disability and then fight very hard to give that child an ordinary life, often to encourage parent involvement such remarks have to be taken very seriously. A final point to be considered when introducing remote control is that it is an interest that can be developed, start with a car and simple switches to encourage controlled movement but then a plane or boat might be managed purely for entertainment. This is another important factor, many disabled adults have the television as their main form of recreation, technology should be able to change this and remote controlled "toys" are something that can be used and is not static or appearing on a screen.

Toys on Rails or Tracks

It is well known that many Dads have purchased a train set for their child before it has even arrived. Various manufacturers make toys that run on rails or tracks, but, when it comes to it, few are suitable for the very severely motor disabled child. Where there is enough movement for piece manipulation and the operation of a controller there are no problems for any disabled child but where control is very limited there are many difficulties. It isn't only that the electric control box cannot be operated, cars and trains easily come off the rails, there are bad contacts to deal with and points that don't switch back easily. It isn't until you start really looking at this set of toys that you realise that adapting the control box isn't the answer.

The moving toy is very important to the non-mobile child in that if offers an environment that can be controlled so lessons about movement can be learnt. There is also the fact that a disabled child cannot go out and engine spot or just take a ride on the train. Life revolves round cars and vans with the occasional educational trip on a train. The toy train is, for the severely disabled child, an education on how this form of transport is organised.

In the last few years, a number of new racing car sets have appeared offering more realistic driving, electronic sound and lighting, and just more scope. These sets were looked at in detail, including various scaletrix TCR etc., none could be found where the cars stayed on the track. Therefore, for this toy to be suitable for a severely motor disabled child it must really be treated as a two person game and it is the controller that needs modification, not usually very easy.

Train sets also had their problems. The smaller gauges were ignored because it was felt than N and Z were not large enough to be suitable for someone operating from a wheelchair. At first it did appear that 00 (four millimetre) was very suitable but on trials it was found to be very fiddly as derailment was common and connections could be bad. If the track was built using some of the long lengths of flexible track, say Pecko Knickle-silver, then bad connections were cut down but still the occasional engine would stick over the points or would have a faulty pickup. Even this size of model was also found to easily pick up dirt on the wheels often making it stop. But the toy could be made more reliable using additional pickups and improving the rail connections but then it was adapting the controller. It is in the last two years that model trains have been controlled by pulse coding through a microprocessor driven controller. This type of control gives the disabled user a great deal of control but there are problems.

As a part of this project, the Hornby Zero One computerised controller was looked at in detail. To use this controller with rolling stock requires that a special chip module is fitted to the engine, no simple task but it does work. Having made this modification, up to sixteen locos and up to 99 points and signals can be controlled from the same

box. Other modules can be added to the basic model so that more direct control is given. Looking at these kind of controllers gives a good idea of what is needed for full operation of such a system by a severely physically disabled child, but as the unit is sealed and very integrated it is a case of simulating or doing some electronics mods. The controller has many tiny buttons, difficult for many people with poor movement, direct control of speed is from a slider, which again is difficult for many disabled people.

Many of the type of problems that are experienced by disabled children when playing are ideal for projects for school electronic programmes or computer clubs. The model railway, or other track based toys, offer a great deal to children with poor movement but they are also motivating for those looking for something to do with a group of enthusiasts. So, the electronic controller has a great deal further to go but study of it shows some interesting simulation projects.

So there is room to examine both the very new electronic controllers and the older ones, remembering that there are still difficulties with dirt and moving stopped rolling stock. In the experiment, described later in this section, we used a large scale model with high quality track. This would be rather expensive for many families but suitable for schools, prices are given as a guide in Appendix 2.

However, in spite of the difficulties, OO trains can be made to run reasonably given attention but then there is the controller. Some of the simple conventional controllers have lever control which could, with imagination, be adjusted for some children. This is really a case of matching the individual to what is available while making the necessary adjustments. Often the rail enthusiasts in the model shops can be very helpful, or approaching the local model railway club can produce some amazing results. Writing to a magazine like "Model Railways" will also bring results and plenty of offers of help from enthusiasts. But these controllers are not electronic.

Electronic Programmable Toys

The programmable toy is an area that will grow very rapidly as it means that something can be operated on different levels cutting down the

boredom factor that exist with many children. At present, there are very few of these toys on the market, the most well known is Big Track. In fact, for some years, work has been carried out on something that could be called the big brother to Big Track at Edinburgh University and some comments on this project have been included for completeness although the equipment is more educational than just purely for play.

Big Track is basically a toy tank but as unwarlike as they come. At the back it has a touch sensitive key pad allowing various movement commands to be entered and stored. When a program of commands has been entered, say some instructions for the tank to move in a square, the GO button is pressed and the toy carries out its stored program. The simple language of forward, back, and turning through angles can easily be understood by very young children and, in fact, they are learning programming but in very real terms. In fact, the Big Tracks purchased through this project have been lent out to a special school for exactly this purpose, see Section Four for further details.

Because Big Track is so rewarding and it is teaching skills that are very valuable to disabled children, it was looked at in some detail. Like all toys with a touch sensitive keyboard it is very difficult to adapt and this is complicated by the key pad being actually on the moving toy. In fact, great interest was shown in Big Track by someone, Mr. Malcolm Sobey, very interested in control by the disabled and he is still formulating plans of how such toys can be made available to severely disabled children.

Big Track leads on very naturally to the LOGO turtle. This is a similar piece of equipment in many was but its language capabilities are more complex and it is able to draw the pattern it is tracing. In fact, the whole turtle operation can be used through a visual display unit (VDU) or by using the programmable "robot." LOGO is not really a toy but, it has been included, because it is a natural progression from the electronic toy to educational equipment. It has been used very successfully with autistic children who seem to be able to relate to the reliable and predictable actions of a machine and thus increase their condfidence in other areas. There follows some notes, written by Mary Plunkett a

researcher on this project, giving further information about LOGO. Dr. W. Tagg, of the Advisory Centre for Computer Based Education, has a LOGO turtle for experimental use with plans for further units to be produced and used in the next year. Work at Edinburgh still continues.

Notes on LOGO

"LOGO is a procedural, interactive language with facilities for drawing using a turtle and for symbol manipulation using integers words and lists as data-types." (McArthur 1974). The turtle itself may be either a mechanical device which runs on the floor in response to the users commands or a screen turtle which the user manipulates on a VDU.

The turtle and Logo the language that drives it was devised by Seymour Papert at M.I.T. some ten years ago for the purpose of helping children and adults to develop mathematical thinking through the necessity of describing mathematical processes in words and observing the effects of that description when carried out by the turtle. Where there was a mismatch between the intention and the result the fault could be traced to an error in the description, thus emphasising the need for adequate conceptualization of the process.

Logo commands are, in essence, simple but can be built up to form procedures for quite complex figures, these procedures can then be called recursively throughout the program.

For example:- FORWARD 500 will cause the turtle to move forward 500 units

RIGHT 120

FORWARD 500

RIGHT 120

FORWARD 500

RIGHT 120 will bring the turtle back to the starting point having completed a TRIANGLE. This entire series of commands can be defined as the procedure Triangle which may be called later in the program. Similar procedures may be written for other shapes, letters of the alphabet and simple pictures such as house, flower etc.

The novice programmer is introuduced to LOGO by a button box where the buttons may be used to communicate the basic commands to the system

instead of typing. Some buttons are left free so that the user may define and store his own procedures. When the user can demonstrate his competence with the button box he can move on the the full language, but using only those parts that he needs to solve his own problem. In this way the essential ideas of structured programming are made explicit to the novice user as he defines procedures and sub-procedures and debugs and tests each unit.

Work to date, although limited, has shown that this system is useful, not only for those with mathematical and other learning difficulties, but also for those with communication difficulties such as autism. Howe (1979) reports the case of an autistic child who was shown to make spontaneous utterances after seven one-hour sessions with the machine. Howe cites other instances of children with different learning disabilities and reports in each case an increase in self confidence as the child begins to understand the relationship between the instructions he gives and the results that follow.

Experiment to Control a Large Scale Model from MAVIS

As a working experiment for this project, the problems of controlling a model on rails through a computer were examined. So that the special input software did not have to be rewrittten, this in its general form is a complex program, MAVIS was used. A further advantage of MAVIS was that it already had a mains controller that could be adapted for this purpose. After various experiments with small model trains, the initial experiment was set up using a large LGB tram with the plan to purchase a very simple layout if the experiment worked. The aim was to set this up using a very severely physically disabled child and then show it to a school, from then on involving the Council for Educational Technology in the further running of the equipment. This approach has to be taken as ILEA are not all keen on having experimental equipment in their schools and it would have taken rather too long to try to gain approval for something that might not have worked. It was also felt that a working piece of experimental equipment of this kind would make a useful display.

A small LGB layout was chosen comprising of a passing loop and a loop of track, this meant that two sets of points had to be handled from the

computer. LGB is often known as G gauge, it models narrow gauge proto types running on one gauge track. As the units and track are made to run in the outdoors as well as in the house, factors like dirt on the track and poor contacts have been dealt with; these are the problems which arose with 00 gauge. It was also felt that the larger model was easier to see for a young child and rather more rewarding in the initial phases although the more complex layouts possible, at a reasonable price, with 00 gauge would probably make a better progression from this toy once the concept has been introduced at school. It was also felt that this working model could be used to generate further interest from computer clubs and college projects resulting in further study and a more economic solution. Already a Twickenham college has approached use and is keen to work in this area, possibly building a train controller from a Sinclair ZX81 with an input from switches.

The diagram shows the general arrangement of the hardware used with the second figure being the circuit that was made. This arrangement could, fairly easily be transferred to another machine using an additional decoder chip and a matrix package that is capable of handling a parallel port. Here, the normal way of scanning a matrix has been stuck to but, for toys, this may not matter allowing a simpler programme for the switches to be written.

At the time of writting this report, various hitches had led to the equipment not being tried out fully so there were no results except for the enthusiasm of those working with it and the parents. This kind of toy is important, not only because it introduces independent control of something moving but because it makes the disabled child normal, playing with toys that are basically the same as those for the rest of the family. This is a factor that is often ignored but it is very important psychologically both for the child and the parents.

CLASSIFICATION OF TOYS

SECTION FOUR

Miscellaneous Toys and Some Special Cases

Toys and play materials can be classified in various ways, for example suitability for a certain age group or educational value. The disabled child is really looking for toys to increase independence and fill in some of the missing gaps, as development may be slightly different than in ordinary children, here a simple categoration according to function has been used. The classification is as follows:

Static toys
Moving toys
Construction toys
Musical and noisy toys
Drawing, painting and modelling materials
One and many person games

Disabled children also thoroughly enjoy all the messy things like sand and water but frequently their use of these are limited especially if there is little independent movement.

Various aspects of electronics are appearing in all groups of toys which is a trend that will continue. Electronics also create some new types of toys using items like flashing lights and illuminated colour for motivation. The following few paragraphs give a summary of the groups of toys, showing which types where not included in this study and outlining the effect of electronics on the category especially where it applies to the disabled child.

Static Toys

A static toy is something like a doll, teddy bear or model. It is basically there to be held and looked at having little or no interactive functions with the child, bears may growl when moved or dolls may cry but

nothing more. These toys surround the child with imitations of things in adult life. A disabled child will enjoy, as much as any other children, having these toys; they may even provide conversation and interaction with others around. For blind children these toys are very important as they model things that the ordinary child sees. A child who cannot move will still enjoy, say a cuddly toy, it is just tucked into the wheelchair rather than left in the toy box to be found when wanted.

Until very recently, electronics have played little part in this group of toys although now the odd eyes that light up can be found or, perhaps, an electronic noise comes out. For the disabled child, electronics could be used to provide much more colour, for example a doll could have a synthetic voice; something that a non-talking infant would very much enjoy (see RECOMMENDATIONS R1).

Moving Toys

For many years there has been a wealth of moving toys ranging from small model cars to bicycles and other numerous large items that can be ridden. These toys are important to every child, the problem is to bring them within the reach of the non-mobile child. The Toy Aids Projects Scheme, (Ref 1) does bring a number of moving toys together for the disabled child some of which are electronic, but on the whole toys adapted under this scheme received patchy response although the work being carried out was obviously very valuable and of great importance. Toy Aids Projects basically adapts some existing toys, until recently these were moving dogs, figures, etc., the adaptation being adding a speical activator, usually a very large button, so that the disabled child could independently start up the item. The patchy response results from the fact that some children cannot use the modification and can therefore, only take a passive role by watching, the brighter infant may well become quickly bored looking at a dog jumping up and down. This comment was made by an infant teacher at one of the special schools who use the toys.

Electronics is beginning to play a part in this set of toys with items like Big Track on sale. On the whole there can be a problem of

robustness with these new toys but it is a very important area, particularly for those without movement. The electronic side of moving toys is discussed in more detail later in this report.

Construction

How many adults reflect on their childhood pleasures when Meccano goes in to liquidation yet again. One only has to look along the shelves of any toy shop to see the wealth of Lego, Meccano, Bricks, etc. The construction toys not only allow intricate models to be built but they introduce elementary physics (gears and pulleys, etc.), electronics and design. These toys are enjoyed by many disabled children but are a great problem for those lacking manual dexterity.

Apart from sets including elementary electronics items, there seems to be little that can be done to produce or adapt such a toy for the severely physically disabled child. In fact, while playing with a screen based drawing package, some interesting work on construction became apparent, (see Section Two Drawing and Learning).

Musical and Noisy Toys

This group of toys are not often welcomed by parents although all children take a different view point. The blind child needs little adaptation to such toys, the odd marking may be needed on some of the electronic versions, but, again, the non-mobile child with no manual dexterity has a problem. Striking and some of the pipes common in the conventional toy shops can cause problems for children with less disability but electronics is certainly providing a wealth of replacement possibilities. When looking at this group of toys, one also has to consider the child with no vocal communication, it is here that speech synthesis could well be very useful (see RECOMMENDATIONS R-1).

Noise came in to much of the work carried out as it is central to many of the electronic games and toys. One particular tune generating package is discussed in the section on software simulations in section two. Further discussion of musical toys takes place in section four. Assuming there

is no significant hearing loss the motivation that electronic noise generates cannot be under estimated.

Drawing, Painting and Modelling

A set of coloured pens, a colouring book and a pile of scrap paper are some of the basic play tools for most children within quite a large age range. Drawing, painting and modelling all need manipulative skills and it is again the non-mobile child with no manual dexterity who really feels the miss of expression by this means. The other disability where some of these tools cannot be used is those with very poor sight but here the market produces plastic that can be raised if drawing is carred out on rubber, good modelling materials and crayons whose marks can be felt as well as being colourful. For these children imagination is needed rather than electronics.

Graphics and colour printing are all the rage at present and, at last, some suitable substitutes for drawing are appearing for those with poor movement. Some schools do have mechanical drawing machines but these tend to be unreliable. This is one of the areas where electronics is causing a breakthrough although there are a few problems yet to be solved.

One and Two Person Game

Many parents are pleased to be able to sit their children down round a board game. Not only games important for occupying children they also provide family entertainment and communication. Again, the severely physically disabled child is at the greatest disadvantage in this area as most of the games require at least good manual dexterity, some require speed of movement also. Just looking around any toy shops soon shows how many of these games there are; for some disabilities simply marking or enlarging of pieces is all that is required.

Television games are, probably, the most well known of the electronic toys. An adaptation of the television game is the screen based unit, of which there are many, where the toy is portable and has its own display.

By hunch one feels that there must be a great deal of possibility within this group of toys for the disabled child but this at present, appears not to be so. In the next section, the screen based toys are discussed in more detail along with the problems of the disabled user. However, one and two person screen based, electronic games are such a growth area that something must appear soon that is suitable for the disabled child but one feels that the manufacturers need to be made more aware of the problems.

SECTION FOUR

Musical Toys and Some Special Cases

Introduction

This section discusses some of the more specialised topics that arose during the work. Each sub-section is connected with the others but they have been grouped together here because all resulted from the early survey and discussion. All are areas that have not been fully explored and where further work could usefully be carried out. In many ways this section could be classed as the beginning of the concluding remarks rather than a discussion of a specific aspect of the project work. In all the areas where experiments have been set up, there has not been sufficient time to obtain useful results but it is recommended that a watchful eye is kept on these with further comments from teachers being collected at a later stage, a separate proposal for this supervision has been made but is included for completeness in the final sub-section of the report - Conclusions.

Musical and Noisy Toys

Parents and teachers are often only too well aware of childrens' love of toys that make a noise be it musical or just loud. Disabled children enjoy noise just as much as any other child but they may have difficulties with playing with the normal toys. For blind children this is a very special area and it will be discussed later in this section.

The newer electronic toys have a very important role to play in this area as the range of noise is interesting to a child and it is part of an ever increasing child awareness of space, science fiction and computers. Often, one of the mistakes that occurs with teaching packages for young children is the lack of awareness from those that write the material of the motivating role of noise, particularly where a computer is used and the child has speech difficulties.

The deaf child of course, needs special attention where noise is concerned as, with a computer, it may be possible to incorporate sounds that can be heard where speech cannot. As deaf children's needs are very individual, this topic was not taken further. Electronic toys and systems that use noise can be divided in to three categories:

1. Bleeps, tones, rewards etc.
2. Music making systems and toys
3. Talking toys

Each is discussed separately below with special reference to the severely physically disabled who, again, have the most difficulties in toy manipulation and reward for effort.

Bleeps, Tones, Bangs and Sound Rewards

It has already been mentioned that sound is frequently not used enough in early learning material that, in recent years, has become computer based. Although noise can be a nuisance in schools, it provides another important goal for a child who has to put a great deal in to doing anything indpendently. Conventionally, tones have always been used in matrix selection, scanning with a pointer through a menu using switches, but often adding some special sounds for error, command and achievement of goals can increase enjoyment. Obviously, any computer based package can offer noise as a switchable option but its imaginative use can be beneficial. On the MAVIS system, used for some experiments for this project, some ascending notes at the end of lines have been used, a tone sequence for cursor home, special sounds for error and giving a command etc. This added sound has been very well received, especially where children with very poor movement are having to look at a matrix and what is happening on the user screen area, an auditory check aids recognition of what state the machine is in and what has just happened. Interesting sounds were also added to games and packages, these again were received very well. In fact, it is often simple human factors like this that can generate motivation in a child and therefore greatly assist the teacher.

Musical Systems and Toys

Many systems that are being used for young children offer a tune playing program, these systems include APPLE and MAVIS. In fact there is already some very entertaining software available for the Apple for tune playing which has been very much enjoyed by disabled people. Often there is a need to interface these packages to the matrix programmes that are being used, but if these have been written with this factor in mind from the start, there is usually little problem.

For the disabled child with little movement being able to play an "instrument" be it a computer with tunes, is as important as it is for an ordinary child who likes to sit at the piano and pick out a melody. For a very young child, and for some older ones, we used a simple tune playing package, two octaves with letters for the notes, capitals being the lower range and uppercase for the top. The APPLE has far more sophisticated packages but coupling this simple tune facility with the drawing package made a colourful and tuneful picture book which could be gone through independently at home. Although the child used has not yet started writing her own melodies, she has very much enjoyed this colourful "book" but stated that she preferred "ABBA".

One cannot look at musical toys without seeing all the small electronic items that are appearing both in the toy shops and the Hi Fi departments. These range from toys that have a number of built-in tunes as part of a game, to the musical calculators and then through the electronic keyboards and up to the full blown organs and synthesisers. As some of the more elaborate "instruments" were rather expensive the Casio Tone was looked at in detail as a portable, reasonably enjoyable toy that would be suitable for a young child. It is the type of toy that would replace, for the disabled child, the recorder in the ordinary school and, as it is capable of storing a tune, could be operated by switches at least at that level. The problem of button pressing for physically disabled children is discussed in the next subsection and although the Casio was looked at in some detail the problem of making it available for a severely disabled child has not yet been solved although a little time and a good electronics student could sort this out. For those less disabled, it would be possible to make the buttons larger on this particular toy, often there is not enough space left for this which is something that has to be looked for when choosing the right toy.

Talking Toys and Games

The computerised synthetic voice was something that, a few years ago, only those in research had heard. Now, most people know the rather flat sound. Speech technology has recently become cheap enough for it to be used in various applications, these include toys and games. Many of the small computer systems found in schools will support speech technology so some teachers have added this for extra motivation. There is little evidence of this approach being used widely for non-speaking children, but it is something that is just around the corner.

Three of the commonest toys with a voice output are, speak and spell, speak and maths and one of the chess playing machines. These toys are very rewarding for many disabled children but, unfortunately, they have not been designed with a handicapped person in mind. Both the following section on the problems found with keyboards and buttons, and the section after that on work with the blind, discuss most of the difficulties found with these systems. But although there have been difficulties with these toys, there are many more talking toys to come so perhaps a little influence with manufacturers is necessary.

Buttons and Keyboards

When working with the disabled child, it very quickly becomes apparent that, central to many difficulties, are the buttons and keyboards used on many toys. Unfortunately, in this area, microelectronics are not making things easier for the disabled child as toys are becoming generally more flimsy or the keys are made touch sensitive. Following quickly through the development of the Speak and Spell serves to illustrate this point.

The Texas Instrument's Speak and Spell tries, very successfully, to inject some fun into spelling tests. The computerised voice offers a word to be spelt, there are various levels of difficulty, and the user has three attempts at it. This means that the toy has various control buttons and an alphabetic keyboard. When the game first appeared, the keys were small press buttons, this meant it could be operated by people

without sight by counting and adaptation could be achieved as the key contacts could be got at. There was a small problem that the cheap production of these buttons meant that gradually, through use and various falls, the buttons came off.

During last year, Texas produced an update to the Speak and Spell and a similar toy Speak and Maths. Both of the new toys have touch sensitive keyboards. Speak and Maths does not have a verbal repeat when the key is pressed. The touch sensitive keyboards are very much more difficult to adapt as larger keys cannot easily be added, a certain amount of pressure is needed to operate the touch sensitive mechanism (this is more than for the conventional buttons), and the toy has to be taken apart to get at the contacts. Maintenance and toy breakage must be less but for adaptation for disabled children the touch sensitive approach is not usually an advantage. Further work needs carrying out in this area as touch sensitive key pads will obviously increase because of their low maintainance cost and the simplification of producing plastic casings. (See Section 5 - Recommendations R8 for indications of where further effort and research is needed.)

Perhaps one of the largest bars to disabled children with motor problems using electronic toys is the amount of button pressing required. Now, keyboards are not just part of adult life they are widely used in schools as part of the computer courses and are introduced far earlier than the senior school. For those with severe motor problems, there are three solutions to this problem of button pressing, this project has been able to look at these generally but not do any specific experiments in the time scale. The solutions are as follows:-

1. Simulation of the toy on a small microcomputer
2. Adaptation by rewiring
3. Button pressing by robot arm

No one solution will work for every toy but it seems that some work in this area would be very rewarding and it is the type of work that could be, and is being, taken up by schools, evening institutes and willing enthusiasts. (See Section 5 - Recommendations R9.)

Simulation of Toys and Games

This topic has already been discussed in Section Two. In schools it is often a very viable approach as the equipment and skills are available. For children at home the situation is different as it will all depend on the enthusiasm for home computing within the individual family and the ability to apply this to the handicap. For moving toys, simulation does not work so well, as it is direct control of movement that the child really needs, they see moving objects everyday by watching films on television and the two are not the same.

Control by Direct Connection

To find a generalised method by which a number of toys can be used by a child with little movement will take time and effort. The problem was posed to a couple of engineers while this project was in progress, both could have successfully worked on the problem but not within the six months duration of this work. The following is an outline of what was suggested. This is the type of topic that could be undertaken by a school electronics team, the Toy Aids Project (who are already doing this kind of work but need further guidance), or REMAP (a group of engineers, often retired, who devote their spare time to altering equipment for the disabled). In the final section under Recommendations R9 the type of work that is needed is discussed further.

There are two distinct problems but they need similar solutions;

1. toys with a few control buttons
2. toys with a keyboard

Further problems arise when the toy control has one switch but is has continuous movement rather than discreet positions.

One solution that was given was to produce a box with a number of wires that could be attached to each switch on the toy. These wires would be controlled by a small processor or decoding chip. The normal two-way switch would be used for the disabled person. This small processor could

either be attached to a home computer or a system like MAVIS, or a simple display or lights, as is used in environmental control aids, could be used as the switches are selected through the input. This is, in fact, a slightly different use of the controller used for the tram in the experiment discussed in Section Three.

The problems with using this approach are that each toy has to be adapted individually and some are rather easier to do than others. Easy adaptation depends on how easy it is to attach something to the key contact, and, up to a point, how many keys the toy has. For example, it is quite a large job to use this approach on even a simple toy like the Casio VL tone.

Control by "Robot Arm"

As robotics improves, one can see the day when many of these toys will be able to be controlled by "programming" a robot arm. The problem with wiring directly on to a toy is that it destroys the appearance of it, possibly making the child feel that again he/she is playing with something special. For some toys, one can see the possibility of attaching an overlay that would press the keys, something like moving a carriage along a typewriter and hitting a key, operated by the normal inputs, when the right position was reached. This approach has the advantage that an untouched toy can be used, and if carefully designed, the adaptation would be useful for other toys. This approach has been looked at during this project but there has been little experimental work except for finding someone who would be willing to continue. (See Recommendations R8 and Appendix Two.)

The Special Problems of Blind Children

When this project started, little work was going to be carried out on the problems of blind children as, on the surface, they seem few compared with other disability groups. This opinion was revised on discussion with the Head Mistress of Chorleywood College, a secondary school for bright blind girls. Since starting at the school in 1969, she said she

had immediately been concerned about the lack of both play and toys that were used by the girls. Schoolwork and learning living skills with some sports formed the whole of some girls time, there was no idly picking up a toy and playing with it as seeing girls had done quite naturally at her previous shcool. She also felt that some of the electronic toys could also help with teaching in her special environment. When someone doesn't see, they have to learn by experience and this often means lots of models and experience. As Miss Marks, the Head Mistress, was so enthusiastic about this project and she controlled what could and couldn't be used in her school, no approaching ILEA for approval, it was decided, very late in the project to do a little experimental work at the school. If these problems had been realised earlier in the project more results might have been available with some further work carried out.

To respond to the information given by Chorleywood and so that some work could be quickly started, three problems were isolated with some experiments set up. These were:

1. Spelling problems
2. Music toys
3. Assistance with teaching the abstract problems of programming.

As this work was not discussed until the end of the Christmas term, the toys have been purchased ready to be used from the start of the Easter term. Comments from the school will be attached to the end of this section.

Spelling

A Speak and Spell has been purchased and lent to the school. Blind children have great problems with spelling as, unlike other children, they are not able to read words when walking around. Each word has to be read, usually in a book, and learnt. The situation is further complicated by the fact that blind children use a form of shorthand to write braille making it unnecessary for them to spell out most of the words. Further work than the Speak and Spell would have been initiated on their computer in the form of spelling correction software and perhaps

some learning programmes. At present the school is having problems obtaining the necessary terminal equipment to make the computer more available. These schools also have a very experienced staff who are expert in their own field, the teaching of such staff to use the computer has to be carefully organised and great resentment can occur.

As synthetic speech will be of great importance to these blind girls in their adult lives - already there are talking-reading machines and watches - a request was made for the Speak and Maths also. This is to be tried in early maths classes partly for motivation and partly as in introduction to computing; terminals are now available with similar speech.

A Casio VL Tone has been purchased as a musical toy for the school. Nearly all girls learn an instrument but this is taken as a serious subject. It is hoped that the Casio will be used more for out of school activity. Again, this is a good introduction to technology-teaching a little about music while also introducing the techniques how a note can be made up electronically, and memory. Again, comments from the school will be given later.

The final project that has been initiated has been to use Big Track as a programming teaching aid. A rather obvious thing to do but the maths and computing teacher was very keen. The toy will give immediate results from writing a program, without having to correct typing errors, and will perhaps be motivating to those at the bottom of the school. Again, it is a toy that can be used purely for recreation also.

All of the equipment used in these small experiments needs adapting. The school will carry out tactile marking of the touch sensitive keyboards and report back on their method. For blind children, an actual press button keyboard is desirable, button positions can then be found by counting. Although this school does not have very young children, the intake is eleven-plus, they have been used because of their skill in adapting equipment. Perhaps a similar experiment should be set up in another blind school where infants are present (See Recommendations R10 and R11).

SECTION FIVE

Conclusions and Recommendations

Introduction

In this section the finding of the work on electronic toys for the serverely disabled are given. It has been impossible to cover every aspect of the subject in the limited time available but the ground that has been covered has already yielded some interesting comments and results. There is no doubt that the electronic toy market could offer a major breakthrough for both play and early education of disabled children, in fact for any child. It is really up to bodies like the Council for Educational Technology and the Department of Education and Science to inform the manufacturers of the needs of children with disabilities so that allowance can be made in toy design. It is only when this takes place that toys will be cheaply and easily available to the parent and teacher of a disabled child. It is often quite simple factors that need to be presented to the manufacturer, for example the marking of a touch sensitive keyboard like that now on Speak and Spell, so that it can be operated by a child without sight.

The following paragraphs give the recommendations that have resulted from this work. They are given in a list with numbers against them, references to these numbers can be found in the previous text thus giving the background. Obviously, some of the experiments have not been running for long so further information will be available if these are continued.

Before listing specific recommendations a comment should be made on robustness. A disabled child, often through no fault of its own, may well be quite rough on the toys around it. Electronic toys seem to be in many cases, introducing an element of fragile plastic casing which could well rule out a very useful toy. Obviously, making a strong toy is costly, but, in many cases, the trend is going too far the other way leaving the disabled child with more problems.

RECOMMENDATIONS

(R-1) Talking Static Toys

It was surprising that nobody has yet put a speech chip in to a doll or teddy bear. There seems a market possibility here for many young children but particularly those who have severe problems with spoken communication or who will never talk. Obviously, without experimentation it is difficult to guess what the results would be with such a toy but it is certain that, say even random speech on squeezing the toy, would not bring great enjoyment.

Talking toys for the disabled seem an obvious was to encourage communication and start teaching symbols or writing. There are easily imagined variations on the talking squeezy toy, one being a small vocabulary that is meaningful and is more controllable. This seems an area where some simple research could be carried out with a range of both useful and educational toys resulting.

(R-2) Replacement Construction Toys

There has been little done under this project on simulating construction toys. The construction toy seemed an area where the non-mobile child just would have to miss out, finding the information from other sources. However, when examining the problems of teaching such a severely disabled child to draw, the amount of effort required for creating detail is more than the amount of motivation that results from seeing the picture, the idea of drawing blocks was suggested. This project was only able to briefly examine this concept by putting together some simple pictures, (house with tree and ground for example). Pictures are drawn by selecting items, like roof and door, from the matrix; thus having to draw detail is avoided.

This concept was very promising although, at the time of writing, tried for a very short period of time. It seemed that an intelligent package could easily be put together in this area, not only for drawing pictures, but for simulating a construction toy. For example, try and add a wall

to a pointed roof and the wall falls off. Obviously, the disabled child observes others playing with construction but rarely experiences the problems independently. Such a package could be built as a television game and would result in a great deal of fun and independent play, judging from the simple work carried out so far. Sound effects, for example a crash for falling down, could be added to further increase motivation.

R-3 TV and Screen Based Games and Toys

Most children, both at school and at home, have a set of toys that are just around to be played with when the mood arises. Many disabled children are unable, for various reasons, to have this set of toys but technology is making it possible. Further work needs doing on looking at how some of the existing TV games or screen based units might be modified to be usable and motivating to a disabled child. In practice this means talking with some manufacturers, looking very closely at some toys that are around and about to be launched and then studying possible modifications. While doing this work, knowledge of the disabled child and their play needs have to be gained. The work is important as an interested and motivated child approaches education far better than one that is often bored, even if it is outside school.

The reboxing and adaptation of some of the electronic TV games would make a good project for a student (electrical engineering undergraduate) or an extension to the work already being carried out under the Toy Aids Projects. To use the Toy Aids Projects would require some external funding and guidance.

R-4 Hangman and Word Sequencing

Hangman is traditionally played using words and must assist very young children with spelling. The non-talking child has great trouble with word sequencing and this problem might be attached using a similar game but with words rather than letters. This came up as a suggestion during the work on electronic toys but was not tried out.

R-5 Drawing Packages

Colour drawing on a television screen has been something that has delighted many severely physically disabled children, and in fact some adults. Drawing using computer graphics is becoming increasingly important in industry, for example in computer controlled printing and in engineering and computing, so skills in this area might later lead to

increased job opportunities. Many computer companies and individuals in schools have packages and something can be learnt from each. There have been various experiments and it is now the right time for some of the good features from all of these packages to be brought together, perhaps providing some standards but at least pooling the valuable knowhow that is about.

Such factors as colour and ease of use are essential. A certain amount of reward for effort is needed, especially for the young child with severe control problems as boredom and frustration is always present. There is a need for more standards in producing drawing matrixes, the selection menues presented for someone using special switches, and there is a need to look at possible methods of producing hard copy either by photographic means or using a colour printer. Both of these hard copy options have been very expensive but they are now becoming viable. Being able to draw like other children and take a copy home to Mum is very important for the disabled child.

Therefore it is recommended that some standards are drawn up for computer graphics for children including producing hard copy. This type of project is applicable to both disabled and able bodied children as, in the early stages, matrix selection and simple two way switches may be easier for an infant than a frustrating keyboard. This comment is applicable to the following recommendation R-6.

R-6 Electronic Contruction Toys

While watching a child being frustrated by the detail required to put together a simple colour picture, a method of drawing from built in blocks was tried. This was very successful and is an idea that would benefit from further work perhaps as a final year, B.Sc computing project or as an M.Sc thesis.

To try the idea out a matrix was built up of words like ROOF, WALL, DOOR, TREE, etc. By selecting these items, a picture could be constructed easily but a door could not be put in before a wall was present. This concept could be taken much further with an electronic version of lego

being developed. We found that, for the very severely physically disabled child, the motivation of colour was very important, sound could also be added for effect. This type of electronic picture construction would probably make a good introduction to computing for many young children.

R-7 Large Moving Toy

This recommendation is based on requests from parents and teachers who were contacted in the initial phases of the work. The toy is needed to provide very young children, with very severe physical disability, direct experience of independent movement. For some it might be preparation for later use of an electric wheelchair, for others an offer of some free movement. Some work with large moving toys has been carried out in the education department of Hull University but, owing to circumstances that could not be helped, this project has not yet been visited although contact has been made.

There is a need for a large, big enough to house a child inside it, programmable moving toy with controls similar to those of Big Track or even the LOGO turtle. Many disabled children need considerable body support so such a toy would need to reflect this. It also needs to be built imaginatively, say to look like a television monster or colourful toy object, this would increase the general motivation of children to ride in it, obviously under teacher or parent supervision. There are automated warehouse trollies on which such a toy could be modelled rather than a total research phase and full development. Attempts have been made to build this type of thing before but not enough attention has been given to the body support problems or to the possibility of flexible electronic controls. Many young severely physically disabled children are very frustrated by lack of free movement and it is felt that electronic programmable toys could assist greatly in this area. It is not entirely satisfactory for such a child to have to just watch a moving toy, participation is greatly needed.

R-8 Adaptation of Remote Control Toys

This is the type of project that could easily be undertaken by a school electronics project or, perhaps, associated with an evening class in electronics. Two problems exist with the remote controlled moving toys which are that they tend to be rather fast for many disabled children and the controllers are unsatisfactory. However, there are a growing range of these toys with varying degrees of control and they are something that many non-mobile children would enjoy.

In this case, the main thing that is needed to make some of these toys available is imagination. For many children, the controller needs to be altered so that it can be operated with two switches but frequently the basis of this is already there. In a few cases, it is just some springs that need slackening off and then the levers can be operated. Hobby shops are usually very helpful about this type of alteration. Those shops that exclusively deal with models for adult children, will often suggest the best controller and perhaps make an adjustment, they are used to enthusiasts. A model shop would not tend to stock the cheap toy but it is usually a good place to look around for ideas.

R-9 Button Pressing

Many physically disabled children are severely hampered in independent play by not being able to handle buttons and switches. This is becoming an increasing problem as many of the electronic games ar dependent on button pressing. The Toy Aids Projects (see address list) do seem to have looked at the simplest form of this problem but, as yet, no general approach has been researched. Again, this is an area that would be well suited to school electronics programs or evening classes, it might also be an interesting problem to pose for a final year B.Sc electronics project at a university or polytechnic.

During the duration of this project, it was not possible to look at the problem in depth although various discussions did take place providing workable solutions. For some toys, an overlay could be prodcued, for others a small electronic interface box could be made to connect the normal input switches used by the child to the toy and in other cases it

might be possible to use a grid selection mounted over the toy. Obviously, any solution must be based on the type of toy; some have many more switches than others. The robot arm solution was not really considered during this project, although it would be a possibility. This was because the arms available did not seem to be able to make fine enough movements for toys but this is an area that is rapidly changing.

R-10 Big Track

Big Track was found to be a very interesting toy but very difficult to adapt as its control keypad is attached so it easily moves out of range. Obviously, work on the LOGO turtle may well overlap with any adaptation of this toy but it is proposed that this item is looked at further because it is readily available and fairly cheap. It introduces easy programming techniques to children and has a great deal of reward.

R-11 Blind Children

Very late in the project, a small amount of work was started after some comments were made by a head mistress of a special school. In this case all that is needed is to establish a means of marking the keyboards of toys like Big Track and to offer a selection of these to see how they are received. This has already been proposed as an extension of this project as it is an area where initial work has not really been completed.

General Comment

No specific recommendation has been made on the continuation of connecting rail based toys to computers. This is because it has been impossible to try out the work that has been carried out so far in this area. However, at the time of writing, a local sixth form college has approached us for a project in this area and the rail toys have been suggested based on a Sinclair.

CONCLUSIONS AND GENERAL COMMENTS

The outcome of this study is that electronic toys have a large part to play in the future lives of the severely disabled, particularly for those children that attend special schools daily. There is, currently, a great deal of very valuable work being carried out with computers and school children but this project was set up to examine some of the cheaper items that have been missing from many young disabled people's lives. The experiments set up show that it is worth looking at what the electronic toy market is producing and what it might produce that is useful to the severely disabled child and his or her parents. As it has already been stated, the disabled child has so many things to learn that ordinary play, with its normal rewards, can be pushed into the background.

The detailed recommendations from each phase of the project have already been given in the preceding list. These are based directly on the work that has been carried out during the six months of the project and have often been suggested by a parent or a school. However, I feel that there are three main areas where there is already strong evidence that further work would be well worthwhile. These are:-

1. Moving toys, particularly large ones
2. Further experiments with blind children
3. The role of speech synthesis for the very young, non speaking, child.

Whenever this project was discussed with those involved with very severely physically disabled children the topic that came up most was the need for a large moving toy that was imaginatively built, for example a Darlek. Teachers wanted this to be programmable so that a child could be sat in it in the outside playground and experience independent movement. Something like a large Big Track seems the kind of thing but with upright support so that a child with no control does not flop out of it. A visit to Hull University is planned to look at the work they have been doing in this area but it has not yet been possible to arrange it. Perhaps further research from this group might produce an answer; looking at the automatic warehouse vehicles could also be useful. Small moving toys that can actually be controlled by the child are also very important and

missing. Here, the interfacing is relatively simple, perhaps each school computer should come complete with a "O" gauge train or tram and the matrix driving package. This would be a motivating toy for all school children able or disabled, teaching a little about computer control, programming and toys on tracks. Control from a matrix is often easier for a young child than using a keyboard, especially if the software is organised so that a good reward is given on selection. For example a train moves off and a picture is shown on the screen. There is also a need to look at the existing moving toys so that they can be used by disabled children.

Visual handicap is, in many ways, different from many of the other disabilities mainly because everything is based on seeing first, touch second. It is in this area where many of the cheaper electronic toys can be used assisting with things like spelling, early keyboard work, the concept of movement and diagrams and early computer programming. There is much to learn in this area but it is nice to see that there are a few things that are now available fairly cheaply.

Very little has been done during this project on work with synthetic voice. For blind people this will be part of reading in the future so becoming accustomed to the strange voice is important. However, the greatest importance of this kind of technology is the possibility of allowing people to actually have ordinary conversations in a media used by everyone. The recent BBC Horizon program "Finding a voice" showed some of the possibilities for adults in this area but the human problems had not really been sorted out. Putting together a talking communicator is technically possible now but there is a great need to make it easily usable. Such a communicator will need to have intelligent software so that the amount of human selection is minimised and the actual control by people with very limited movement will also need a great deal of further work. As this type of communication will be available when the current young, non talking, school child is adult, it is important to introduce the concept of computer voice early. Mastering and even obtaining the right control switches is often very difficult with very young children as their movement control has often not fully developed. However, the voice will also be strange, not being really like those of parents and family so a toy is badly needed to bridge this gap.

Finally, although this project has concentrated on the young disabled child, usually those with physical handicap, much of the work is just as applicable to ordinary infants starting school. As computers move down through the school, introduction of concepts associated with machines will have to become simpler and simpler. It is here that the computer controlled toy and electronic games have a great deal to offer.