Driving to Learn

The role of powered wheelchair training in rehabilitation

Occupational Therapist Lisbeth Nilsson

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Foreword

This method book was produced with the aid of a grant from the Swedish Handicap Institute.The grant was provided in order to publish a method book based on the experience gained from using powered wheelchairs with severely disabled and multi-handicapped children of pre-school age.

Studies of the effects of training began in January 1993, and a decision to support the publication of a book was taken in 1997.These studies are continuing, and the method is continually being refined.The results of training have been studied in several age groups, with varying degrees and differing causes of disability. In addition to studies of the disabled, a study of normal infants has been carried out.

The aims of the training method have been altered and extended with the passage of time, as has the assessment of which individuals can benefit from it.The greatest deviation from conventional thought regarding the use of the powered wheelchair has been its use in the treatment and rehabilitation of individuals suffering from severe/profound mental handicap, severe visual impairment or visual field defect, and in those able to walk.

This method makes unconventional use of a product that was originally designed to provide mobility for the severely disabled. Experience gained from the studies shows that the greatest resistance to this novel concept of allowing the slightly disabled and the ambulant to take part, is found among relatives and carers. If, however, these people have the aims and benefits of the training method clearly explained to them, their scepticism can be transformed into curiosity and interest.

The results of training vary, depending on the individual's degree of disability. Learning to drive can provide the drive to learn new skills.The observed benefits can vary from increased alertness and interest in the environment, to an improved ability to carry out simultaneous tasks, and greater ability to retain attention and concentration.

There are many different products offering independent mobility on the market.There are a variety of available control devices and a variety of

ways of training with them. The way these different items of equipment and methods are combined into an individually tailored training programme determines how successful the programme can be.

This method of training and rehabilitation is based on a two-way relationship between trainer and trainee. The programme is designed to provide a level of challenge just above the trainee's current skill level. Apart from his innate capabilities, there are many external factors that govern the results that an individual can achieve.

I hope that this book will help to make it possible for more individuals to have the opportunity to train with a powered wheelchair, an activity that is both motivating and easy to vary in complexity. I also hope that carers of every profession can enjoy the same pleasure as I, and others, have had watching the method develop through a series of studies and projects.

As regards the development of the method, I should like to thank all those who have believed in the concept, all those who have worked hard to achieve it, and all those who have given their support and encouragement when nagging doubts have surfaced. I should particularly like to thank the management of Gällivare Hospital, who have shown great interest in the project and made the necessary arrangements that allowed research and development to take place. I am also very grateful to all the bodies that have given financial support, and made the work possible. In particular, I should like to thank the research department of Permobil, the manufacturer, that has spent much time and money supporting the project and developing a wheelchair more suitable for this type of training.

My greatest acknowledgement must however be given to all those individuals who have taken part in the various studies and projects. Without them, their relatives and carers, none of the work on this method could have been done. The participants' own descriptions of their personal experiences, and discussions with their relatives and carers have been of invaluable help in developing the method and the special training wheelchair on which it depends.

Evelina, one of the children that took part in the very first study, continues to train - nowadays in one of the prototypes of the new training wheelchair. Note especially the centrally placed control device, the tray and the collision guard.

1 Introduction

The powered wheelchair - surely that's something you use when you can't walk! It's the final proof that you've reached the end of the road and you're just never going to get any better. You can have a powered wheelchair only when you can show that you can't move under your own steam, and then you're stuck with it, or at least stuck in it. Children and adults exercise and train to the bitter end in order to be able to move in any other way - crawling, rolling or using mobility aids such as a manual wheelchair. It is only when these options are no longer practical that they finally agree to try a powered wheelchair. It's hardly surprising, therefore, that there is a considerable degree of resistance to the use of powered wheelchairs among users, parents and therapists .The powered wheelchair is often regarded as the ultimate symbol of failure by the user and as a financial burden by the health authority.

There are many preconceived ideas and prejudices about the use of powered wheelchairs. Small children become lazy if they are allowed to use one. The child's desire to move in other ways is suppressed, therefore they must train at crawling, standing and walking before being allowed to try a powered wheelchair. Both children and adults who are mentally disabled can't learn how to drive. Adults who are wholly or partially unable to walk will get 'too comfortable' and lose the motivation to persist with rehabilitative training if they get to use a powered wheelchair. Many occupational therapists are unwilling to authorise the use of a powered wheelchair during rehabilitation, fearing that this will lead to an increasing demand for powered wheelchairs as a permanent mobility aid, with dire consequences for the health authority's technical aids budget.

The experience of many years' use of powered wheelchairs as rehabilitative aids shows clearly that these prejudices are groundless. Children don't become lazy - they become curious, and then try to move around in a variety of ways. Severely mentally disabled children that have previously shown minimal desire to move around with walking aids, have shown much greater motivation to use these aids after a period of training with a powered wheel-

chair. Once they learn to crawl or walk, they lose interest in the powered wheelchair. Small children with a mild physical disability learn to crawl and walk earlier once a powered wheelchair has got them accustomed to the idea that they can move around at will. Even some severely mentally disabled people can learn to control and direct a powered wheelchair, although it may take a very long time. Very few adults become 'too comfortable' and lose the motivation to improve their walking ability. Increased demand for powered wheelchairs has failed to materialise, once the underlying need for these aids has been satisfied.

Improved knowledge has led to a complete revaluation of how powered wheelchairs should be used. The greatest difficulty has been, and indeed remains the widely held belief that powered wheelchairs are just an aid to mobility. We adults have lost the child's more flexible and imaginative perception of how things can be used. The saucepan is a good example of how restricted our thoughts become as we grow up. An adult sees a saucepan as just something to cook food in. A child sees endless possibilities in this fascinating object. Filled with water, it becomes a boating lake. Turned upside down, it becomes a drum or a mountain to climb. It can become a huge ladle for water or sand, a hammer or an offensive weapon! Stick it on your head and you have a ready helmet, hold it in front of your chest and it will defend you against the enemy's arrows. The possibilities are limited only by the imagination. By the same token, adults have a restricted view of how a powered wheelchair can be used. It is regarded as just another mobility aid to be provided to someone who can't walk. This attitude is particularly prevalent among those carers and therapists nearest the disabled individual. Children with a mild physical disability see the powered wheelchair as a sort of toy car that's fun to play with. The difficulty experienced in learning to drive it is more than matched by the pleasure of becoming a slick and speedy driver. Adults with an acquired handicap can, when fully informed of the method, learn to look on the powered wheelchair as a tool for training and treatment rather than just a means of getting around. They often discover that it's actually fun to drive, and makes it easier for them to assess their own progress.

Most of the preconceived ideas about the use of powered wheelchairs are held by the able-bodied. My own experiences of using powered wheelchairs as a rehabilitation tool show that motivation to try the method depends entirely on how it is presented. It is a prerequisite that relatives, staff and the individual in question all receive a clear explanation of the goals of treatment and easily understandable information about the expected benefits.

If the purpose of the method is clear, then motivation usually follows automatically.

The purpose of this method book, therefore, is to show how a powered wheelchair can be used for treatment and training. The method is suitable for all individuals who have a disturbance of brain function. The treatment and training is partly aimed at those individuals who are not expected to be able to learn to drive the wheelchair themselves e.g. those at an early awareness level or with a severe or profound mental handicap. It is also aimed in part at individuals who don't need a powered wheelchair to move around and who are expected to be able to walk with or without the help of technical aids, and those who can move themselves around with a manual wheelchair. The aims of the training method can be varied with the age and developmental stage of the individual, and on the nature and extent of the brain impairment. Training can provide an agreeable sensation of movement, and the opportunity to explore simple cause and effect relationships. It can provide the ability to influence and control the immediate environment and can promote concentration, attention, memory and the ability to perform multiple tasks simultaneously. The idea of powered wheelchairs as training aids grew out of many years' experience as an occupational therapist in paediatric rehabilitation. Development of this method of training in powered wheelchairs took place in the complementary environments of practical work with rehabilitation in the northernmost part of Sweden, and research-based studies at the Department of Community Medicine, Lund. The knowledge gained and reflected upon during my studies has provided an insight into how this method of training might be used in children and adults with different disturbances of brain function.

There are certain traditional criteria that govern the prescribing of powered wheelchairs. The individual user must be in need of a powered wheelchair in order to move around independently, and must be able to drive purposefully without risking injury to himself or to others. One can identify 3 groups that do not meet these criteria. The first group consists of those who have some ability to walk or use a manual wheelchair, or who are deemed likely to develop these abilities. The second group consists of those individuals who have a reduced level of awareness or a severe mental handicap in combination with other disabilities affecting mobility, vision, hearing, perception, or speech and communication. The third group consists of individuals with acquired brain dysfunction in combination with other disabilities affecting visual fields, perception, attention, memory, or speech and communication. For individuals in the first group, the question of a pow-

ered wheelchair never comes up. Individuals in the second and third groups are rarely, if ever, offered the opportunity of training in a powered wheelchair - either because they are judged not to have the required understanding or physical capability needed to learn to drive, or because it is difficult to be certain that they can ever gain these skills, i.e. to drive with purpose and safety, even after a long period of training.

The powered wheelchair is a technical aid that is expensive to buy, adapt and maintain. Its optimal use demands sufficient resources for proper instruction and follow-up. Why therefore use a powered wheelchair to reach treatment goals that might be attained with simpler and cheaper equipment? How can one justify such high costs for rehabilitating individuals whose treatment goals do not even come up to the established criteria for the prescribing of powered wheelchairs? Experience from work with individuals in the second group (reduced level of awareness /severe mental handicap) shows that a powered wheelchair can enable them to more easily develop an understanding of simple cause and effect. It is easier for these individuals to discover and understand that the *joystick makes the chair move* than *flicking the switch starts the toy*, because moving the joystick gives immediate feedback with a sensation that is felt by the whole body and all the senses. The experience is intensive and makes it easier for the individual to understand that it is his own action that makes things happen, i.e. that movement occurs. From this we can conclude that training in a powered wheelchair is suitable for the second group, as preparation for the use of switch-controlled equipment. Other experience gained with all groups shows that this training benefits concentration, attention, memory and the ability to take in several simultaneous sensory stimuli. Each action performed with a powered wheelchair gives immediate feedback which demands both a high degree of alertness and speed of reaction. The development or regaining of these functions has great significance for the individual suffering from an impairment of brain function.

Ordinary powered wheelchairs are constructed for quick and safe movement in a variety of environments, both indoors and out. A special training chair is required in order to ensure a favourable outcome. This is designed solely for training indoors. It is cheaper than standard powered wheelchairs, and simpler to use - making learning easier. A training chair must be capable of being used by many, therefore the seat can be easily adjusted to fit individuals of varying age and weight. The training wheelchair is a piece of equipment that could be bought for use in paediatric and adult rehabilitation, special schools and day centres - so that many individuals in these units

could have access to training.

In common with other individualised treatment, powered wheelchair training is time-consuming. Observation of, and interaction with the individual in training demands continuous attention. Interaction and dialogue between trainer and trainee is a prerequisite for learning and development. It is therefore an advantage if the role of trainer is shared between several people in any single department. Different professions, care assistants, ancillary staff and interested relatives can all play a part in the training process. All participants need guidance and instruction in the method to be able to understand, explain, carry out and further develop the training programme.

I hope that by sharing the experience I have gained I can persuade others to try out the powered wheelchair as an aid to training and rehabilitation, and would like many others to enjoy the same positive and heart-warming experiences as I have had with this method. Those who have success with the method can inspire others, and as our numbers grow we can develop a broader and more varied approach that will encompass even more individuals, giving them greater possibilities of developing and improving their abilities by this method. Furthermore, our work can become more stimulating and we can transform our own attitudes to the potential of individuals and the benefits that can be attained. This in turn can affect the attitudes of other staff and relatives, who can come to understand that improvement is possible, even when it previously seemed impossible. Improvements in function can raise expectations even further and can change attitudes to, and relations with the disabled individual. Raised expectation can pave the way for further improvement in function. Each positive experience raises the level of ambition as regards what is achievable by training. With increasing knowledge of the benefits of training, with access to a specialised training wheelchair and with changing attitudes in those who hold the purse strings, I hope that many will start to use this method of using a powered wheelchair as an aid for training and treatment of individuals with a disorder of brain function.

2 Studies upon which the method is based

The role of powered wheelchair training in impaired brain function

The original study that was carried out on children that would never normally have been given the opportunity to try a powered wheelchair has, with time, expanded to include several studies of how training in powered wheelchairs can benefit those with impaired brain function. The benefits achieved have been common to all individuals across a broad spectrum of age and underlying disease. Participants in the various studies have ranged in age from 3 months to 86 years at the commencement of training. Causes of impaired brain function have ranged from developmental delay, mental handicap and cerebral palsy, to stroke, brain tumour and early dementia. The degree of impairment has ranged from slight to profound, and additional handicap e.g. impairment of vision and visual field defects have commonly been present.

The greatest deviation from traditional methods of using powered wheelchairs was made when ambulant individuals were allowed to take part. The effects noted in ambulant individuals most definitely confirmed our impression that the powered wheelchair is an effective aid to treatment and rehabilitation for individuals with impaired brain function, despite the generally held view that powered wheelchairs were just an aid to independent mobility. 'Brain exercise' with powered wheelchairs has become a familiar term in those units that currently use the method. The term makes it easier for participating individuals and their relatives to understand the objectives and purpose of training in a powered chair. It also helps to make the quantum leap in attitude needed to get away from the belief that a powered chair is just a means of getting around independently.

The development of the training wheelchair

The development of a special training wheelchair has taken place in parallel with the various studies. It became obvious at an early stage that a standard powered wheelchair, designed for efficient mobility, was not suitable as a means of training. A training wheelchair had to have simple controls, predictable function, low motor power, and needed to be adjustable to fit many different users. We have been talking to, and collaborating with Permobil, a manufacturer of powered wheelchairs, since the summer of 1994. The first prototype for children and teenagers was used in a study of the powered wheelchair as a teaching aid in a special school for the mentally disabled during the academic year 1997-1998. An improved prototype for adults is being used in a continuing health centre based study of daycare groups. About 50 individuals have so far had the opportunity to use one of these prototype chairs. The results show unequivocally that special adaptation of the electronic controls is necessary to make them easier to understand, and to make it easier to learn to drive, particularly for those with a reduced awareness level. The chassis and the seat have been designed so that many different individuals can use it, and also to make using the chair safer for the individual and safer for the immediate environment.

Original objectives

The original aim was to describe how training in independent mobility could be carried out with a powered wheelchair without a line follower, to record any observed change in the child's capabilities, and to gain an understanding of the physical and social obstacles that existed in the child's environment. Using these results we intended to formulate a possible method of carrying out and documenting the training programme and to determine future study requirements.

The target group was defined as pre-school children with multiple handicap in the form of severe physical and severe mental handicap in combination with vision and hearing impairment, impaired perception, and with little or no capacity for speech. The children that partook in the study had never been thought eligible for a trial with a powered wheelchair as a means of independent mobility because in addition to severe mental handicap, they had profound impairment of vision.

Using a powered wheelchair without a line follower

When the project plan was being formed it was stipulated that a powered chair without a line follower was to be used. It was then standard practice to use line followers when teaching the use of a powered chair to some groups of mentally handicapped, to small children who needed help with steering the chair at the beginning of the learning process, to those with severe impairment of sight or hearing, and to the severely physically disabled, who could only move the controls in one direction. One reason for this stipulation was that in the county where the study was to be carried out, a chair with a line follower had only been prescribed on one previous occasion, and the availability of service and repair was severely limited by the remoteness of the workshop.These conditions made it pertinent to look at the potential benefits that training in a standard powered chair could bring to children who normally would not have been considered for training in independent mobility using a powered wheelchair.

Changing attitudes to objectives and target groups

The results of the first study, done on 2 pre-school children with severe mental handicap and several physical disabilities, showed that the most important objectives of the training programme were the development of a basic understanding of cause and effect, the discovery and understanding of how the hands can be controlled and how tools can be used, and to allow the individual to experience the thrill of movement and the joy of being able to make things happen.The training programme was designed to encourage the individual to keep the chair moving once it had been set in motion, to explore how the movement could be started and stopped, and to experiment with speed and direction.The initial objective was to learn and practice independent movement, in essence, teaching the individual to change position within the room without the help of others e.g. by learning to stop a circular movement in order to face the door. It was judged that theses individuals would need a long time to learn how to steer - to drive purposefully - if indeed they could ever learn to move independently to or from a place or a person. (Nilsson 1994)

Early training promotes the idea of being able to move around

With the change in the objectives of the training programme came a change in the perception of which individuals could benefit from and enjoy the method. Follow-on studies were carried out with small children aged from approximately 18 months in whom medical opinion judged that they would likely suffer from significant or severe physical disability. The results were encouraging, and led in turn to further studies with younger children with less severe disabilities as a result of delayed sensorimotor development. Training was introduced when the child was about 12 months old. A certain resistance was experienced as regards using this method on young children at an age when they would normally be learning to walk, even if in these cases this milestone was markedly delayed. This resistance resulted from the traditional view that a powered wheelchair is a mobility aid to be used only when exhaustive training has failed to enable the patient to walk with or without ambulatory aids. The results, however, clearly showed that the method had benefits for very young children who could not move independently because of developmental delay. The experience of being able to move independently by using a powered wheelchair encouraged these children to try to move in other ways - rolling, crawling or walking with support. It could also be shown that the method gave quicker results the earlier it was introduced.

Training in teenagers and adults

With the completion of the studies of children right down to the age when the normal child starts to walk, attention was shifted to older individuals. What would happen if youngsters and adults with severe/profound mental disability were given the opportunity to attempt independent movement by means of a powered wheelchair? Would this method provide benefits, and if so, would they be the same as those observed in younger children? The results of various studies of adults and teenagers aged from 13 up to 50 years old did confirm the same benefits, although they took longer to achieve. In some cases the learning process demanded 're-education' - which constituted an obstacle that complicated and lengthened the training programme.

Studies of normally developed infants

In order to ascertain at which stage of development it is suitable to start training, a study of normally developed children aged 3-12 months was carried out. The lower limit was established at an age when children have developed the level of head and neck control necessary to try out a powered chair. Previous studies had been carried out on individuals aged 1 - 50 yr. As the individual results were not directly comparable, it became obvious that answers to this question had to be obtained through studies of the behaviour and activity of normally developed children in a paediatric powered wheelchair. The development of infants is well documented, and therefore their individual results are comparable in a way that comparisons of individuals of differing ages with differing disabilities are not. The decision to study infants was also influenced by the common practice of expressing the abilities of the mentally disabled by comparison with function normally present at a certain age. Results showed that infants as young as 3-4 months investigated and manipulated the functions of the joystick and as early as 7-8 months of age had developed an understanding of how the controls could be used in order to move the chair towards a determined object. These results imply that many individuals judged to have severely impaired intellectual capacity may benefit from training in a powered wheelchair.

Training in adults with acquired impairment of brain function

The idea of attempting powered wheelchair training with adults undergoing rehabilitation and daycare developed over a period of several years. The foundation had been laid with the experiences gained in the training of children with mild physical disabilities, and with ambulant pupils in the special school. Training in these groups had shown clear benefits that had not been seen in the participants in earlier studies. These improvements were mainly in powers of attention, concentration and memory and in the ability to carry out more than one task simultaneously. My own experience of patients with a sense of bereavement over lost functions also had a great influence in the development of this idea. This sense of loss of a part of everyday life, the space in which we live and move, was acute. Coping with this change took so much energy that it left the individual feeling extremely tired, forgetful

and unable to concentrate or remain alert, and so led us to reflect over how adults with acquired brain impairment might react to their new reality. It is well known that the loss of someone or something close to the heart can result in severe mental and physical changes, so how much greater these changes when the loss involves the very nature of everyday life and the ability to influence it in a meaningful way? In comparison, it appeared that it is much harder to accept the loss of mental or physical function - not being able to do the things one used to, not being able to move around as before, not being able to think in the same way, not having the energy, not being able to communicate or to be shown the same respect.

The aim was, and remains, to commence powered wheelchair rehabilitation as soon as possible after the onset of the illness, in order to promote the early recovery of cognitive function, and to give the individual the feeling that he or she can make progress despite the drastic change that has taken place. In addition, it facilitates movement between different treatment locations during inpatient or outpatient care.This new concept met with resistance when rehabilitation teams were asked to collaborate.These negative attitudes arose from the traditional view of the powered chair as merely an aid to mobility.The reasons given for not participating in the project were the perceived risk of inducing passivity in the patients and the fear that they might come to regard the powered wheelchair as a personal possession and lose interest in other forms of rehabilitation. It was only when an occupational therapist with particular expertise in psychology and neuro-psychology became involved that the study finally got going. It is been in progress for the past year in a health centre with attached daycare and a 10-bedded observation unit. Participants in the study have taken to the idea of training in a powered chair with enthusiasm, and it has become a popular part of the rehabilitation programme.The feared risks have not materialised, and the results have been excellent especially in stroke patients suffering from neglect of the paralysed side.They have managed to develop strategies for compensating for their lack of attention.The study is continuing and will be completed within the next six months.

Our hope is that the next study can be carried out in a rehabilitation unit with patients that have a newly acquired impairment of brain function. Research goes on, and continually throws up new thoughts, experiences and knowledge.Although the results are as yet incomplete and discoveries remain to be made, the time is ripe for committing pen to paper.

3 Thoughts and aspirations that have influenced the development of a training wheelchair

It became obvious in the early stages of applying the method that individuals at an early awareness level found it difficult to learn through the use of a standard powered wheelchair. Some individuals have difficulty understanding instructions and lack the ability to initiate an independent act, and if they are to learn about causality, i.e. that a certain act has a certain consequence, moving the joystick on the wheelchair must result in a consistent effect. Each type of movement of the joystick must always result in the same effect. Without a consistent relation between cause and effect, these individuals cannot make the association between the two. Immediate electrical response, and direct association between joystick movement and chair movement irrespective of the direction of travel, are two essential properties that improve the prospects of understanding cause and effect, i.e. understanding the relation between movement of the joystick and movement of the wheelchair.

Why is it difficult to train with a standard powered wheelchair?

The electronic and mechanical design of the standard powered wheelchair has been primarily governed by the need to produce a chair that lets the user navigate easily and safely. This has resulted in control functions that are inconsistent in their response, which makes them unsuitable learning devices for the mentally disabled. The powered wheelchairs that are currently available on the market are designed to fulfil the need for manoeuvrability, the ability to negotiate a variety of obstacles, and the need for remote-control of e.g. doors and computers. An analogue joystick is most commonly

provided for steering. These chairs are equipped with advanced electronics and powerful motors, and are built for people who can quickly learn to use the chair's advanced functions in order to get to where they want to go.

Modern powered wheelchairs have many electronic settings that govern power, speed, delayed response etc. Certain settings are useful for people suffering from muscle weakness or involuntary movements, others for novice drivers or for the experienced user. Despite these advanced electronics, it is nearly impossible to find a chair with a joystick that provides direct control with an immediate power response. It is even more difficult to find a chair with a joystick that delivers the same speed in all directions of travel.

For safety reasons, modern powered wheelchairs have an in-built setting that links available power to the direction of travel. Forward movement of the joystick releases more power than joystick movements sideways or backwards. In the training situation the combination of low speed/low power has benefits - preventing wheelspin when the chair has run into an obstacle that stops movement, and limiting damage in the event of a collision. However, this reduces the chair's capability of overcoming minor obstacles, e.g. carpet edges, thresholds and soft, uneven surfaces. If available power for forward movement is reduced to a minimum, then the chair becomes incapable of backward movement if the guide wheels are slightly angled. The setting that may be best for forward movement may therefore make backward movement or backward turns impossible in the presence of minimal resistance.

Some powered wheelchairs have protective fenders that cut out electrical power when they come into contact with surrounding objects. In order to reactivate electrical power, the user may e.g. have to return the joystick to the neutral position and wait for a sound signal that confirms that power has been restored and that the chair is back in function. In order to cope with this system the individual user must be able to carry out a sequence of actions, and have the understanding to wait for the signal that confirms that the chair is once again driveable.

The combination of low speed and low power, and the presence of safety fenders results in inconsistency in the chair's response to the controls and places greater demands on the intellectual capacity of the user. In order to understand the pattern of relationships between several different events, the user must be able to understand causal relationships and have a reasonable understanding of temporal relationships.

The joystick automatically springs back into the neutral position - the 'dead man's handle' - whenever it is released for whatever reason. The spring

required to make this recoil mechanism work safely may prove too strong for a small child, or for an adult with muscular weakness (MS, muscular dystrophy) or inappropriate muscle tension (e.g. cerebral palsy, stroke). The joystick commonly has a rubber skirt linking it to the control panel, and this also increases the joystick's resistance to movement.

The joystick and control panel are most often mounted on the right or left arm support, as determined by the individual's arm function. Less commonly they are mounted on a tray resting on the arm supports. It is generally accepted that a tray makes it difficult to get in and out of the chair, and represents a barrier that restricts access from the chair during use. Some wheelchairs have a hinged arm with a mount for the joystick and a control panel built into the arm support. Sometimes the set up of the controls lacks proper forearm support necessary for an ergonomic hand position. Forearm support is important for precise control and enables those with impaired strength, co-ordination or tone to drive for longer periods.

Design of the training wheelchair

The seat is designed so that many different individuals can make use of the chair. The seat's depth and distance from the footrest, and the distance between the backrest and tray can be easily and quickly adjusted to fit each person. An analogue joystick is used to activate, steer and regulate the speed of the chair. Movement of the joystick produces an effect without any delay. The joystick recoils to the neutral position with the help of a weak spring and has no rubber skirt that increases resistance to movement, so that individuals with impaired muscle strength and even infants have no difficulties in moving it. The design is simple and lacks sensors and electronic gadgets that may affect consistency of response to control movements of the joystick.

It is possible to limit the power of the motor to a low level and yet still attain sufficient speed for the individual to experience body movement. Movement of the joystick produces equal speed irrespective of direction. A speed that can be felt by the whole body heightens the sensation of movement and promotes alertness. Low motor power minimises the risk of collision damage or injury. A shock-absorbing fender protects the feet in the event of a collision.

Consistent and predictable response gives the mentally disabled the best possibility of developing an understanding of how their actions on the

joystick affect the movement of the wheelchair. When they have begun to initiate conscious movements they are then free to experiment with the joystick, investigating the link between different positions of the joystick and the speed and direction of movement of the wheelchair.

The analogue joystick is mounted in a clear Plexiglass tray. The clear plastic enables the individual to see the lower body, and to see obstacles at foot level. The tray has a recess for the body and wings that extend backwards to provide users of all shapes and sizes with good forearm support. The tray extends forward sufficiently to protect the knees in a frontal collision.

The base of the joystick is sunk below tray level so that it does not interfere with movement of the joystick, which juts out 3-4 cm through a hole in the tray - at a level which enables the user to grip the joystick while resting the forearm on the tray for support. The joystick is placed in the middle of the tray about 6-8 cm from the edge of the body recess. The mid-placing gives the user the possibility of using either or both hands. The grip on the joystick can be a ball measuring 3-4 cm across or a 10 cm rod of the same diameter.

There is nothing on the tray except the joystick, which naturally focuses the individual's attention, curiosity and experimentation on this object which is related to the movement of the chair. The control panel which regulates the various setting is mounted on the rear of the backrest, easily available to the person in charge of the training programme.

This design, incorporating a tray and a centrally placed joystick, has worked well for a large number of individuals - from the very young to the very old, with all grades of postural problems and a variety of functional impairments of the hand and arm. The tray gives good support for the forearms, elbows and upper body. The inset joystick unit provides a good working position for the hand working the joystick, and the tray can easily be adjusted to fit individuals of all ages and sizes.

Reasons for placing the joystick centrally

Choosing a joystick as a control device for powered wheelchair training has many advantages. The joystick's very design promotes the development of an individual's understanding of control movements. The individual can see and feel the direction in which he is moving the joystick, and the association between the position of the joystick and movement of the wheelchair is thereby reinforced.

Training can be introduced at a simple level, in order to develop the individual's awareness of the association between his actions and the movement of the chair. As this awareness increases, the programme can gradually move on to a more complex level, without ever needing to change either the joystick or the chair.

The centrally placed joystick has many advantages. When a person manipulates something or carries out an action, he often chooses to have the tools and materials directly in front of him. It is easier to carry out precise work in front of the body's mid-line - the body is better balanced, it is easier to see and both hands can be brought to bear. Therefore it is easier for an individual to develop an awareness of the association between the joystick and movement of the chair if the joystick is placed directly in front of him, rather than on the right or left arm support. With the joystick in the body's mid-line, the individual can both see and feel his steering movements and it is easier to relate these movements to the induced movement of the chair. Central placement increases the chance of accidental movement of the joystick and subsequent movement of the chair as a result of random movement of the hands and arms. These random occurrences are less likely with a joystick placed to one side. It is also easier for the joystick to capture the individual's attention if it is placed directly in front of him and can be examined with both hands. A centrally placed joystick can be manipulated with either hand, or with both hands together.

Powered wheelchair training is a skilling activity

By practising how to control a powered wheelchair with a joystick, an individual can learn to develop his capacity for conscious action. Moving around in a powered chair alters the individual's position in the room and stimulates several senses simultaneously. It is the individual's own actions that produce this change. When movement is effected without anyone else being in close proximity, then it becomes obvious to the individual that he himself has made the chair move by moving the joystick. The sensation of movement which results from the individual's action is a strong incentive to continue to act, to experiment and to investigate the relationship between the position of the joystick and the speed and direction of the movement experienced. By experimentation and reflection on his experiences, the individual can discover how the controlling device can be used to move

the chair at a desired speed in a desired direction, thereby learning to drive purposefully.

When the individual becomes more skilled at steering the chair, speed is the only setting that needs to be changed in order to increase (or decrease) the level of difficulty. Higher speeds place greater demands on the individual's alertness, his ability to take in several stimuli simultaneously, his ability to plan and adapt his movements, and his ability to react quickly and safely to unexpected situations.

4 Electrically powered mobility aids, various devices, methods and the potential for improvement

There are various types and makes of electrically powered mobility aids. These aids have been designed around prospective users, in the most likely locations. There are products for children and adults for indoor and outdoor use in both rural and urban environments. There are also some products designed for very small children, and for individuals that require a lengthy training period in order to learn to drive, perhaps with specially adapted controls. The choice of a suitable aid for any particular individual relies heavily on good knowledge of the different characteristics of the available aids and their functions, and what demands each of these aids places on the individual and his or her instructor. The choice is also influenced by other factors, e.g. assessment of the individual's innate capabilities, the objective of the training, the environment in which the aid is to be used, and which people will be assisting with the individual's training programme.

Personal and shared experiences with the use of various mobility aids, discussions with product developers and increasing knowledge of human development and learning processes have led me to consider what opportunities electrically powered mobility aids can provide. I shall describe the differences between products as well as tools and techniques for the promotion of independent mobility. All products are intended to facilitate mobility and to provide greater opportunities for activity and personal development. A standard powered wheelchair places considerable demands on the user and those with severe physical and mental limitations may find it too difficult to use for training. The methods of track-guided driving, perimeter limited driving and free driving with their different constructions, functions and uses, provide various possibilities. The various appliances make differing intellectual demands. Some of these appliances are particularly suitable for

those with more random behaviour patterns.

The way in which products and techniques are combined determines what level of intellectual demands are placed on the individual. Different combinations place differing demands on the interplay with the trainer and the immediate environment. The risk of injury or damage depends on the chosen combination, the intellectual capacity of the individual and the success of the interplay with the trainer. The combination of product, steering method and control device that an individual has used to train, determines how easy he or she will find it to move on to another combination designed to promote independent mobility. The chosen combination also influences the individual's chances of progressing to other product types, e.g. the control of toys, appliances, computers or communication aids. Examples of these might be remote-controlled toy dogs, switch or mouse activated computer games or communication aids.

Most individuals with some form of impaired brain function, irrespective of their ability to walk, have better prospects of rehabilitation if they are given the opportunity of training in an electrically powered mobility aid. The main aim of such a training programme is to stimulate conscious thought and insight, to improve the level of physical activity and to enhance the ability to interact with the environment. Independent movement through the use of powered aids is not just a way of compensating for impaired mobility, but also a highly motivating activity that can encourage individuals of differing ages and differing handicaps to strive for progress, to recover lost functions and to attain new capabilities.

The individual's prospect of improvement with these different methods and products does not depend entirely on his or her level of intellectual function and physical capability. The improvements that are achievable in both intellectual and physical function are also governed by various beneficial and adverse factors in the physical and social environment. Physical factors include the individual's form of accommodation and pattern of daily activity. Whether these factors are beneficial or otherwise depends on the content of activities such as the handling of objects, movement, interaction with others, learning and rehabilitation. Social factors include the attitude of others towards the individual's capabilities, and how they view the prospects for improvement and personal development. The attitude of others strongly influences the individual's view of himself - in either a positive or a negative way.

Motivation to train and confidence in the equipment and training method improve the prospects of success. This applies equally to the individual

and the trainer. If the trainer has confidence in the individual's potential for improvement, and expects success, then this conviction will be transferred to the individual, and strengthen, in turn, his self-confidence, willingness to co-operate and ability to act and interact. Improving co-operation and small signs of improvement stimulate the trainer's commitment and preserves the individual's interest in the programme. If the individual, the trainer, carers and relatives are united in their belief in the potential benefits, then it is much easier to achieve a significant and sometimes unforeseen level of improvement.

Powered mobility - products and methods

The standard powered wheelchair

The standard powered wheelchair has been developed for individuals who have a need for a mobility aid because they lack the ability or the physical strength to walk unaided. They are expected to learn to use the chair with little or no special training. These individuals have an undiminished ability to act and interact and can participate in meaningful activity. They have experience of different aids and in the use of appliances, and regard the wheelchair as a useful means of carrying out actions that physical disability would otherwise prevent. There are powered wheelchairs for indoor, outdoor and limited outdoor use.

The demands placed on the individual

It is assumed that the individual can sit in the wheelchair without any need for special adaptations. The main demand made of the individual is the requirement to learn quickly how to steer and regulate the speed of the chair. He must gain an understanding of the dimensions of the chair and how much room is needed to avoid collisions when moving forwards, backwards and sideways. Getting where you want to go requires forward planning and continuous steering adjustments which demands that control movements must be carried out in the right sequence and at the right time. The ability to drive safely in confined spaces full of fixed objects and moving people demands that the driver remains alert and attentive and has the ability to handle several sensory impressions simultaneously whilst making continuous adjustments to his plans according to the ever-changing environment.

Electronics and functionality

The joystick that is normally used to steer a powered wheelchair activates the motors and regulates speed and direction. It normally works in an analogue fashion. Fine and coarse movements of the joystick release proportional amounts of power. Moving the joystick enables the wheelchair user to regulate speed and direction in a continuously variable fashion. Modern powered chairs are fitted with enhanced electronics which makes it possible to adjust settings for speed, acceleration, braking distance and joystick sensitivity. Normal speed settings allow for greater speed when moving forwards compared to sideways or backwards. This can prove to be a problem when using the wheelchair at the lowest settings for speed and power. If the chair has small guide wheels at the rear, and if these are not aligned in the direction of travel when trying to reverse, then the power may not be enough to straighten them up and move off in the desired direction. Yet at the same setting, forward power may still be sufficient to cause wheelspin when a forward-moving chair comes to a halt against an obstacle. The standard setting is designed to make for safer driving with adjustments being made according to the individual's capabilities and the requirements of environmental safety.

The individual's potential for improvement

The ordinary powered wheelchair gives the user the opportunity to master the art of driving a wheelchair. How well he manages this depends on his own innate ability, the design of the chair and the environment in which it is to be used.

The standard chair is not designed for the training of individuals with impaired intellectual capacity who have not developed, or have lost the ability to act and to interact with others. The chair cannot be set to travel at equal speed in all directions. In order for the individual to develop an understanding of the consequences of his own actions it is vitally important that the chair reacts predictably and consistently in response to a given movement of the joystick. The response of the chair should be simple and obvious - providing an easily recognisable pattern which can later become the basis for conscious action to achieve a desired goal. Only when the individual makes the connection between a certain action and its effect does he come to un-

derstand that the choice of a certain action can achieve a desired effect.

It is also difficult to set the speed and power at a level that minimises risk of damage to the surroundings, and still provide the sensation of rapid movement. It is difficult to develop a sense of cause and effect unless the consequences of one's actions are clearly felt - i.e. it is necessary to allow collisions and to permit the sensation of speed. Conscious choice and verbal communication have not developed to such a level that warnings and explanations will promote safe, collision-free driving. It is only an improving capability of conscious action and the bodily experience of collisions and movement that can lead the individual to adapt his speed and way of driving to the surroundings.

Powered wheelchairs with a line follower

Line followers for powered wheelchairs have been developed especially for individuals who have difficulty in steering a standard wheelchair. The product that is currently available on the market is manufactured by Permobil in Timrå, Sweden, and is considered suitable for individuals who can only cope with a standard chair after a long period of training, if at all. The limited adaptability of these individuals might depend upon young age, developmental delay, or physical or visual handicap. It may depend on an impaired ability to take spontaneous action, or to interact with others. It may depend on an inability to use equipment and appliances or to participate in meaningful activity. Line followers are primarily intended for indoor use but may be adapted for outdoor use in certain locations.

The demands placed on the individual

It is assumed that the individual can sit in the wheelchair without any need for special adaptations. The main demand placed on the individual is the need to remain alert and be able to initiate voluntary actions and interact with the surroundings either spontaneously or with the encouragement of others. The use of line followers requires that the individual can examine, feel and press upon various parts of the chair in order to understand which part of the chair is related to the generation of movement and how this movement can be started and stopped.

Electronics and functionality

The track consists of white reflective tape, or if the background is pale, black vinyl tape.The tape is applied to the floor along the path that the wheelchair is to travel.The powered wheelchair has a sensor or a camera that can detect the reflection from the white tape, or the contrast between the black tape and the pale floor. In this way, the chair can follow a predetermined path as soon as the power is switched on. Normally the track is a loop along which the individual can drive continuously without coming to a barrier. It can be laid in a single room, or along corridors and into several rooms, depending on the premises.The chair that makes use of a camera and black tape can cope with crossing its own track, as in a figure-of-eight.The loop can be constructed to go back and forth between two points if a turning circle is created at each end.With a simple loop, the chair is activated by a simple switch.With loops that include junctions, activation and steering is done with 2-3 switches or an analogue joystick with limited functions.With switch-based activation, the individual cannot regulate speed.The speed of a sensor-guided wheelchair must be restricted to approximately. 1km/hour (about 17 metres/min) to allow the sensor sufficient time to locate and follow the tape.A camera-guided wheelchair is more efficient and can manage speeds up to 2 km/hr or 34 metres/min. Excessive speed on curves in the track increases the risk of 'derailment'. It is impossible to reverse along the track whatever guidance or activation system is used. If the individual happens to drive past something interesting, he or she must drive all the way around the loop again, as the wheelchair cannot be reversed.

Individuals who have developed the ability to take a conscious action can be provided with tracks that include junctions.The exit from the junction can be chosen with one of two or three switches or a simplified analogue joystick.A switch-activated chair automatically comes to a halt at a junction in the loop.The wheelchair can then be reactivated with a switch for forward, right or left movement.Altering course with an analogue joystick occurs without an automatic halt at the junction, but the property of being able to select direction must be pre-programmed into the wheelchair's electronics. It is also possible to place short strips of guiding tape as an aid to navigating narrow passageways or doorways if the user has learnt to steer the wheelchair but lacks sufficient precision to steer through these more difficult areas.

A powered wheelchair with a line follower is most commonly used in training classes, day centres etc. - places where several users need to be able

to try out their skills. The wheelchair's seat is adjustable so that as many individuals as possible can make use of it, but if the chair is intended for dedicated use by one individual, the seat is adapted specifically for that person.

The individual's development potential

Training with a track-guided wheelchair can help to develop the user's ability to steer and influence events through his own actions. Actions become conscious, active and purposeful - designed to achieve a desired goal. An individual with limited understanding of the effect of his own actions experiences movement as an enjoyable experience in its own right, and not just as a means of doing something else. When it dawns upon the individual that a certain action always achieves a certain result, then he can begin to act in a more purposeful way. The pattern of how one should act to start and stop the wheelchair begins to form. The action of activating the chair and experiencing a sense of movement can act as a basis for the further development of purposeful behaviour patterns.

The use of a switch to activate the wheelchair represents the use of a simple tool. The individual's actions are channelled towards the switch which becomes the means to an end - the achievement of movement. When this process has been learnt, and demands less concentration, attention can then turn to the surroundings which become more interesting when the individual can, through trial and error, stop the chair by objects which capture his attention. The individual can learn to drive to an interesting object that is not immediately visible when stimulated by sensory impressions from the surroundings and armed with the memory of what has happened before and the expectation of what he can achieve through his own actions.

By using an analogue joystick to chose the direction of travel, the user makes a *conscious choice between action sequences with the aid of a tool.* The joystick has the same construction as the joystick on a standard wheelchair. The difference lies in the limited functionality when used to select junctions on a guiding track, as opposed to free driving. It is not possible to reverse, and it is only possible to select a new direction of travel at junctions. Taking action to change direction works only part of the time, depending on whether the chair is positioned at a junction. The joystick must be moved at just the right moment if the desired effect is to be achieved, i.e. before one has moved past the junction. If the settings are made so that the user can

regulate the speed within the range of 0-2 km/hr, then he may be able to learn to reduce speed before selecting which way to go at a junction.

Chairs equipped with directional control in the form of two or three switches allow the user, after the chair has come to an automatic halt at a junction, to choose a new direction of travel by making a conscious choice between several devices - e.g. to release pressure from the switch for forward movement, move the hand to the selected switch and press that switch to initiate movement to the right.

Those individuals that manage to control the direction of travel by using an analogue joystick, or even switches, have the best prospects of moving on from track-guided wheelchairs to standard powered wheelchairs. They have developed an understanding of how they can steer and influence events by the choice of actions or sequences of actions, or by the selection of specific devices.

Most users of track-guided wheelchairs activate the chair by pressing a spring-loaded switch, which does not give the user the possibility of making a choice, of taking an action or a sequence of actions that will regulate the speed and direction of his wheelchair. There is a great difference between using a single switch to initiate movement and using an analogue joystick to steer freely, and this makes it difficult for the user to progress from the former to the latter. Several studies have confirmed that very few individuals progress to free driving once they have learnt to use a track-guided wheelchair activated by a single switch. (Birath, 1989 and 1994; Christiansson & Hjortsby, 1991)

The Akkaplatform with line follower, perimeter limited driving or free driving

The Akka platform, manufactured by JCM in Helsingborg, Sweden, was at the outset intended for use in the training of small children in independent mobility. Later the range came to include 4 different sizes that can now tolerate loads of up to 100 kilos. It is used nowadays in the temporary training of, or for permanent use by individuals of all ages who have difficulty using a standard powered wheelchair. The Akka platform allows very young children to drive while lying on their stomachs, sitting in a customised support or specially adapted seat which is strapped to or permanently mounted on the platform. Older children, teenagers and adults can steer the chair from a specially adapted chair or even their ordinary manual wheelchair which can be mounted on a sufficiently large platform. The platform can be used with

a line follower or for perimeter limited and free driving. The commonest use is with line followers, and only about 5% use the method for other types of driving. The Akka platform is used exclusively indoors on flat surfaces.

The demands placed on the individual

Very small children and individuals that cannot sit unaided or who need special adaptations in order to sit can be more easily positioned on an Akka platform than in a standard or training wheelchair. The requirement for successful track-guided driving are no different with an Akka platform than with a track-guided wheelchair as described above. If the Akka platform is used in perimeter limited driving, greater demands are placed on the individual's powers of conscious decision, action and interaction. In perimeter limited driving, the area in which the chair can be driven is delimited by a tape boundary. When the Akka platform detects the boundary, the power is cut off and the user must chose another direction of travel within the restricted area. Perimeter limited driving requires a greater understanding of the relation between cause and effect. It requires that the individual can learn that there is an obstacle to movement outside the restricted area, and can learn the necessary pattern of action needed to move away from this obstacle. As regards free driving, the demands placed on the individual using an Akka platform are precisely the same as with the use of a training wheelchair.

Electronics and functionality

The Akka platform is shaped like a rectangular tray with rounded corners. It has 2 drive wheels that sit under the forward part of the tray, and 2 castors that sit under the rear corners. The tray has about 10 cm floor clearance. The electronic 'black box' is attached to the underside of the tray and has a control for setting the speed and a jack for connecting various steering devices. The speed can be set between 0 and 20 metres/minute. The steering devices are attached to the user's seat or manual wheelchair, which are normally strapped to the tray.

When used with a line follower, the Akka platform is steered with a switch. The track is laid out with black vinyl tape, and the sensor comprises of a photoelectric cell. Reversing is not possible. If the platform is used for perimeter limited driving or free driving, a number of switches or a digital joystick are required to control the direction of travel. The digital joystick

unit contains 4 spring-loaded switches which can be activated, one at a time, by the movement of the joystick. From the central, neutral position, the joystick can be moved through one of four gates towards each of the switches - straight forward, straight back or at right angles to the left or right. The four functions connected to the respective switches are forward movement, backward movement, rotation to the left and rotation to the right. When the joystick activates one of the switches, power is supplied to the motors. Both motors come into action with forward or backward movement, while turning is achieved by the slowing down of one of the motors - producing rotation of the platform either to the right or to the left. Negotiating a curve demands several changes between forward movement and rotation. The speed of the platform is pre-set with an electronic control under the tray, and the user has no means of regulating speed during use. Free driving can utilise the maximum available speed, but the risk of leaving a curve on a loop, or crossing the boundary during perimeter limited driving increases with increasing speed. The speed must be set according to the time required by the sensor to detect and follow the tape, or to switch off the power before crossing a tape boundary. The manufacturer intends to further develop the electronic controls so that it will become possible to steer the platform with an analogue device. In other words, the platform will respond in an infinitely variable way to movements of the joystick - regulating speed and direction in exactly the same way as with a standard powered wheelchair. This would make the transition from using an Akka platform to using a powered wheelchair considerably easier.

The individual's development potential

Training with a track-guided Akka platform equipped with a line follower provides the same improvement potential as with a track-guided wheelchair. The individual's behaviour can become more conscious and can develop into more purposeful action to influence or interact with the surroundings. The beginnings of a conscious use of a device can develop further through the repeated use of, in this case, a switch to start and stop movement of the platform.

Perimeter limited driving and free driving place greater demands on the level of interaction with the trainer. The individual's exploration of the relation between actions and results, within a constructive relationship with the trainer, paves the way for the development of conscious and planned activity that can achieve self-determined goals. The interaction with the trainer promotes the mutual acceptance of names for a variety of objects, terms for

different actions and spatial relationships. This mutual acceptance of terms can be the result of the trainer repeatedly making the connection between certain words and the actions or objects they describe. During the training process the trainer describes and explains what type of action makes the platform start to move, stop or move off in another direction. The individual is given support and encouragement when selecting a switch or moving the joystick in order to move away from an obstacle or boundary tape that has caused the motors to cut out.

Those few individuals that can manage perimeter limited driving or free driving using several switches or a digital joystick have better prospects of managing the transition to a standard powered wheelchair. They have learnt to make active choices and to vary their patterns of activity. They have also become familiar with the use of a joystick although the digital joystick on an Akka platform differs in its functional properties from the analogue device found on the standard wheelchair. With the digital joystick, movement is initiated and controlled by selecting 1 of 4 positions. Speed cannot be regulated. Purposeful driving requires that the user can consciously carry out an appropriate sequence of actions in order to achieve the desired result. These actions consist of moving the joystick from neutral to drive in one of four pre-set directions - i.e. to turn right requires that the joystick be moved to the right to rotate the chair in that direction, returning the joystick to neutral and then selecting forward movement. Adjusting the direction of travel demands one or more movement sequences. The analogue joystick allows the continuously variable regulation of both speed and direction proportional to the deviation of the joystick from the neutral position.

Most individuals that use a track-guided Akka platform control the chair's movement with a spring-loaded switch. Learning to control movement with an activating switch does not allow the user to learn to make active decisions, to develop the capacity to carry out sequences of actions, or to control speed and direction of movement. There is a considerable difference between using a switch and using a joystick, which means that individuals with impaired awareness can experience great difficulty in progressing from a switch-controlled Akka platform with a line follower to a joystick-controlled standard wheelchair.

The training powered wheelchair

The training wheelchair has been developed in collaboration with Permobil, Timrå, Sweden, with two roles in mind - firstly as a means of providing an opportunity for independent mobility to individuals thought unlikely to

cope with a standard wheelchair, and secondly as an aid in the rehabilitation of individuals with impaired brain function.

Individuals who need a powered wheelchair to be able to move independently often take a long time to learn to drive, and may even have a permanent need for a training wheelchair. For individuals that use the training wheelchair as a means of training and treatment, it can become a tool that promotes the development of conscious thought, insight, and patterns of action and interaction irrespective of whether the user is ambulant or relies on the chair for mobility. The individual's functional deficit can vary in both nature and degree. Many individuals can gain benefit from this training - from those with a slight dysfunction to the severely disabled. The demands that this training places on the individual can be tailored to his or her capabilities - at a suitable level of complexity. The training wheelchair is only suitable for indoor use, on level surfaces.

The demands placed on the individual

The demands placed on the individual are the same as those for track-guided driving. A certain level of attentiveness is required, as well as the ability to sit upright with the support of a tray. It is possible to use detachable or moulded seats in the chair. It is also necessary that the user can consciously initiate an action, or is thought capable of doing so with the encouragement of another person. In comparison to track-guided driving, free driving places greater demands on the trainer and other support persons, in that they must develop a programme that is tailored to the individual's level of ability. Driving a wheelchair purposefully can be complicated, and the level of difficulty can be set at a high or low level. The trainer must adapt the programme according to his observations of the individual's capabilities and limitations.

Electronics and functionality

The training wheelchair has basically the same electronics and functionality as a standard powered wheelchair. The settings however differ, being adjusted so that the chair responds at the same speed in all directions. It is possible to set the power at such a low level that the wheels cease to turn when the chair comes into contact with an obstacle such as a human leg. Even with such a low power setting, it is possible to generate a speed that is sufficient to give the user a sense of movement. The chair is controlled with

an analogue joystick, providing continuously variable regulation of both speed and direction. The joystick is very sensitive and requires little strength to move. Normally, the chair is activated as soon as the joystick is moved, in whichever direction. In other words, there is no delay between action and response, which provides the user with direct and immediate feedback and makes it easier to learn how to control the chair's speed and direction of movement.

The easily adjusted seat is designed to make it easy and quick to adapt the chair to users of different sizes and shapes. The training wheelchair is most often used just for short training sessions so comfort is not an absolute requirement, as it would be for a chair that is used for hours on end. The control panel is mounted behind the backrest. The joystick is mounted in the tray which has a recess for the upper body, and which can be easily moved forward or back according to the dimensions of the user. Seat depth and footrest height are similarly adjustable. Infants as young as 3 months, and individuals with poor upper body stability can use the chair, provided that they can control head movement. The upper body is supported at the front and to the sides by the recess in the tray, which also supports the arms.

The individual's development potential

Training with free driving in a special training powered wheelchair can help the user to develop an understanding of how his actions can generate certain results. This enables him to develop a more active, meaningful and purposeful life. All individuals, irrespective of their initial levels of ability, can improve certain functions e.g. concentration, attentiveness, memory, reaction time, and multitasking capability. When the user has learnt the art of purposeful driving, the level of difficulty can be raised by increasing the speed.

Free driving places greater demands on the trainer and other support staff, mainly through the requirement for greater attention, and the need to tailor the programme to the individual's level of ability. Training is a mutual learning process that is heavily dependent on the reaction of others in the immediate environment. The trainee learns how to act, to interact with others, learns new terms and how to use a new device. During this process the teacher learns the art of analytical observation, and how to use his relationship with his trainee to tailor the progress of the training process to suit just that individual. Other support persons learn how to adapt their reactions to the individual's driving ability - when to move, to keep a little distance, or

when to take avoiding action etc.As the learning process requires feedback, it is necessary to let the individual experience collisions, and this requires that the trainer keeps a watchful eye and tries to anticipate the consequences of the individual's actions. Collisions are a necessary part of the learning process and should not be prevented, although damage must of course be kept to a minimum.The trainer must therefore be constantly on the alert and ready to make a guiding hand-on-hand intervention, and cannot let his attention stray, or leave the individual unattended even for a few seconds.There is a significant risk that the individual may harm himself or others because he only has a limited ability to foresee the consequences of his actions - i.e. when he moves the joystick.Warnings from others about danger, collision damage and other risks serve only to inhibit curiosity and the desire to explore and experiment. Co-operation calms, improves self-confidence and promotes the will to explore.The learning process is a mutual one, and the trainer's observations provide the basis for the development of a programme that can promote the development of the individual's capacity to act and to interact with others.

Both the training and the standard powered wheelchairs are controlled with an analogue joystick which regulates both speed and direction.The individual can, as the result of random movement of a single instrument, develop an understanding of which actions produce which results.Although the same principle applies to both wheelchairs, there are differences.The joystick on the training wheelchair produces a direct effect, and one which does not vary in degree depending on the direction of movement. In addition it is possible to adjust the power and speed settings to lower level on the training wheelchair, reducing the risk of damage and injury in the event of a collision.

Whether the user can make the transition from a training to a standard powered wheelchair depends entirely on the progress made during the training programme, primarily the progress made in the understanding of cause and effect, and how a series of actions can lead to a desired result.The instrument used remains constant throughout the programme and it is the individual's ability to make use of it that develops.

Different devices require different patterns of use and have different effects

The different devices that can be used to control the previously described

products used for power-assisted mobility place different demands on the abilities of the user as regards capacity for conscious action and co-operation. The more options that a control provides, the greater the demand placed on the interplay between the trainer and the trainee. The process of learning how to use a more complex device must be tailored to the learner's abilities and to the observed level of achievement as regards the required driving skills. For individuals with limited capacity for conscious action, the difference between the controlling devices is the deciding factor that governs their ability to move from one method of driving to another. Switches can be called activation controls, as they work by activating or deactivating a certain function. The joystick can be called a steering control, as it both activates and regulates certain functions. The differences between switches and joysticks are described below.

Activation controls

Activation controls are types of switch that complete or break a simple electrical circuit. A momentary spring-loaded switch completes a circuit when it is depressed, and breaks the circuit when it springs back into the neutral position. They are on-off electrical switches that cannot be used to regulate flow or distribution of electrical current.

A switch is usually activated by a simple movement, the direction of which is determined by the needs of the individual, which also govern the most appropriate placement. It produces an all or nothing effect - e.g. pressing the switch turns on the electrical power.

Momentary switches provide a choice of two effects - e.g. depressing the switch activates power which is maintained as long as pressure is maintained on the switch, and releasing the switch shuts off the power.

Two or more switches can be used simultaneously - giving the user a further choice of effect by changing from one switch to the other - e.g. one switch can activate power, a second can make the chair rotate and a third can sound the horn. Just how many switches can be used in parallel is determined by the design of the switches, and the user's physical and intellectual capacity.

Several switches can be built into a tool which can be used to select a desired effect - e.g. a digital joystick can be used to select one of four effects, i.e. directions, depending on which switch is activated by the movement of the joystick.

Steering controls

Steering controls are a form of regulating device. On powered wheelchairs, they are often constructed as joysticks. Power is switched off when the joystick rests in the neutral position, and activated whenever the joystick is moved in any direction. The flow of current is regulated by a resistor and a distributor, thus providing many variations of many different effects with just the one device.

An analogue joystick can be used to activate - switch power on and off - and continuously vary speed and direction. Current (speed) and distribution of power to the motors (direction) is continuously regulated by varying the position of the joystick. Speed is proportional to the deviation of the joystick from the neutral position, the greater the deviation, the greater the speed. Direction of travel is related to the direction of the deviation of the joystick. As the regulating mechanism is continuously variable, a large number of combinations of speed and direction can be chosen.

Reversed placement of the control device

Reversed placement means that the control unit is mounted so that the chair moves forward when the joystick is pulled towards the user. Small children and the severely physically disabled often find it easier to draw the joystick towards the body. The aim of the training programme is to help the individual to move independently in a forward direction, and not backwards which is the result when the user pulls on a normally mounted joystick. At the beginning of the training programme it is often the case that the individual, for a period, finds it easier to move either forwards or backwards and only later develops the ability to choose between the two. If the individual has a limited intellectual capacity and has difficulty in making the association between action and result, then training with the reverse-mounted joystick can cause a problem. Such an individual can have great difficulty in changing to a normally mounted joystick at a later stage. It is easier to understand the association between movement of the joystick and movement of the chair if both movements occur in the same direction.

Dual controls

Dual control is provided by an analogue joystick that the trainer or other support person can use to take over control of the powered wheelchair or the Akka platform (which has a digital joystick). The training wheelchair lacks dual controls. Switching between user control and carer control is achieved in different ways with different products, but the aim is to be able to do so easily and quickly. Dual controls are often used to facilitate transport of heavy users over longer distances, on inclines or difficult surfaces. Carer control is nowadays available as an accessory on many user controlled wheelchair models and comes into action when an empty chair has to be moved, or if the user finds it difficult to negotiate a difficult stretch, feels tired, or loses control of the chair.

When the user is first learning about cause and effect, i.e. how movement of the joystick produces movement of the wheelchair, it is extremely important that the result of a certain action is identical each time it is carried out. If the chair moves when the joystick has not been touched, then it makes it all the more difficult for the user to make the association between the two. Those with an impaired awareness level have a limited capability of understanding language, and a poorly developed sense of 'self'. It is therefore difficult for them to understand the meaning of 'Now let me drive', and so the learning process can be disrupted if the carer takes over the controls. For these individuals it is far better to provide tangible hand on hand guidance instead of the more abstract dual control. With hand on hand guidance the user always has his hand on the steering device when the wheelchair is being steered. This reinforces the association between the steering device and movement of the wheelchair. This method can also be used to help the individual move towards an object that he seems curious about, or to avoid damaging collisions. So if the user is learning to use the joystick, the movement of the chair should always correspond with the movement of the joystick. A carer who takes over the controls to adjust or stop the movement of the wheelchair makes it more difficult for the individual to understand the association between the steering device and the movement of the wheelchair.

Dual controls can be a useful mobility aid for individuals with good intellectual capacity, who can more easily understand the link between the steering device and control of the chair. These individuals find it easier to co-operate with others, and can understand verbal explanations of who is steering, and how.

Summary

The standard powered wheelchair

The standard powered wheelchair has a broad range of possible uses and places greater demands on the user. It is commonly steered with an analogue joystick. Steering skills can reach a variety of levels depending on the type of equipment and the environment in which it is used. There are products for indoor and outdoor use, and the environment can provide a range of challenges as regards planning and foresight. Driving over rough ground or in traffic obviously places greater demands on the user, compared to driving around indoors on a level surface.

The standard powered wheelchair can be used to help an individual learn about cause and effect and to continuously vary speed and direction. It is, however, difficult and risky to try this with an individual with limited intellectual capacity or limited insight.

Powered wheelchairs with line followers

A powered wheelchair with a line follower is most commonly used indoors on level surfaces. The track can be laid on surfaces with varying textures which can produce varying noises. Tracks can be laid on inclines. They can even be laid outdoors. Individuals with a severe impairment of cognitive ability, who have difficult in acting alone or with others, can attain greater personal development by the use of this method.

A powered wheelchair with a line follower allows the individual to learn to understand the link between his own actions and their effects. He can also develop a memory of these events that allow him to foresee the results of a given action and thereby learn to act purposefully. He can learn to carry out sequences of actions and link these into chains so that he can move to an object he finds interesting.

After learning to use a switch to activate a track-guided wheelchair, it can be difficult to change to a standard powered wheelchair which is normally steered with an analogue joystick. A switch does not allow the user to learn how to vary speed and direction. The differences are so great that a user changing from one method to the other must learn a whole new way of steering the wheelchair.

If the individual has learnt how to manage junctions on the track, then

he has an understanding of how to select a direction of travel, and can more easily make the transition to a standard powered wheelchair, especially if he has used an analogue joystick to select junctions, as this allows a certain degree of speed regulation.

Akka platform with line follower, perimeter limited driving or free driving

The Akka platform is intended solely for use with indoor training on a level surface. Individuals with limited awareness who find it difficult to act and interact can attain greater personal development by training with the Akka platform.

With a switch-activated, track-guided Akka platform the individual can learn to understand the link between his own actions and their effects. He can also develop a memory of these events that allows him to foresee the results of a given action or series of actions and thereby learn to act purposefully.

In perimeter limited driving or free driving with more than one switch or with a digital joystick, the individual can learn to foresee the effects of more involved series of actions and link these into chains. He can learn to make choices and steer in a desired direction although not in a continuously variable way. He cannot learn to vary speed as this is pre-set by the trainer.

It is difficult to make the transition from a track-guided Akka platform to a standard powered wheelchair, for the same reasons as described above for the track-guided, switch-activated wheelchair. It is somewhat easier to change if the Akka platform has been steered with a digital joystick. The remaining obstacles are that the individual has yet to learn to regulate speed, and that the technique of using an analogue joystick differs from that used with the digital variety. From the neutral position, the digital joystick can only be moved along one of four channels towards one of four switches inside the steering unit. Each of these switches activates a single movement function - forward , backward, right rotation, left rotation. The analogue joystick can be moved in all directions, and the greater the deviation from the neutral position, the greater the power released - regulating speed.

Training powered wheelchair for free driving

The training wheelchair is exclusively intended for use indoors on a level surface. Individuals with limited awareness who find it difficult to act and interact can attain greater personal development through use of this piece of equipment. The potential for improvement and development is limited primarily by the individual's capabilities - attention span, physical and mental development, age and whether any disability is congenital or acquired.

The training wheelchair allows the individual to become a tool user, and to learn to understand the link between his own actions and their effects. He can also develop a memory of these events that allows him to foresee the results of a given action and thereby he can learn to act purposefully. He can learn to carry out sequences of actions and link these into chains, and learn to choose a means of reaching a desired objective. When the individual reaches the stage when moving around ceases to be a goal in itself, the ability to move independently can become the means to achieve other goals. Once the user has learnt to control it, the powered wheelchair becomes the means whereby the individual can influence and change the world around him.

It is easy to move on from a training wheelchair to a standard powered wheelchair.

The possibility of selecting and varying different functions with different devices

	Number of devices	Number of effects	Variables*	Choice
Simple switch	1	1	none	no
Sping loaded switch	1	2	1	random/yes
Double switch	1	2	none	yes
Several switches in parallel	2 or more	2 or more	none/1	yes
Several in-built spring-loaded switches (invisible)	1	several	1	random/yes
Steering device with resistor and distributor	1	several	3	random/yes

* Duration, strength, intensity

Devices and methods used with different products

	Standard power wheelchair	Powered wheelchair/ line follower	Akka platform	Training powered wheelchair
One switch		●	●	
Two or more switches		●	●	
Digital joystick			●	
Analogue joystick	●	●		●
Track -guided		●	●	
Perimeter limited driving			●	
Free driving	●		●	●

Activation and steering devices have different functions

	Activation	Regulation of direction	Regulation of speed
Simple switch	●		
Spring-loaded switch	●		
Double switch/rocker switch	●		
Several switches	●	limited	
Digital joystick	●	limited	
Analogue joystick	●	continously variable	●

5 The relationship between developmental level and the suitability of various devices and products

A person's developmental level is *the* decisive factor which determines how he or she will react to and use any particular device. Some participants in our studies of powered wheelchair training have in parallel received training in the use of other products activated and steered by a variety of means. These devices include switch-activated toys, lamps, appliances and simple computer programs. Activation of toys and appliances is usually regulated by one or two spring-loaded switches, an ordinary or joystick mouse or a trackball. Our experiences so far indicate that these devices vary enormously in the demands they make of the individual's capabilities.

Individuals at an early awareness level

Individuals with severely limited development of their cognitive, perceptive and social skills find it hard to understand how their behaviour can influence their immediate environment. They have difficulty, therefore, in using tools. It is not just the individual's innate ability that determines how easy it is for him to learn to use a particular device. The device's ease of use, the magnitude of the response, and how that response affects the user both emotionally and physically are all important factors that determine the ease with which it can be mastered. The functions and effects of any device influence the motivation of a potential user to actually use it.

The differences between activation devices and steering devices

An activation device has a simple function and activates one effect.A steering device has several effects and can both activate and steer, regulating several effects that can be varied and combined.

Many factors other than the available functions of the steering device influence an individual's interest, desire and motivation to continue using it. These factors include the number, nature and intensity of the sensory and emotional experiences produced by its use, and to what degree the user can exert control over them.The intensity of these experiences is reinforced if the response to the joystick takes the form of an immediate bodily sensation - e.g. as with a powered wheelchair, or exclusively affects an object in the immediate surroundings e.g. a remote-controlled toy.

If the device is used to regulate an object that is sometimes activated by others, e.g. a lamp or a tape recorder, greater demands are placed on the individual's understanding of cause and effect .To develop and maintain an individual's desire for conscious action, an understanding is required of the relationship between an action and its effect.This is more difficult if the same effect is sometimes the result of action by others, e.g. sometimes I drive and sometimes I am driven by someone using the dual control. It is also more difficult to gain an insight into cause and effect if the effect is separated by space or time from the cause, e.g. with remote-control devices or with projectors or computer programs that have a delayed response.

Spring -loaded and permanently mounted switches are the most appropriate for individuals that explore their surroundings in a random way

Both activation and steering devices can be spring-loaded, e.g. switches and digital or analogue joysticks.A spring-loaded switch can, by means of the spring, produce 2 effects - power is turned on as the switch is pushed, and turned off as the switch springs back. If a joystick is released, it returns automatically to the neutral position, switching off the power.

Spring-loaded devices are most suited to training with those at an early awareness level, whose actions follow a random pattern.They often lack the ability to link cause and effect, to act with purpose or to use tools. Random exploratory movements e.g. hitting, slapping, banging, pressing, pulling,

bending, poking and picking at the control device can result in some sort of effect. The duration of this effect depends on the nature of the contact with the steering device - slapping producing a shorter effect than a pressing action, for example. Repeated events of this kind can, with the help and encouragement of someone who reinforces this association, help the individual to create a link in his mind between his own action on the steering device and the resulting effect. If the individual perceives the effect as enjoyable, he will then spontaneously try to repeat his action in order to repeat the effect.

A spring-loaded switch or joystick on a fixed mount limits the range of exploratory movements available to the individual. This is a positive limitation, as the individual is confined to exploring the object's shape, surface, moveable parts and spring-loaded movement. A fixed device cannot slide away or fall to the floor. It can't be pulled loose, used to hit something else or thrown away. Exploration of the device is channelled towards the moveable parts that can produce an effect. A fixed mount is also of advantage to those who cannot carry out fine, co-ordinated movements, who suffer from muscular weakness, who can only use one hand or who have a tendency to throw away objects or use them as hammers.

Spring-loaded activation devices or simple activation devices with just one effect

A spring-loaded switch can produce two effects. It activates when pressed, and deactivates when released. Individuals who understand cause and effect and who can make active choices between several switches can use one spring-loaded switch and make use of 2 functions with the same switch rather than have a separate switch for each function. In free driving with switches, a spring-loaded switch is used to control each direction of movement.

Two simple switches, used in parallel with their own dedicated functions can be used to teach an individual to choose an effect by choosing a switch - e.g. one switch to turn on the power and another to turn it off.

Someone that is too weak to maintain pressure on a spring-loaded switch may find it easier instead to use a double switch, rocker switch or separate switches. An individual who uses a wheelchair with a line follower can use one switch to set the wheelchair in motion and another to stop the wheel

chair at the desired destination, without having to maintain pressure on the switch throughout the journey.

The skills demanded of the individual with the use of certain devices and products

Steering devices and activation devices for individuals at an early awareness level

An individual at an early awareness level who has first learnt to activate movement in a training wheelchair by using a steering device can learn to operate electrical toys and appliances more easily.

Training with a steering device promotes the understanding of cause and effect depending upon type of device, how it is used and the response it produces . It also depends upon the nature and intensity of these sensations produced by these responses, and whether they can be varied by use of the device.

An analogue joystick translates an action into an effect, and a sequence of actions into a complex and variable effect.

Effects can vary in strength, intensity and duration.The individual can by learning to use the device develop the ability to regulate these effects.The device is fixed onto the table, restricting the individual to a positive exploration of its functions. Moving the joystick sets the wheelchair in motion, varies the speed, changes direction and causes collisions.The different movements stimulate many sensations and emotions, encouraging and motivating the individual to try to repeat the effects by repeating his actions.

A simple activation device produces an effect that cannot be varied, e.g. turning on a lamp. *With a momentary or spring-loaded switch, the individual can choose up to three different actions which, however, cannot be varied* e.g. 1) press - switch on the light; 2) release - switch off the light; 3) keep pressed - keep the light on.The individual can control the duration of the effect by varying the time pressure is applied to the switch.The user must therefore choose *between several activation devices*, and/or select *one or more actions* in order to make active choices between several possible outcomes, e.g. one device for switching a tape recorder on or off, one for activating a toy and one for switching on the light.

An activation device has a much simpler construction compared to a steering device and would seem much easier for an individual at an early awareness level to understand. It is limited to a simple, non-variable effect. If it is used to activate a toy, its effect results in the stimulation of only two

senses - sight and hearing, acting at a distance or close to the body, rarely directly upon it. Its ease of use depends on the combination of devices, objects and methods used. Sometimes the use of a simple activation device can be intellectually more demanding than a steering device.

If the individual is placed in an object that is set in motion by an activation device, then more senses are stimulated and the sensory impression gained from its use is greater - e.g. slot machine rides outside supermarkets, or for that matter, a track-guided powered wheelchair or Akka platform. Alertness is closely related to balance, which means that sensory perception is heightened when movement is included in the effects that are experienced.

Activation of a training wheelchair with a steering device such as an analogue joystick, gives the user a more intensive sensory experience, as all the senses are stimulated to a degree that the user can continually vary. In free driving an unlimited number of movements can take place, under the direct control of the individual. The immediate environment is the only limiting factor. In free driving, it often happens that the individual drives round in tight circles, making several sudden changes of direction. This type of behaviour means that several senses are subject to intensive stimulation - much greater than that produced by track-guided wheelchairs. Rotation enables the environment to be viewed from all angles and reinforces the individual's perception of 'self' - something with a unique relation to the environment. He can develop a greater understanding of people and objects and their relation to the environment. Rotation stimulates the sense of balance and thereby the individual's alertness and concentration, which is a vital requirement for getting the individual to explore the relation between his behaviour and events in the environment.

Training with powered mobility aids can make it easier to learn to activate simple computer programs with an activation device

An individual who has learnt simple action sequences in a powered mobility aid (with or without a line follower, with a switch or a joystick) finds it easier to learn to use simple computer programs controlled by one or two switches.

Carrying out a sequence of actions requires the ability to consciously carry out two or more actions in the right order in order to achieve a desired result. Training in a powered wheelchair leads the individual to understand

that his own actions can produce certain effects, and so his behaviour can become more conscious. Memory of previous events leads to an expectation that certain actions produce certain effects, and when this link is established in the mind, the individual becomes able to choose the appropriate action required to produce a desired effect, e.g. activating movement along a track, maintaining movement by maintaining switch pressure, or stopping movement by releasing the switch on arriving at something interesting. Another example would be activating a simple computer program with a switch, waiting for the desired image to appear on the screen and then pressing the switch to load a new image.

Training with a powered wheelchair can make it easier to learn to use a computer with a control device e.g. mouse, trackball or joystick

An individual who has learnt to control a powered wheelchair with a joystick finds it easier to learn to control a computer cursor to activate computer functions. Steering a wheelchair is a less abstract activity than moving a cursor with a mouse.

Steering a powered wheelchair with a joystick is a more concrete task. The joystick can be felt with the whole hand and it can be moved in a more tangible way. It is easy to judge its direction and degree of movement. Both the controlling device and the wheelchair itself move in the horizontal plane, and it is easy to feel how the wheelchair moves and changes position relative to other objects. The joystick is moved in the same direction as the desired direction of travel and it automatically returns to the neutral position when it is released in order to stop. A conscious decision to stop, made with a retained grip on the joystick implies that the user knows where neutral lies and has purposefully moved the joystick into that position.

Controlling a computer with a mouse is more abstract. Admittedly, the mouse sits in the hand and can be moved in a concrete way, but it is more difficult to fathom out the relationship between movement of the hand and movement of the cursor across the screen. The effect is abstract and the moving object is a symbol - a picture, arrow or cursor - which may have a particular significance. The controlling device moves in the horizontal plane whilst the cursor moves in the vertical plane, which makes is difficult to establish the relation between the two. Moreover, the cursor is often very small and can be hard to see and distinguish from the background even

when enlarged.The choice of computer function is always governed by the position of the cursor on the screen, and therefore the user must be aware of the current position before being able to decide how to move the cursor to another symbol and 'clicking' in order to activate another function.

There are several different types of mouse device, and different movements are required with each.A standard mouse has a floating ball on the underside which rotates as the mouse is moved over a suitable surface - often a mouse mat.A trackball is really an inverted mouse with the ball on the upper surface which can be rotated in all directions with the hand or fingers.A joystick mouse looks and responds like an ordinary joystick, such as the ones found on powered wheelchairs.The standard mouse is a moveable object with invisible moving parts.The trackball and joystick are fixed devices with moving parts that can be seen and felt.A mouse or trackball is in a neutral state as soon as it stops moving, whereas a joystick springs back into a physically defined neutral position as soon as it is released.

The cursor's position on the screen represents the abstract starting point from which the cursor can be moved to another defined position.The starting point can therefore be any point on the screen and its position governs the way the mouse must be handled to move the cursor to any other defined position. If the cursor lies on the lower edge of the screen, it can only be moved upwards or sideways. If it lies on the lateral edge, it can only be moved up, down or towards the opposite edge.The standard, moveable mouse often ends up outside the mouse mat, and it must then be lifted and placed on the mat in a position roughly opposite to the desired end position of the cursor on the screen.These problems do not occur with fixed control devices.

It is often easier to learn to control the cursor with a joystick mouse, which most resembles the steering device on a powered wheelchair.A trackball is easier to use than a standard mouse, because it has a fixed position and one can directly feel the movement of the ball.The standard mouse presents the most difficulties as it is moveable and the moving parts are hidden away on the underside.

Preparatory training in a powered wheelchair provides benefits regarding the learning of simple computer games and for more advanced computer-assisted communication appliances.A far greater range of software products is available to the user who can handle a steering device such as a joystick as opposed to a simple switch.A joystick, with its many in-built functions, is much quicker to use than several switches that must be operated independently. For example, selecting symbols on a communication panel or computer screen is easier with a joystick than with a series of switches.

Summary

An individual's developmental level has great significance for his ability to develop the skills needed to use different types of device. There are two main types of device that can be used to control electrically powered appliances. Switches are activation devices that switch on and switch off electrically powered functions. Several switches can be combined into a device such as a digital joystick which can have the outward appearance of a steering device. The latter is a device that can be used for continually varying a product's functions. The analogue joystick and the computer mouse are examples of steering devices.

Activation devices are not always easier for those at an early awareness level to use, and an individual's ability to make use of control devices is governed by many factors and by the way these factors relate to each other.

A individual at an early awareness level is more likely to be able to control electrical toys and appliances if he has previously learnt to use a device to control a powered wheelchair.

An individual who has learnt simple action sequences in a powered mobility aid (with or without a line follower, with an activation device or a steering device) may find it easier to learn to activate a computer program by using one or more switches.

An individual who has learnt to steer a powered wheelchair with a joystick may find it easier to learn to control a screen cursor and activate computer functions. Steering a powered wheelchair towards a desired objective is a more concrete activity than controlling a computer with a mouse.

6 Independent Mobility

The traditional aim of powered wheelchair training is to enable the individual to achieve independent mobility during ordinary daily activities. Such individuals are usually unable to move around independently due to a physical disability. A powered wheelchair enables them to move around independently in the home and to go out and take part in a variety of activities. Some of these individuals may be able to walk short distances with suitable aids or use a manual wheelchair to a certain extent, but are unable to manage greater distances outdoors. Even with the aid of such devices, some individuals may totally lack the ability to move around independently, either indoors or outdoors, and need the help of an electrically powered mobility aid. The aim therefore is that the powered wheelchair compensates for the individual's limited capacity to use his own legs.

The history of the powered wheelchair is relatively short. Only about 30-40 years have passed since it became an aid to be provided at the expense of the public purse. Technical development has been rapid, and today's advanced products have designs and electronics that make them comfortable and easy to use. They are fitted with remote-control devices that can operate other appliances and computers. The use of such advanced electronic functions places physical and intellectual demands on the user.

Independent mobility has great significance for the individual's development, and a great influence on the perception of self in relation to the external world. Research into disability and within developmental psychology has thrown light on the role of independent mobility in child development, and in the development of the physically disabled. Many aspects of development show a clear improvement when the child or disabled person is given the opportunity to move around independently of others. It is especially important that individuals with severe physical disabilities are given the chance to move independently within the immediate environment. A person that has power over his own position within a room is better able to choose, act and interact - greatly enhancing his ability to understand how the external world can be influenced and directed.

An understanding of the relationship between independent mobility and the development of the individual is vital for the understanding of how to develop a powered wheelchair training programme.

A brief history of power-assisted mobility

Electrically powered wheelchairs for disabled adults

During the 1960s it became possible to apply for a powered wheelchair as a personal mobility aid. County councils were given the right by the Swedish National Board of Health and Welfare to apply for a central government grant to cover the costs of more expensive aids, including powered wheelchairs. It was not until 1976 that the funding responsibility was transferred to the county councils. The first Swedish-manufactured powered wheelchair was produced by Permobil, and was released in the mid 1960s onto a market that was then dominated by German and British products.

Powered wheelchairs for disabled children

During the latter part of the 1960s and the early part of the following decade, it was relatively unusual for children to be given a powered wheelchair. Adult models were adapted for those children that were granted this type of aid. Outdoor chairs were only granted to children thought able to cope with traffic i.e. not before the age of twelve. Paulsson (1973), in a study of 15 children ranging in age from 8 to 12, demonstrated that powered wheelchairs for outdoor use were suitable even for children under twelve. As late as 1976, there was only one children's powered wheelchair available on the Swedish market - the British-made Bambino.

When Paulsson and Christoffersson (1980) were planning a study of the significance of independent mobility for child development - the Go-cart Project - they sought participants aged between 21/2 and 5 years. They contacted rehabilitation units and special nurseries throughout the whole of Sweden and yet only managed to enrol 12 children, having hoped for 40. They described how doctors and physiotherapists declared that it was not suitable for small children to be given electrically powered aids as there was a risk that they would become passive and lose the will to develop their capacity to walk. Some expressed doubt as to whether small children

could learn to drive, and others thought that small children should not be given such expensive 'toys'. The results of the studies, published in 1973 and 1980, showed that, contrary to these widely held prejudices, the participants showed no signs of passivity. Indeed, the opposite was the case - the children displayed greater independence, initiative and motor activity.

The first Swedish-manufactured powered wheelchair for children came onto the market in 1981, and it became increasingly common for children to be given their own powered wheelchair. Studies carried out in the USA and New Zealand (Butler, 1983; Iles & Souksmith, 1987) showed that independent mobility had great significance for the development of physically disabled children. Butler studied children aged between 17 and 35 months. She showed that, despite their young age, these children quickly learned to drive confidently, safely and responsibly.

The latter half of the 1980s and the 1990s has seen great progress in the understanding of the part that independent mobility plays in the development of children with disability, and the concept has gained greater acceptance among professionals working in paediatric rehabilitation and among those working with mobility aids in general. Nowadays it is quite common for the pre-school child to be given a powered wheelchair on loan in order to make independent mobility possible. There remains a degree of scepticism, particularly with regard to the risk that small children might injure themselves or others by uncontrolled driving. There are some who, despite evidence to the contrary, remain concerned that small children might become passive and that their motor development might be inhibited. Access to a means of mobility increases interest in other forms of mobility - rolling, shuffling, crawling and walking (Nilsson, 1994).

Electrically powered mobility with training aids - for adults and children with physical disability, developmental delay and visual handicap

As the vital role of independent mobility in physically disabled children became more widely understood, interest came to be focused on other groups with impaired mobility. Could the opportunity of attaining independent mobility have equal significance for individuals who, in addition to physical disability, suffered from mental handicap or other impairments of function? These individuals' physical and intellectual disabilities made it impossible for them to train in a standard powered wheelchair. The develop-

ment of line followers put independent mobility within the reach of individuals with severe, multiple disabilities. The first track-guided wheelchair came onto the Swedish market in 1986, and the manufacturer, Permobil, remains the only Swedish manufacturer of this type of product. The track-guided Akka platform was developed with young children in mind, with the aim that this simpler and cheaper product would also give them the opportunity of independent mobility. This latter product is manufactured by another Swedish company - JCM - and came onto the market in 1993.

During the eighties and nineties, Call Centre, Scotland, carried out extensive research into electrically powered independent mobility. Part of the research project was to develop a 'smart wheelchair'. A series of adaptations made this wheelchair more user-friendly for those with severe physical or mental disabilities. Their results confirmed that training in a powered wheelchair is a highly motivating activity which can play a vital role in the development of individuals with a variety of disabilities. The ability to move independently is a driving force that promotes a greater level of activity and, thereby, improved motor, perceptual, social and emotional capabilities (Call centre, 1988; Odor & Watson, 1994).

During the late eighties, the Swedish Handicap Institute issued a variety of information leaflets concerning the training of individuals with mental handicap and training with track-guided wheelchairs. The institute has also supported projects that have looked at the effect of using these systems (Birath, 1989; Swedish Handicap Institute, 1985a, 1985b, and 1987). It has also held seminars on the use of line followers and supported several projects promoting the use of electrically powered mobility aids in individuals who had not previously been offered such help on the grounds of impaired functions. Several studies of the beneficial effects of training with track systems have been published during the nineties (Paulsson & Winnberg, 1991; Christiansson & Hjortsby, 1991; Birath, 1994; Birath & Leinskiöld, 1996). The message that training in powered wheelchairs is beneficial for individuals with physical and mental disabilities has been reiterated in magazines produced by patient, professional and industry associations, backed up by further research published towards the end of the decade (Nilsson, 1994, Nilsson & Nyberg, 1999).

The delayed acceptance of powered wheelchairs as a method of training for independent mobility

Despite the proven beneficial effects of training with electrically powered track-guided wheelchairs, Akka platform and training wheelchairs, the method has been slow to gain widespread acceptance. There may be several reasons for this. County councils and municipalities have had to prune their budgets, and powered mobility aids are quite expensive. County councils have reorganised their cost allocation and management practices, and most now have a central budget for more expensive equipment such as powered mobility aids. Some county councils have central, financially independent units that sell or lease technical aids to local departments. There are never-ending discussions about which department is to bear the financial burden of powered mobility aids, and on which terms equipment can be leased, lent or sold from one department to another. Should aids be lent or hired out directly to individual users, or should local government units active in daycare, rehabilitation etc. buy in the equipment which would then remain the property of the council and be considered as part of its equipment inventory? Should a training powered wheelchair be regarded as a means of transportation, recreational activity or rehabilitation? The matter is made no easier by the fact that many of the individuals that would benefit from this method of training are unable to voice their opinion and make their wishes known. Parents and guardians are often insufficiently well-informed to be able to demand the services to which their charges are entitled.

Independent mobility - a term that can be interpreted in many ways

For most people, the term 'independent mobility' means the ability to move to a chosen point unaided. Movement can take the form of crawling, walking, running, with or without a technical aid. People can make use of walking sticks or frames, walkers, glider chairs, a manual or powered wheelchair. Professionals who refer to 'independent movement' usually mean 'purposeful independent movement' even though they may not say so specifically. It is a standard requirement that a powered wheelchair user can drive both independently and purposefully.

When dealing with individuals who are training with a powered mobil-

ity aid, it is preferable to use the term in its simpler sense - i.e. the ability of the individual to influence the movement of the chair. If the user moves the joystick or switch, deliberately or by chance, and the wheelchair changes position in the room, then movement is independent but not purposeful. The individual's behaviour has resulted in a movement to a new position. In this case, movement is an end in itself.

Simple purposeful movement does not necessarily imply that the individual has the ability to steer or change direction. On a guiding track, a wheelchair user can deliberately stop at a certain point in order to experience something interesting or stimulating. A training powered wheelchair enables the individual to make simple changes of position e.g. rotating in order to see who has come through the door. These simple movements have purpose, as the individual takes a deliberate action to change position in order to achieve a goal. Movement then becomes a means to an end, rather than an end in itself.

More complex independent movement means that an individual is capable of choosing direction at a junction on a track and drive to a chosen destination by using several switches, or a digital or analogue joystick. Complex purposeful movement requires the planning of several actions, often requiring some precision.

When the individual has mastered complex and purposeful movement he can negotiate narrow passageways and manoeuvre out of a corner without the help of others. It means that he can plan ahead and foresee the consequences of his actions. He can get to where he wants to, and carry out demanding manoeuvres on the way there. Movement then becomes a means of access to other activities - e.g. getting to the dining room in order to eat.

How perception, motor skills and independent mobility influence development

The ability to crawl and move, and brain maturity

Normal infant development leaps ahead when the child first learns to crawl or move under his own steam. Independent mobility gives the infant access to a new world of objects that he is free to explore at will, learning how things work by investigation and experimentation. Children with delayed development, the physically or mentally disabled of all ages and those

with a visual disability are denied access to the immediate environment.

Children develop rapidly between the ages of seven and nine months. This is expressed by dramatic changes in perception, sensorimotor skills, and emotional interaction.The child begins to develop a memory of terms for objects, begins to understand spatial relationships, develops more complex forms of imitation, and begins to understand simple associations. He also begins to protest at being left by his parents and to show fear of heights, strangers and unfamiliar objects.The frontal lobes begin the process of maturing at around 7 months of age, and the child develops the first signs of being able to plan ahead, to feel expectation and experience fear - an emotion that is built upon expectation and the ability to form associations.The growth and development of the brain, and the development of the ability to move independently are mutually dependent processes.The infant's ability to crawl is closely related to other developments that take place between seven and nine months.There is research that suggests that independent mobility can stimulate the development of the brain and assist the healing process after a brain injury (Berenthal et al, 1988).

Severe impairment of vision and reduced motivation for behaviour, action and interaction.

Sight enables the registration of images - which is crucial to normal child development. Sound can also provide an understanding of spatial relationships in the immediate surroundings.The difference is that sound comes and goes quickly, while light provides perspective and a retained image of the room, which enables the environment to be explored.The sense of touch provides little information about spatial relationships and distances between objects (Sonksen et al, 1984; Nielsen, 1989).

Adelson & Fraiberg (1982) have shown that motor development is usually delayed and takes on a particular form in children with severely impaired vision. Sonksen et al (1984) believe that the drive to explore, interact and master is a prerequisite of all aspects of development, including motor skills. It is common for children with impaired vision to display a reduced activity drive and to be more passive than children with normal vision. Sight provides children with massive and continuous stimulation which promotes the desire to explore the environment, whilst blind children live in a empty space where noise can suddenly appear without warning or any apparent reason, and every touch is a surprise. Opportunities to interact with parents or others are severely reduced when the child cannot see.These children

do not return a smile, and may appear quite passive when they are listening intensely, which is often misinterpreted as lack of interest. Normally sighted children delight in practising newly acquired motor skills, an activity that is rare in blind children.

Early detection of impaired vision is vital to a child's development. The child's ability to interact with his environment using his other senses is greatly enhanced by the early introduction of methods that enable the parents to stimulate these senses.

Severe visual impairment, body perception and independent mobility

Infants with normal vision start to inspect and play with their fingers (finger regard) at around 21/2 - 3 months of age. This is when the child, through the sense of vision, discovers his fingers and begins to realise that they are a part of his body that can be used to grip and feel. This discovery starts with spontaneous but random movement of the arms in front of the face. When a hand suddenly happens to enter the visual field, it attracts the child's attention. The child can then stop moving the arm in order to study the various small movements he can carry out with the whole hand, or with individual parts, e.g. the fingers. At the same time sensory signals from the muscles and joints reinforce the visual image and confirm that the hand is a part of the body which can be moved at will. This exploration of the hand progresses to active and conscious attempts to reach out and grasp nearby objects. The discovery of the feet and legs follows a similar pattern. At around 41/2 months the infant will, when lying on his back, start to move his legs spontaneously. The knees and hips are flexed, and parts of the leg will come near the infant's face and enter the visual field where they can be explored, studied and experimented with.

Partially or totally blind infants start to make spontaneous movements in front of the face at the usual age. However, visual feedback is severely reduced by the child's impaired vision, and positional sense obtained from joints and muscles is not sufficient to allow the child to understand that the hands are part of his body and are under his control. This is the reason that spontaneous arm movements tend, over time, to decrease or even cease altogether leaving the arms inactive and held limply by the body with the hands opening and closing aimlessly. Infants with severe visual disability usually show delayed development of the ability to reach out for objects, partly

because they are slow to learn what they can do with their hands and partly because they can't see objects that might otherwise stimulate them into activity. Visual impairment and the delayed development of the ability to reach out for objects can also hinder the discovery and exploration of the feet and legs. If the child cannot see his feet and toes when they come near his face, and feel them with his hands, then spontaneous leg movements tend to disappear. By 5-51/2 months, the child may have ceased to make spontaneous movements of the limbs, which then rest lifeless and still. The inability to achieve an understanding of how to use the limbs has a severely adverse effect on the progress to independent mobility. The drive to move and explore cannot develop until the child has learnt how to control the movement of his body (Sonksen et al, 1984; Nielsen 1989).

As researchers have highlighted the various difficulties facing the visually handicapped child, strategies and methods have been developed in order to promote normal development. For example, parents are encouraged to interact with their children in a way that stimulates the child's body perception, and helps him to understand how his arms and legs work. Play can encourage the child to reach for, and explore an object with the outstretched hand or reach out and feel his legs and feet. Independent mobility makes the world bigger and expands the opportunities for exploration and learning.

The significance of motor skills and perception for development

Holle (1980) emphasised that understanding of the normal child's motor and perceptual development is necessary in order to provide the right stimulation for mentally handicapped children. An understanding of the child's current stage of development provides the basis for assisting the child to reach the next level, with training, stimulation and instruction provided at the right moment for a specific skill. Holle uses Vygotsky's 'Zone of Proximal Development' as a guide to how a training programme should be formed and carried out. The term 'Zone of Proximal Development' refers to a level in the individual's development of a skill when he can only manage this action or activity with the help of another person. At the level immediately above this he can manage unaided. Therefore, in order for a child to achieve a new skill and reach the next stage of development, he must initially be helped and guided by others.

Motor and perceptual development go hand in hand. Delay in one results

in a delay in the other. Together they provide the child with perception of his own body and spatial relationships with surrounding objects. They eventually provide a sense of space and time and with experience, an understanding of the magnitude and direction of movement required to achieve certain goals. A purposeful action requires integrated motor and perceptual skills to produce a smooth, co-ordinated and precise movement at the right time, for the right duration and with the appropriate force. Each new movement must be learned, repeated and practised until it eventually becomes automatic.

Brodin (1991) emphasised the importance of independent mobility for the development of severely mentally and physically handicapped children. 'If a mentally and physically handicapped child is given the opportunity to achieve independent mobility, his intellectual capacity will also improve.' She agrees with Holle that physical and perceptual development are interlinked, but points out that it is only in recent years that we have come to understand the link between independent mobility and the ability to communicate. 'A child that is unable to move around at will becomes dependent on others for the normal childhood opportunities to explore the surroundings'.

The importance of independent mobility for action, interaction and communication

Granlund & Olsson (1987) have shown that the development of intellect and the ability to communicate depends primarily on the individual's ability to move around and actively manipulate (handle/influence) nearby objects and persons. An individual needs to be able to alter his position in relation to these objects in order to develop a perception of space and distance, and to be able to localise sound. An impairment of spatial perception makes it more difficult to reach out for objects or to make contact with other people. There is an indirect association between visuospatial ability and the ability to initiate meaningful communication. It is therefore important that the individual is given help to manipulate his environment and move freely within it.

The ability to distinguish oneself from the environment - 'I am a separate person that can interact with, and influence others' - is very strongly associated with the individual's ability to understand temporal relationships and ability to direct the attention of others by communication. Directing the attention of others demands communication of reasonable clarity and precision compared with simply gaining attention or influencing the behaviour of others (Granlund & Olsson, 1987).

Independent mobility with the training powered wheelchair and the development of communication skills

Our experiences with powered wheelchair training confirms the impression that independent mobility is very important for the development of the ability to interact with the environment. As the individual develops an understanding of how his actions can produce certain results, communication progresses from making contact to influencing behaviour - e.g. from rocking back and forth or shouting when the wheelchair won't move, to stretching out a hand towards the trainer and indicating 'help me'. When the individual begins to understand how to make sequences of actions for a purpose, he can usually communicate to direct the attention of others - e.g. whilst driving, he spots a mobile hanging from the ceiling and points to it so that others will also look at it and comment. The development of self-identity and the perception of time is clearly shown when an individual can plan a drive which may involve several sequences of actions, and then show pleasure at achieving his goal - e.g. when he spontaneously decides to do a demonstration 'spin' for someone and after showing what he can do, looks up and laughs with delight.

Powered wheelchair mobility for individuals with an acquired impairment of brain function

An acquired physical or mental disability can mean severe loss of function and skills for those who have previously led a full and active life. The consequent changes in daily life and the new dependence on others demands a great deal of the individual's ability to reassess and adapt to new circumstances. It can lead to tiredness, passivity and depression, especially at the beginning of the process of rehabilitation, when the risk of sinking into helplessness is at its greatest. The loss of functions, skills and roles coupled with feelings of failure and inadequacy can disrupt both everyday life and attempts at rehabilitation.

A powered wheelchair facilitates independent mobility in the early stages of rehabilitation, when fatigue is at its most pronounced. This leaves more energy for specific measures, e.g. physiotherapy and occupational therapy. The opportunity to move around with less effort may lead the individual to become more active over a greater area. Improved initiative and activity promotes recovery. Wider contact with others can help the individual to

reassess his situation and find a new identity in the light of his disability. To acquire new skills and roles following an acquired disability, the individual must develop a realistic understanding of his limitations and capabilities.

Training in a powered wheelchair demands powers of memory, attention, concentration and a capacity for multitasking. Letting one's attention stray whilst driving a powered wheelchair has immediate consequences - loss of direction or driving against or into a wall. Sharpening the various senses leads to greater powers of attention and concentration, which in turn improves the chances of learning new skills to compensate for lost functions. Carrying out actions that demand recall and concentration is more difficult while driving a powered wheelchair than when walking. Controlling the wheelchair requires concentration, leaving less for other tasks. In contrast, walking is normally an automatic, unconscious action that needs little concentration. This difference is most apparent in individuals who have acquired an impairment of memory and concentration, yet who can walk quite normally.

Stroke victims that have been left with a visual field defect or difficulties in perception of visual signals from the affected side (unilateral neglect) are not normally given the chance to train in a powered wheelchair. The usual reason given for this is that the disability prevents the individual from learning to drive the wheelchair. An individual who can't see to one side is considered a danger to himself and others. Swedish research into unilateral neglect has shown, however, that activity that demands attention and concentration can help patients to compensate for this loss of function by teaching them to turn the head (Tham, 1998). Experience with powered wheelchair training confirms this view. After a lengthy period of training, patients with unilateral neglect learned to compensate for their disability.

Psychological complications, e.g. loss of self-esteem, denial and lack of insight into one's disability represent obstacles to the patient's drive to recover and rebuild a meaningful daily life. Training for independent mobility in a powered wheelchair can actively prevent such complications. Improved self-esteem, better awareness of one's limitations and diminished fear of failure mean that the individual is prepared to try to gain new skills in the belief that he will succeed in spite of his disability, thus paving the way for successful rehabilitation.

Summary

Power-assisted independent mobility in individuals with congenital impairment of biological functions

Independent mobility is crucial to the development of both normal infants and individuals with congenital impairment of biological functions. Physical, mental and visual disability adversely affect the ability to move around independently. Action and interaction develop in the presence of others in the context of the immediate environment. Motor and cognitive development requires innumerable opportunities to explore and inspect the nearby surroundings. Similarly, learning to use tools and devices requires repeated practice. Training in a powered wheelchair provides an opportunity to learn to use a steering device - the joystick - to attain a desired objective. Learning to use a device and developing the ability to drive purposefully provides the individual with a means of transportation that also increases the opportunity to explore at will, to examine and handle objects and to interact with other people. Moving around the room helps the individual to learn to take action, to understand size, quantity, space and time. The ability to interact and communicate with other people develops in tandem with the development of the concept of self - an identifiable 'me' that can influence and control objects and people in the immediate environment.

Power-assisted independent mobility in individuals with acquired impairment of biological functions

Training in a powered wheelchair is also important for those with an acquired disability. It can lead to achieving independent mobility both indoors and outdoors and to regaining the ability to use tools, including previously unfamiliar appliances such as computers and communication devices. Training can also improve levels of alertness, powers of concentration, memory and attention, and the ability to carry out multiple tasks simultaneously. Driving a powered wheelchair provides immediate feedback to the user, and can have a beneficial effect on self-esteem and insight. Improved self-esteem increases the motivation to train and better insight makes it easier for the individual to participate in the setting of individually tailored rehabilitation targets

7 The potential benefits of training and treatment with a powered wheelchair

This method of rehabilitation capitalises on the functional improvements that can be produced by the use of a powered wheelchair. It is an unconventional method that in many respects flies in the face of accepted wisdom. Regarding a wheelchair as a means of 'brain exercise' rather than just a means of getting around requires some lateral thinking. Just one of these wheelchairs can be used to help many individuals, and although it may be expensive, the cost can be quickly recouped. The method can be used in a wide range of individuals - from those who may never learn to drive with any degree of purpose, to those who are able to walk and who have no need of a mobility aid.

The powered wheelchair can be used for sensory stimulation, training, treatment and assessment. The primary goals are to stimulate the individual's various senses and to promote a number of different skills. Enabling the individual to become independently mobile is a secondary goal.

Moving around with a powered wheelchair

The term i*ndependent mobility* does not necessarily mean that movement is made purposefully - movement of the wheelchair can be started or stopped by random movement of the controlling device.

Purposeful mobility means that movement is the result of a conscious decision to move to a desired point. It requires that an individual can initiate movement and regulate both speed and direction. This requires concentration, attention, motor ability, body perception and a perception of space and time. The individual needs to be able to cope with multiple simultaneous tasks and to be able to shut out distracting sensory impressions. He needs to understand the consequences of his own actions, and be able to anticipate

events. Effective and precise navigation demands an understanding of how other people and objects behave. So purposeful movement places demands on the individual's motor, cognitive, emotional and social capacities. Individuals in whom these capacities are poorly developed can be helped by training in a powered wheelchair.

Independent mobility implies that, at the very least, an individual can, unaided, maintain movement that has already commenced. It does not matter whether this movement was started by the individual himself or by others, just as long as he is able to keep enough pressure on the joystick to maintain movement for as little as a few decimetres. This type of activity can be beneficial for those with a pronounced inability to understand and relate to their surroundings. In time, independent mobility can develop into true purposeful mobility as the individual's skills improve.

The goals of training can vary. For most people, the aim is to stimulate and develop improvements in one or more functions, but for some the goal may be the attainment of purposeful and independent mobility.

Various aspects of training and its effects

There are three different yet overlapping aspects to consider regarding training with a powered wheelchair. Firstly one has to consider which senses can theoretically be stimulated by the process, secondly which practical skills can be promoted and thirdly how any improvements can be observed and measured.

The benefits of training depend not only on the individual's prior capabilities, but also on several external factors, including the level of motivation and inspiration of carers. The physical, psychological and social qualities of daily life are important, as well as the degree to which the trainer can induce enthusiasm, the help given to understand the training programme, the quality of the training environment and how well the programme is adapted to the individual's changing needs.

The theoretical aspect - the senses which can be stimulated by training

Moving with a powered wheelchair stimulates all the senses throughout the whole body, and changes the individual's spatial relation to surrounding

objects. Movement is felt in the body and provides changing visual images. The perception of sound sources changes even if the individual just rotates on the spot. Rapid rotation affects the sense of balance.

As the senses are stimulated and the ability to interpret these impressions improves, the prospects for meaningful communication and interaction also improve.

Motor and sensory effects

Training stimulates the development of motor and sensory powers mainly in the arms and hands. The greater the extent and variety of experiences and sensory impressions, the greater the opportunity for the individual to develop the ability to interpret these sensations, and adapt his behaviour and actions in a way that will enable him to drive a powered wheelchair.

Individuals who show that they are most sensitive to the sense of touch may need massage or tactile stimulation of the palm of the hand before they can learn to explore by touch the tray, joystick or switch. Stimulation can reduce the risk of unpleasant surprises and encourage the individual to continue exploring spontaneously.

Using one or more switches requires a good range of movement but little fine control. The opposite applies to using a joystick. If the arm is well supported the joystick can be controlled by fine movements of the hand or fingers. Without arm support, the joystick must be controlled by coarse movements of the arm and shoulder which results in loss of precision and greater physical effort.

Vision

Training stimulates the sense of sight, which is required for many functions e.g. the perception of colour, contrast, movement, distance and spatial relationships within the surroundings. The ability to visually fix on an object and move the eyes to track its movement is required for effective vision.

Using a powered wheelchair stimulates greater use of vision by bombarding the individual with ever changing visual images. The quality and intensity of these images can consciously or unconsciously be altered by using the wheelchair to change position or change speed. Self-initiated movement gives the individual a greater opportunity to understand the relationship he or she has with other objects or people in the vicinity.

Hearing

Hearing is used to localise objects. Familiar sounds can provide a perception of distance, new sound sources only of direction. Hearing is vital for the visually disabled. Someone who is listening intently can give the impression of passivity, whereas in fact he may be concentrating intensely in order to interpret a sound.

Training with a powered wheelchair gives the individual the opportunity to experience old sounds from new angles. Just starting and stopping a stationary spinning movement enables experimentation with, and analysis of the direction of sound sources.

Balance

The organ of balance - the vestibule - regulates spatial orientation and provides information on position and movement. Overstimulation of the vestibule produces dizziness or even motion sickness.

Stimulation of the vestibule can improve wakefulness. There is a close link between it and the reticular activation system of the brain stem, whose signals produce arousal of the brain, regulating wakefulness and alertness. Movement and rotation stimulate the vestibule and indirectly, through the activation system, increase wakefulness.

Under close supervision, individuals may be permitted to drive with a speed that can produce g-forces strong enough to be felt in the body. After a period of training it is often possible to observe that individuals carry out compensatory movements of the body to balance centrifugal or g-forces, e.g. straightening the upper body as it is thrown forward during braking, or leaning into the direction of rotation to keep the upper body upright.

Kinaesthesia and proprioception

The kinaesthetic sense provides a perception of joint position and movement. Proprioception provides a perception of the spatial position of parts of the body, and their relation to one another. One might say that these senses are mediated by signals from within the body, and are necessary to be able to know the position of parts of the body without using the eyes.

Stimulation during training is felt mainly in the upper limbs and helps the individual to judge the power, joint position and range of movement required for a particular action.

The practical aspect - skills that can benefit from training

Using a powered wheelchair can help to develop many skills. Most able-bodied people can quickly learn to control the wheelchair. It is easy to get the impression that learning to drive is simple. It is only when someone with impaired intellect or a physical disability tries to learn, that it becomes apparent how complex a task it really is. When the learning process is slow, the different stages of development become more obvious.

Attention, concentration and memory

Attention and concentration depend upon alertness, and are necessary for any individual to be able to memorise learning experiences.

Individuals with a more fully developed intellect find that training improves the ability to memorise driving manoeuvres, and thereby the ability to anticipate the consequences of control movements. Training improves staying power and the ability to concentrate on the task in hand, shutting out extraneous stimuli. The individual learns new ways to use the wheelchair and adapts quickly to new situations. He learns to use the wheelchair as a means of achieving other tasks.

Motor abilities

Learning to feel with and move the fingers as part of a stimulating activity improves the ability to carry out precise and co-ordinated movement. Better grip makes it easier to grasp moveable objects, or reach out for objects in the vicinity.

The ability to use one or both hands to explore objects may improve. The ability to co-ordinate both hands and arms improves if both hands are used to steer the chair, e.g. when the joystick is placed in the mid line. Many who could not previously transfer an object from one hand to the other learn to do so after this type of training. Some learn to cross the mid line with the arms, e.g. leaving the right hand on the joystick while using the left arm to stretch across to reach something to the right of the body.

Some individuals learn to carry out separate tasks with each hand simultaneously, e.g. using one hand to steer the chair nearer a table and at the same time stretching out with the other hand to reach for something lying on it.

The ability to understand cause and effect

Training can improve the ability to understand cause and effect at all levels of complexity. At a simple level, the individual can learn that a movement of the joystick produces a movement of the wheelchair. At a more complex level, an individual can learn that the joystick can simultaneously regulate both speed and direction. At the highest level of complexity, the wheelchair can be steered to a predetermined point through a crowded and busy room.

Spatial perception

Training can develop the ability to understand spatial orientation - the relation in space with, and between other objects. By being allowed to collide repeatedly with fixed and loose objects in the room, an individual comes to understand how much space he and the chair occupy, and so learns how much room is needed to carry out manoeuvres in restricted spaces. He also learns which objects are immovable and which can be brushed aside as he drives.

Moving around a room that is set up for some sort of activity - a nursery, schoolroom, play therapy - enables the individual to randomly or consciously come into contact with, manipulate or examine a variety of objects and learn how he can best reach them by altering his position in the room. If the individual has a severe visual handicap, it is vital that the position of objects and furniture remains constant, so that he can create and retain a mental picture of the layout of the room.

People with a restricted field of vision can develop a better spatial understanding of their surrounding if allowed to collide with objects in the room. They then learn to turn the head to detect obstacles and hazards in good time. They also tend to become more careful and plan ahead more effectively.

Perception of time

An understanding of associations in time - wait, first, after, now, later - is needed to carry out complex actions consisting of several stages, some of which may be delayed - e.g. waiting for a certain image to appear on a screen. Powered wheelchair training provides plenty of opportunities to learn to understand time. A simple example would be learning that the

joystick must be held in a certain position for a certain length of time before any effect is produced. If it is moved quickly in several different directions in succession, nothing happens. A more complicated example would be the subjective perception of how much time it has taken to get from A to B compared with previous attempts.

Multitasking

The ability to perceive more than one sensation, or perform more than one task at a time is referred to as multitasking. Powered wheelchair training provides innumerable opportunities to develop this capacity. During the first stages of training, the individual's concentration is often strongly focused on the wheelchair and its functions. At this time he may find it difficult to handle more than one sensory input at a time. Purposeful driving requires multitasking capability, i.e. the individual needs to develop his ability to drive and at the same time notice obstacles and changes in his surroundings in order to have time to respond appropriately. Lack of this ability often means that the individual's driving skills are easily affected by extraneous and distracting sensory impressions. He may also find it difficult to drive and at the same time remember what else he has to do.

Planning, sequential organisation, timing

Complicated actions require planning and the ability to carry out actions at the right moment and in the right order. Memory is required, especially for the results of previous similar actions. Anticipation is also required, as well as the ability to decide between alternative actions. If these abilities are lacking, then collisions with fittings and furniture are the inevitable result.

The visible aspect - the observable results of training

Powered wheelchair training has many effects, not all of which are easily detectable, and not all observed effects are necessarily the direct result of training. It is therefore important to point out some effects and behaviour patterns that can be observed. Some of these are actually measurable, e.g. an individual's staying power during training sessions, and how well he or she manages to shut out distractions and stay in control of the wheelchair.

Improved alertness and staying power

Even when an individual arrives tired and sleepy at a training session, he may brighten up and become fully alert when he gets to sit in the powered wheelchair.

Individuals with a very poor attention span can develop greater staying power during training. At the beginning of the training programme, they may only be able to concentrate for few minutes, but later on they could well manage 30 minutes or more. The observer is able to note that the individual can control the wheelchair as long as he can keep his concentration. As soon as he loses concentration, he loses control of the wheelchair and ends up colliding with other objects or just rotating on the spot.

Increased use of the hand as a gripping instrument

An individual who has yet to learn how he can control movement of the hands may, after a period of guided exploration, show greater interest in using his hands. He may lift up the hand in front of the face and study it as he turns it in various directions and wiggles his fingers. This is normal behaviour in an infant of 2-4 months and coincides with the realisation that he can move his hands at will. Visually handicapped children make this discovery later, but also exhibit the same behaviour (Sonksen et al, 1984).

Individuals who can only manage coarse movements of the hands can learn to develop better fine control during training. Some who, at the beginning of the training programme, can only grip by opposing the thumb and all the fingers collectively can learn to move the fingers independently of one another. This is first seen in the index finger, which can be used to investigate objects by poking at them. The ability to draw attention to something by pointing at it develops later. Even the other fingers may, after a longer period of training, begin to move more independently during manipulation of the joystick or other objects of various shapes.

Fine control of the hand is necessary to be able to control the wheelchair's direction and speed. Purposeful driving requires small, precise movements of the hands and fingers. Some find it hard to judge where the neutral position lies (i.e. where nothing happens) without letting go of the joystick. They may also find it difficult to make small movements of the joystick, tending to make the maximum possible deviation to the one side and then the other. These movements are often made with some force and changes

in direction can be made quite precipitously, sometimes too quickly for the chair to respond with any sort of movement. When the individual learns to judge movement more finely, the grip becomes more relaxed and movements become slower and more precise.

Increased ability to perform actions

With the help of powered wheelchair training, an individual can develop his capacity to perform actions, from the most elementary to the very complicated. Random behaviour can become conscious and purposeful. Simple actions can give way to simple sequences of actions which, in turn, develop into complicated chains of actions.

When an individual sets the wheelchair in motion by a chance movement of the joystick, then the resultant action is just an expression of behaviour. A simple action is the result of a deliberate movement of the joystick with the hand in order to initiate movement. Actions may be joined in simple sequences e.g. varying between acceleration and deceleration by varying the deviation of the joystick from neutral. An example of a more complicated and ordered chain of action sequences would be driving to a predetermined point by steering and regulating speed.

The degree of difficulty experienced by the user is reflected in the way he makes use of the different functions of the wheelchair, how well he uses the chair to perform other activities and the extent to which the environment needs to be adapted.

Increased interest in exploring cause and effect

An individual that has discovered an association - the chair moves when I move the joystick - often goes on to investigate if something happens when other parts of the chair are manipulated. This exploration can take many forms - he may thump, slap, poke, feel, pull or grasp parts of the chair, or even put them into the mouth. Individuals capable of only limited or coarse movement seem to benefit significantly from being allowed to explore the joystick structure in their own way. It differs from other objects in that it is fixed at one end and yet can be moved at the other end. It can be manipulated without gliding away or disappearing.

By the time investigation of the joystick has given way to more purposeful action aimed at producing movement of the chair, the individual may

show greater interest in investigating other causal relationships. He may discover that pushing and pulling the joystick produce different effects, and that moving the joystick further away produces greater changes in speed or direction. At this stage, the individual can be given the opportunity to explore the link between other devices and machines - e.g. toys and simple computer programs of the type 'press to activate' which are regulated by a single switch. This switch is often explored in the same way as the joystick and needs to be highly durable.

Increased interest in studying the surroundings

Someone who can change his position within a room by driving a powered wheelchair around in a circle or rotating on the spot may develop a new way of using his eyes. He may stop to fix his gaze on an interesting object. He may even learn to fix his vision on an object when the wheelchair is in motion.

At the beginning, when the individual usually drives round in circles of varying sizes, he often fixes his eyes on an object directly in front of him, learning to rotate his head in the opposite direction to the rotation of the chair, in order to keep looking at it. When he eventually learns the layout of the room, his behaviour changes to one of anticipation - rotating his head in the same direction as the wheelchair in the expectancy of seeing something familiar come back into his field of vision.

Increasing interest is shown in moving towards attractive objects that can be seen and recognised, and in exploring unfamiliar surroundings.

Someone who is blind to, or less aware of peripheral objects, i.e. has a restricted field of vision, may show a greater tendency to rotate the head in order to obtain a better visual impression of the surroundings.

Increased interest in other means of locomotion

People with a severe physical disability, especially children, often show an interest in moving around in other ways once the powered wheelchair training programme has made them realise that it is possible to move around independently. All children and adults, including the physically disabled, are naturally curious and are keen to explore the world in many different ways. When someone has learnt that it is possible to move around independently in a powered wheelchair, he will often explore other ways of getting around.

His desire to try rolling, crawling and shuffling increases, and he may well be more receptive to the use of ambulatory aids or manual wheelchairs once he has been in the training programme for a while.

When we plan to carry out an action we tend to choose the most effective and effortless method. This is seen clearly in individuals who, after training in a powered wheelchair, become accustomed to move independently, and then start to move with the help of a walker or by crawling. If they haven't mastered the technique of getting quickly from A to B with the powered chair, then they prefer to use the more efficient means of crawling or walking with an aid. This is one of the most important reasons why early powered wheelchair training of physically disabled children should not be considered risky. They leave it behind them once they have absorbed the concept of independent mobility and find a more efficient way of getting around.

Increased interest in interaction and communication with others

Individuals at an early awareness level often display introverted behaviour and are only interested in objects in the near vicinity. Someone who has had little opportunity to change or influence his surroundings, or who lacks self-confidence or who feels uncertain of his capabilities may be unwilling to take initiatives or try something new. He may not be aware of how to exert influence, or may believe himself to be incapable of learning anything new or of developing existing skills further.

With a developing understanding of the functions of the powered wheelchair, and increasing confidence in his own ability to control them, the individual can become more extrovert and more curious about the nearby surroundings. Someone who in the beginning sits slumped, head bowed, showing little interest in taking any initiative can, after a period of training, start to raise his head, straighten his back and show interest in the people and objects around him. Someone with limited ability to make a conscious action can begin to stretch out an arm to grasp the trainer's arm and move it towards the joystick - an action that must be interpreted as a form of communication - a request for help to get the wheelchair moving. Someone lacking in self-confidence may be emboldened to show off his new skills to others, even in unfamiliar surroundings.

Our self-identity is enhanced by the realisation of our potential for con-

scious action and ability to take charge of the events that govern our lives. We begin to feel important when we are good at something. Increasing self-confidence is accompanied by an increasing inclination to take the initiative, to work with others and to learn new skills.

Summary

Independent (not necessarily purposeful in the true sense of the word) mobility achieved with a powered wheelchair is a strongly motivating activity that can have great significance for a person's development, and one that can benefit a variety of skills.

Having the ability to make choices, in particular the discretion to move around the room, provides a better opportunity to understand the relation between self and the outside world. This, together with better perception of time, promotes the ability to carry out more complicated and structured tasks. The general level of activity improves. The skills acquired in a powered wheelchair are definable, and relatively easily transferred to other activities e.g. playing with electrically operated toys, or computers.

Becoming good at something, becoming someone of significance, someone who can learn new things, helps to enhance a person's self-identity and self-confidence.

Training in a powered wheelchair is an activity that develops skills and one that allows the individual to grow by constantly adapting and adjusting the programme goals to suit the individual's needs at that particular time. It benefits a wide range of skills, and the changes in performance and behaviour are readily observed and monitored.

8 Methods

The results that can be achieved by training depend to a great extent on how the objectives of the programme are presented to the individual, his relatives and carers. The potential benefits are described as concretely as possible. This is especially important for those individuals who do not need a powered wheelchair as a means of mobility, and for those who are not expected to learn to drive purposefully.

The training programme is tailored to the individual's needs and existing skill level. Setting up such a programme requires knowledge of which skills are necessary for purposeful driving and knowledge of the learning stages that must be reached on the road to success. An understanding of that person's level of development and brain function is also needed in order to establish which demands can reasonably be made of him during the training programme.

There are many facets to the method - interaction, dialogue, interpretation, hands-on guidance, verbal support and explanation, time for reflection, adjustment of demand level, and tempo. The demands made of the individual are adjusted according to his achievements during training. Training can be made more complex by combining driving with other tasks and activities. The required skill level is set just above the individual's current skill level.

The environment in which training takes place is of great significance for the individual's self-confidence, learning capacity and motivation. Changing the environment and the method of driving represent other ways of altering the level of difficulty of the training programme.

As long as there is any doubt as to whether the individual can drive safely, he must remain under supervision at all times during training sessions. The observer may be close at hand or at a little distance away, depending on the nature of the environment and the speed settings of the wheelchair. Observation is also necessary to monitor how the individual responds to training.

Presentation and information

When someone is being considered for a powered wheelchair training programme, it is essential that the individual, relatives and carers are given the facts in plain language so that they can understand the benefits that can be achieved. These potential benefits should be specific to that particular individual. Even if it is thought that skills improvement may produce benefits in other aspects of daily life, one should be cautious about making any promises as the outcome of training is uncertain. It is however important to make it clear that the possibility exists. Most of all, it is important to make sure that the individual and his relatives don't assume that potential direct and indirect benefits are guaranteed improvements, but rather see the programme as *an opportunity for progress and development.*

Example: Children and adults at an early awareness level. The objective of training may be to develop the individual's ability to carry out conscious actions that influence his surroundings. The results may be increased alertness, a greater understanding of how to use the hands, and an increased interest in people and objects in the nearby surroundings.

Example: Children and adults with a minor physical disability. The objective of training may be to develop the individual's ability to use various control devices. The results may be that the individual makes spontaneous attempts to investigate and experiment, becomes more motivated to improve his skills, and finds it easier to use technical aids that compensate for his handicap.

Example: Adults with acquired brain impairment. The objective of training may be to increase attention span and the ability to cope with multitasking. The results may be that the individual finds it easier to learn, can read and retain what he has read, and can keep his attention focused, despite distractions.

Developmental stages during training

People do not follow exactly the same pattern of development during the process of learning to drive. The separate stages are easier to distinguish in those who take a longer time to learn. In a quick learner, the stages pass quickly, merging into one another. The length of time needed to learn depends on age and the extent and cause of the handicap.

Stage 1 - Excitement, curiosity, serendipity

When someone is first allowed to sit in a powered wheelchair, events are usually governed more by chance than by conscious and deliberate action. The characteristics of this stage are:

* excitement, anxiety, pleasure, curiosity
* increased alertness
* unintentional exploratory movements of the hands
* need for hands-on guidance and verbal support
* ability to retain grip on control device after initial guidance
* lack of frustration

A person at an early awareness level or with an acquired brain impairment may display this type of behaviour. Those suffering from severe mental handicap may remain at this stage for some considerable time before signs of further development can be seen. They often need hands-on guidance before they can develop more conscious behaviour and progress to stage 2. Verbal support in the form of naming objects and actions should be given irrespective of any prior determination of the subject's understanding of language. Words are used in direct association with the actions or objects they describe, reinforcing the connection and thereby encouraging the development of a meaningful vocabulary.

The typical characteristics of this stage could be described as a behaviour pattern consisting of a mixture of anxiety, excitement, curiosity and pleasure. Individuals often become more alert when placed in a powered wheelchair, appearing to wake from a slumber, sitting more upright, opening their eyes and showing more interest in the surroundings. They often make uncontrolled, coarse, even wild movements of the limbs which may unintentionally come into contact with the joystick and activate the wheelchair.

Those with a severely constrained ability to move can be given hands-on guidance to feel and grip the joystick. They can be helped to move it so that they can experience a sensation of bodily movement. Physical support is then gradually withdrawn towards the elbows as soon as the individual shows signs of being able to maintain the movement of the chair either unintentionally or with a rudimentary awareness that the motion of the chair can be influenced.

After initial hands-on support to activate or maintain movement of the chair has been given a few times, the individual is often able to retain his grip on the joystick. He may do this only momentarily in the beginning, but

may then go on to retain his grip for steadily increasing periods. His attention may initially be attracted to objects or people close to or in contact with his body.

At this level of skill, the individual rarely shows any sign of frustration and is quite happy e.g. to drive round continuously in a tight circle. This lack of frustration depends on a lack of awareness of the wheelchair's potential. As long as he fails to understand that the wheelchair can be directed and used for a purpose, he is quite happy to literally 'go for a spin'.

Stage 2 - Initiative, investigation, expectation

When someone first becomes aware that their own actions can produce certain results, they begin to take the initiative in order to make things happen.

The characteristics of stage 2 are:

* awareness that the hands can be moved voluntarily
* understanding of rudimentary cause and effect
* intentional activation of the wheelchair
* ability to start/stop at will
* investigation of the regulation of speed

Stage 2 still requires a degree of hands-on guidance and verbal support. The subject usually responds to verbal encouragement e.g. start, stop, push, pull, if he has heard these terms in direct association with the relevant actions sufficiently often. Even so, much time is spent going round in circles and crashes are frequent. Fine motor control has yet to be developed, so the individual often drives by moving the joystick first to one extreme and then the other, sometimes not maintaining the position of the joystick long enough for the wheelchair to give any sort of response. Hands-on guidance may be needed to help the subject hold the joystick in position and wait for the chair to respond.

In stage 2 the individual characteristically shows obvious signs that he understands that he can set the chair in motion by moving the joystick. He also begins to investigate how speed and direction can be controlled. He has a basic understanding that the wheelchair's speed and direction *can* be controlled but is unsure of *how* to do it. His interest is focused on the workings of the chair and on objects in the near vicinity.

At this investigatory stage, it is not uncommon for the individual to show signs of frustration e.g. irritation, anger and disappointment. On the other

hand, he may show signs of passivity or lack of motivation. The latter signs may be interpreted as lack of interest in the external world, but a more reasonable explanation might be that he has given up after failing to learn how to get the chair to do what he wants. In this situation motivation can be improved by a little guidance to help the individual move in the direction in which he appears to want to travel. During this stage the individual can usually get the chair moving but needs help to steer it. He is encouraged to indicate in which direction he wishes to go, and to then set the wheelchair in motion. Only the minimum of help with steering is given - just enough to keep him in approximately the right direction. Help is withdrawn gradually as the individual's steering skills improve. The sense of achievement provided by reaching a goal without help is a further boost to motivation.

Stage 3 - Experiment, influence, self-determination

When an individual understands sequences of actions and their relation to one another, and becomes more conscious of self vis-à-vis the external world, the possibility of influencing his own situation begins to open out.

The characteristics of stage 3 are:

* Understanding of how to regulate speed and direction
* Self-awareness in relation to the external world
* Ability to deliberately move around the room in a planned manner
* Difficulty in driving with precision, several attempts needed to get to chosen destination
* Erratic driving, crashes and collisions, difficulty in coping with distractions
* Demonstrable pleasure with success

An individual at stage 3 knows that a powered wheelchair can be steered and that speed can be controlled. He still has difficulty in carrying out actions in the right sequence and at the right moment, which is a requirement for controlled driving. The joystick cannot be used with sufficient precision and several attempts are needed to reach a chosen destination. He may be able to cope with 2 tasks simultaneously, e.g. driving with one hand and reaching out for something with the other. It is plain to see that he understands that he is in control, as failure induces displeasure or anger and success brings joy or laughter.

If an individual drives up against something, he may push the joystick even harder, instead of stopping, reversing and changing direction. There is

more than one possible explanation for this. It might be that the individual has learnt that some objects can be brushed aside by driving into them. When the wheelchair comes to a standstill, he tries to produce more power to move the object out of the way. Another explanation might be that a collision or other unexpected event causes muscles to tense, exaggerating pressure on the joystick in the current position. This type of instinctive reaction to an unexpected event or sudden noise is the opposite of that which might be expected with a considered action.

The individual may be slow to react, and may be easily distracted. He may need silence and freedom from distractions if he is to succeed in negotiating doorways, driving between items of furniture or along narrow corridors without crashing into things. Interest in nearby objects and spatial relationships begins to increase.

At this stage of experimentation, it is common for subjects to show frustration, in which case it is important to root out the cause. Anger and irritation may be the result of pain, discomfort or displeasure entirely unrelated to the wheelchair. It is more likely at stage 3, however, that the individual is frustrated at the imbalance between what he knows he could achieve with the controls and the actual results of his attempts. This frustration is sometimes expressed as an unwillingness to ask for, or accept help. Those unable to express themselves verbally may push away the trainer's helping hand. Small children can seem fractious, become red in the face or start to scream when things don't go as planned. Some who have learnt to talk can openly reject help - 'me can!', and although stuck, will stubbornly refuse help. Others, both children and adults, may react by wanting to give up, i.e. discontinue training when they repeatedly fail to get the chair to do what they want it to or habitually fail to avoid collisions.

Stage 4 - Conscious, purposeful, skilled

By now, the individual has learnt to drive in restricted spaces without crashing into things. He can also manage to drive while doing something else at the same time, e.g. holding a conversation.

The characteristics of stage 4 are:

* purposeful and confident driving
* ability to plan and carry out driving and do other things at the same time
* ability to navigate in restricted spaces e.g. toilets
* skills become refined

An individual at this stage of development has the driving skills needed to navigate safely in restricted spaces. He copes well with distractions. He uses his wheelchair as a means of getting about and can focus on other tasks as he is driving along. His reaction time, and ability to manage several simultaneous sensory stimuli are so well developed that he can manoeuvre the wheelchair safely even at higher speeds.

The learning process

For most people, training and treatment in a powered wheelchair involves the learning of a new skill. A good learning environment requires that the individual feels safe, is given just the right level of challenge, and is allowed freedom from distractions while he is trying to learn. The individual's current capabilities determine which teaching method the trainer will use. There is a great difference between the methods used for the mentally handicapped and those used for articulate individuals who are well aware of their disability. The results that can be obtained depend to a great extent on the ability of the trainer and carers to observe and analyse the subject's response and their willingness to adjust the programme accordingly. Many other external factors affect the success of training.

Forming a relationship, working together

The ability of the trainer and the trainee to form a mutually meaningful relationship is one of the vital factors that govern the success of the programme. By this is meant that the trainer should strive towards a relationship based on give and take. If the trainee is unable to understand language, the trainer should try to communicate by sign language or gestures, and wait for a response that may come as a facial expression or other form of body language, and which may convey what the trainee is feeling or thinking. If the trainee can communicate in some other way, or speak, then it is easier for the trainer to get some feedback about his subjective experiences. It is very important that trainer and trainee should, as far as possible, work together as equal partners. This type of relationship, together with a two-way dialogue with the individual, his relatives and carers, has great significance for the effort and motivation required for successful training. The quality of this relationship largely determines whether the trainee experiences the programme as meaningful, stimulating and fun.

Intuition and interpretation

The relationship between trainer and trainee is formed by an interaction based not only on conscious experiences but also on unconscious registration of behaviour, body language and other signals. The interaction involves a constant two-way stream of conscious and unconscious signals. The volume is so great that the conscious mind doesn't have time to analyse them all, and many affect the subconscious mind, producing an emotional response. This emotional response is an important element in the analysis of how well the programme is progressing from the subject's point of view. These feelings may sometimes be dismissed as 'female intuition' or more positively described as a 'sixth sense'. Whatever term is used, these feelings are an important indicator of the individual's subjective experience of the training programme. It is also important that the trainer is aware of the signals that he or she may unintentionally be giving the individual. This could be achieved by making a conscious effort to understand one's own emotional reactions, and putting the reasons for these intuitive feelings into words.

Analysis of the dynamics of this relationship, and of the reactions and behaviour of the trainee should be made in as holistic a way as possible, especially in those individuals who find it difficult to communicate their feelings and experiences. When it is hard to understand what someone is trying to say, it is all too easy to settle for the first and easiest explanation, or assume that a particular expression always means the same thing. If the individual has a limited selection of ways to express himself, it is more than likely that each expression has several different meanings, depending on the situation.

An individual's behaviour can often be interpreted in many different ways. If one is receptive to several possible interpretations, it is then easier to analyse behaviour at a later stage, in the light of experience of several similar situations. An evaluation involves a comparison of several similar situations to see if there is a recognisable common factor that explains the individual's behaviour under these circumstances. Consistent and repeated reactions make it easier to draw definite conclusions. Good documentation is fundamental to any later analysis. This includes video recordings and written notes about previous observations and analysis.

Chaos, breaks, time to think - proximity and distance

The most difficult part of being a trainer is to learn to observe, analyse, and realise when the time is right to introduce new challenges, i.e. knowing how to tailor the programme to the individual's abilities. It is important to structure daily activity to strike the right balance between challenge and ability. A well adapted training programme places demands on the trainer's powers of concentration, observation and analysis and on his ability to put himself in the trainee's shoes and understand when and how to offer help. The trainer needs to increase his awareness of when to give advice or a helping hand, and when to stay in the background and keep quiet. The trainee needs freedom to explore and experiment, and must have the right to make his own mistakes. A close observer may provide security but may also inhibit spontaneity. Keeping a suitable distance may be a better way for the trainer to get the trainee to work out his own solutions and test his own abilities. Being left to his own devices makes it easier for the trainee to realise that he alone is responsible for making certain things happen.

People with underdeveloped intellect are unable to say when they are suffering from sensory overload and need a break or a little calm to sort things out. Someone who can talk is able to communicate more simply and clearly, reducing the risk of misunderstanding. Without speech, the individual is reliant on the ability of others to register and interpret vague or confusing signals, and on their ability to wait patiently for a reply. For these individuals especially, it is vital to the learning process that the trainer is able to observe and interpret the signs of chaos, the need for a break or the need for time to think.

In the condition of *chaos* the sensory input from the environment has become overwhelming, paralysing the ability to make any sense of it all - a sensory overload that blows a fuse, so to speak. It is important to recognise the warning signals that an individual gives when chaos is impending so that it can be avoided. Typical signs include stereotyped movements of the arms or head, whining, shouting, crying, battering, excuses and denial. The trainee then needs to stop and calm down and allow himself to feel secure again, ideally while remaining seated in the powered wheelchair and not breaking off the session. The trainee will often calm down if the trainer approaches, offers a reassuring hand, a hug or a quiet explanation. Chaos is an unpleasant experience which, if it is associated with a certain activity, may lead the trainee to refuse to sit in the wheelchair at the next session. This risk is greatest if he breaks off the session at a moment of chaos, and least if he is

allowed to calm down, continue the session and finish on a positive note.

In the condition of *needing a break,* one might say that there is a logjam in sensory input and a slowing down of the process of sorting things out - a backlog of incoming information.This could well progress to chaos if not detected in time.Typical signs are worry, irritation, passivity, introspection, lack of attention, avoiding contact, diversions and attempts to break off the training session.The trainee then needs a moment or two of peace and quiet.The trainer needs only to keep a little distance for a while, until the trainee has had enough time to catch up and sort out his thoughts. Some may benefit from a quiet word and a little discussion about why things got a bit overpowering. Just how long the pause needs to be varies from person to person, but signs that the backlog is clearing include renewed interest in the nearby surroundings and a renewed desire to interact with the trainer and others. Chaos differs from needing a break in that an attempt is made to shut out all external sensory input.The need for a break occurs most commonly at the beginning of a training programme, before the trainer and trainee have built up a good rapport.

In the condition of *needing time to think,* the individual needs a quiet moment to explore and work out an association that he is just beginning to grasp. He may be engrossed with the effect of a certain action, pausing repeatedly to ponder over what is going on. Signs of needing time to think include stillness, focused attention, avoidance of eye contact, and a kind of active meditation.The trainee needs a few undisturbed moments to focus his attention and to work things out.The trainer can remain silently in the background so as not to distract the trainee from his thoughts.The time needed may vary, but when the trainee starts to focus his attention on external objects again and re-establishes eye contact, it is a good sign that he is ready to go on. He may show signs of irritation if distracted from his thoughts, or finds himself unable to work things out. In contrast to needing a break, a trainee who needs time to think often keeps his eyes open and seems to have his attention focused in a more direct way, although this may not always be easy to discern.

The conditions of chaos, needing a break and needing time to think can be seen in all individuals who are in the process of learning a new skill, especially if it is challenging.

Hands-on guidance

This type of help can be given to individuals who have yet to develop a capacity for conscious action, or who for other reasons have difficulty in carrying out co-ordinated movement. This type of guidance is literally hands-on, giving the trainee help to feel and explore the wheelchair's structures and functions.

In the beginning, the trainee may need considerable guidance in order to initiate or maintain movement of the chair. The trainee's hand may need guidance to grasp the joystick and the arm may need guiding to a good driving position supported by the tray. When the trainee can manage to maintain a grip on the joystick, the trainer's guiding hand shifts towards the wrist. The sooner that the trainer's supporting hand can be moved away towards the elbow, the better. As long as the guiding hand is placed on the trainee's hand, there is little scope for spontaneous exploratory movements. The sense of touch is stimulated on both sides of the hand, from below by the joystick and from above by the trainer. When the trainer's hand is taken away, it leaves the trainee better able to feel the joystick's shape and movement. If the trainee can see, it helps if he focuses his gaze on his hand as movements of the joystick are carried out, as this reinforces his understanding of how these movements can be made.

Hands-on guidance can be given to trainees hands either singly or together. If it is given to both hands, then the trainer first places the trainee's hands on the joystick and then places her own hands on top. The trainer can stand either in front of, or behind the trainee, depending on the desired direction of travel. The principle of moving the guiding hands as quickly as possible towards the elbow and away from the trainee's hands applies in the same way as with the use of a single hand. The following pictures, with attached descriptions, show how hands-on guidance can be given.

Direct stimulation of the palm of the hand before it is guided onto the joystick.Accompanied by verbal support e.g.'This is your hand, can you feel that I'm holding it?'

The hand is guided firmly onto the joystick, the fingers are eased into a straighter position before a grip can be formed.

Direct support of the grip on the joystick, the position of the hand, the lower arm against the supporting tray. Used mainly at the commencement of training to establish a good driving position. The picture illustrates the support given during backward movement of the joystick. Support for forward driving requires that the trainer moves her hand nearer the trainee's wrist.

Position of the trainer's hand used to support forward movement. The same position can be used for movement in other directions, even reversing.

Direct guidance of both hands into a grip on the joystick.This position can be used to guide movement in all directions. Used mainly at the commencement of training or if the trainee lacks strength or co-ordination.

Light support with both hands on the joystick. Uses a looser grip on the lower arms and can support movement in all directions.

Slight guidance of movement forward or to the side. Sideways movement achieved by helping one arm only and leaving the other arm by the trainee's side - creating a sideways movement. The grip on the lower arms may need to be tighter in the beginning.

Slight guidance of backward movement of the joystick. The trainee is helped to move his hand back towards his stomach, by the use of one or more fingers placed in the fold of the elbow.

Slight guidance of forward movement of the joystick. The trainee is helped to move his hand forwards, by the use of fingers placed behind the elbow.

Slight help with steering when the trainee can manage to retain a good grip on the joystick. With one or two fingers, the trainee's hand is guided to one side; in the illustration above, to the right.

Slight help with steering when the trainee can manage to retain a good grip on the joystick. With one or two fingers, the trainee's hand is guided to one side; in this case, to the left.

Unfamiliarity with, or aversion to touch

Someone who is unused to, or dislikes being touched may find it unpleasant to have his hands touched by others and may even find it difficult to grip the joystick. Preparatory tactile stimulation and massage may help to overcome this. Massage given with firm decisive movements following a discernible pattern may be tolerated better than light random massage. This may be because firm decisive movements are easier to interpret, or because a familiar pattern becomes reassuring. The individual learns to know what to expect when the treatment is repeated several times, and this may result in the sensation of touch becoming more pleasurable and comforting. Someone with a normally developed sense of touch may find it pleasant to feel the touch of the trainer's hand, whereas the same action can provoke an unpleasant sensation in an individual with a poorly developed sense of touch.

Verbal support

Support in the form of providing words for objects and actions, and giving verbal instructions and explanations is given to all participants in the

training programme. The language used ranges from the very simple to the more complex, but even if the individual seems not to understand language, it is important to name objects which he is helped to feel and actions which he is helped to carry out. These words should be used in immediate association with the actions or sensations that they describe so that the link between them is clearly established. Even so, the process may need to be repeated over and over again if it is to be registered in the memory. This applies especially to those with intellectual handicap or linguistic impairment, and those who have difficulty in grasping objects on their own initiative. Those who have the ability to manipulate and explore objects spontaneously, and who have a good understanding of language do not need the same degree of support in building up a relevant vocabulary.

The individual's ability to comprehend simple driving instructions depends on whether he can understand the relation between certain words and the control manoeuvres they describe. Learning terms for parts of the body and parts of the wheelchair is important if he is to understand instructions regarding how to carry out control movements with a particular device. Most important of all, he must be able to understand that the part of the body with which he grips things is called the hand, and the part of the wheelchair which sets it in motion is called a joystick. When teaching terms for parts of the body, the trainer can touch that part as she names it, e.g. 'this is your hand', reinforcing the association. When teaching terms for parts of the wheelchair, she can guide the trainee's hand to that part as she names it, e.g. 'this is the tray, now feel the joystick'. To reinforce the instruction, 'take hold of the joystick' the trainer can, after guiding the trainee's hand to the right position, exert pressure on it. The enhanced sense of touch that the trainee gets in this way is experienced as the trainer says 'now you are holding the joystick in your hand' with the emphasis on *holding*. A mentally handicapped trainee may need to have this process repeated on innumerable occasions before the associations are registered and stored in the memory. The learning process is focused on the acquisition of terms that are directly relevant to the act of manipulating the joystick and movement of the wheelchair. Simple explanations e.g. 'you must hold the joystick if the chair is to move' or 'when you let go of the joystick, the wheelchair will stop' are repeated over and over again. Explanations are always given at the same time as the action is being carried out. Only when the individual has full understanding of terms such as *press, pull, press harder* and *drive on* can the trainer use them to provide help from a distance. When the trainee has finally come to understand the association between his own actions and the

movement of the wheelchair, he can initiate movement on his own initiative.

Verbal support can be given at a more advanced and complex level to someone who has the ability to understand that change can be effected through conscious action, and it does not need to be given in direct association with the actions to which it refers, unless the subject has an impairment of short-term memory.

A trainee with a good grasp of language can accept instructions and explanations. He can actively relate his experiences and discuss tasks and his motivation to do them. Explanation and discussion can be used to highlight progress made or problems encountered and, in these individuals, becomes an integral part of the training programme.

Mild provocation

Somebody who is visually handicapped or unable to interpret what he sees can be difficult to attract towards a particular object or place. When an object is used to attract, it needs to be shown, shaken or used to make a noise at a certain distance from the individual. If he is unable to perceive these signals, he will remain uninterested and passive as he can't recognise or form a mental picture of the object. For an object to be attractive, it must provide an expectation of a positive experience.

One possible alternative is to encourage or provoke an individual to drive away from something. If his sight or perception is impaired, he will find it easier to recognise objects near to him, those which he can touch. Instead of using an object to attract, it can be used to e.g. to play 'give and take' so many times that the individual tires, and doesn't want it any more. He may then try to push it away, off the tray. He may become so irritated that he tries to throw it away. He can then be asked 'don't you want it any more?' If he looks irritated or conveys in some way that he doesn't want to interact any longer, he can be shown how to back away from the game. This process can be repeated with several different objects, so that the desire to back away does not become associated with any particular toy. The best toys are those which are not particularly liked. It takes a while to get tired of a favourite toy. This provocation may initially be seen in a somewhat negative light, but the ability to back away from an undesired object or situation is, for the individual, a useful and positive skill to acquire.

The training environment

Training is intended to be carried out indoors. A powered wheelchair for outdoor use has a chassis and suspension that make it heavier and more cumbersome. The indoor environment provides more opportunities to explore spatial relationships. The proximity of objects in a room makes them immediately more accessible and of potential interest. In the beginning, when the trainee is learning how to use the joystick, it is advantageous to train in a smaller room, which should be furnished with tables and chairs. A variety of interesting objects should be placed out on visible and reachable surfaces. For individuals with a visual handicap, or impairment of memory or spatial perception, it is important that objects occupy a fixed place in the room. This enables such individuals to build up a mental picture of the room and its contents, enabling them to train the memory and experience expectation.

The nature of the indoor environment, with the close proximity of furniture and fittings, means that the novice driver will be constantly bumping into things. As long as he just spins around in tight circles, using a minimal surface area, the risk of collision is small. When he learns to move the joystick and hold it in position for a little longer, he starts to move over a greater area, increasing the risk of colliding with something. A collision can prompt a variety of reactions. It is something felt through the whole body, by several different senses, in proportion to the speed at the time. Some objects move when they are bumped into, others are fixed. They may produce different sounds. In time, the trainee learns how much space he and the wheelchair occupy, and how much room he needs to manoeuvre. The risk of collision then diminishes, as the trainee gains in understanding and self-confidence.

It is easier to work out how the wheelchair responds to particular control movements if the response is consistent. This is more likely to be the case on smooth, flat surfaces without mats, thresholds or surface irregularities. Once the control movements have been mastered, the trainee can then progress to driving on uneven indoor surfaces or outdoors in another type of powered wheelchair.

Driving on uneven surfaces makes it necessary to adjust steering movements according to surface irregularities and inclines. The adjustments required will vary from location to location, and so are more difficult to learn, especially if the surface is very uneven. It is for this reason that it is better to start training indoors, and only go on to driving outdoors when the basic principles of controlling the wheelchair have been thoroughly absorbed.

Just how many distractions the trainee can tolerate varies with the form of the training and with the trainee's powers of concentration. It is far easier to learn new skills in a calm and quiet environment. The practising of manoeuvres which the trainee has basically grasped can take place in a noisier and busier environment. This may give the trainee good practice in shutting out extraneous distractions and concentrating on the task in hand. If he has always trained in a quiet environment he may find it hard not to become distracted, and hard to concentrate enough to cope with multitasking.

Some trainees seem to feel that the presence of a familiar person in the room provides an important sense of security. Others find that the presence of others during training sessions can distract from the task of driving the chair and make them insecure and afraid of making mistakes. They may not appreciate the comments of others. These individuals may respond better to being allowed to hone their skills alone in another room, before becoming confident enough to let others see what they can do.

Different ways of increasing the complexity of training

At the beginning of the training programme, learning to drive is an end in itself. Inadvertent initiation of a random movement can progress to active driving with full control over activation, speed and direction. When the art of driving has been mastered, the trainee can be given greater challenges by being asked to use the powered wheelchair in a more complex way.

Speed can be increased - forcing the user to think and plan more quickly. Sharper reactions become necessary to avoid collisions. Speed is the only setting on the training wheelchair that needs to be adjusted to vary driving complexity.

Driving a powered wheelchair can have different levels of difficulty, depending on the method of driving and on the nature of the environment. Driving along a corridor is considerably easier than reversing along the same corridor. Driving into a room, turning around and driving out again is a lot easier than carrying out the same manoeuvre in a toilet, even if it is adapted for the disabled. It is easier to drive around a piece of furniture than to reverse around it. For some, e.g. those with unilateral inattention or visual field defects, there may be a considerable difference between driving around a table clockwise and anticlockwise. This can be put to good use in training these individuals to turn the head to compensate for their visual handicap.

Using a powered wheelchair to carry out other tasks and activities can increase the complexity of the training programme in a variety of ways and

help to develop a number of different functions.A route can be marked out and prepared together with the individual, who then has to manage to drive along it without becoming distracted.The route can be successively lengthened and made more complex.Tasks can be added - e.g. fetching or delivering something.The process can be made even more complex by adding elements that require the individual to communicate and listen.

The limits of complexity are determined by the trainee's capabilities, and the trainer's imagination.The choice of training method and environment should take the trainee's interest and motivation into account. Most important of all, the training programme should be constantly adjusted so that the level of challenge lies just above the trainee's current level of ability.

A simple way of grading the level of driving difficulty

Understanding of the wheelchair's functions

* starting and maintaining motion, with guidance
* starting and stopping
* regulating speed
* steering
* understanding that the wheelchair can be used to get to a desired loca tion

Driving techniques

* driving along a corridor
* reversing along a corridor
* driving through a doorway - wide/narrow
* reversing through a doorway - wide/narrow
* driving between or around items of furniture
* reversing between or around items of furniture
* driving around furniture clockwise and anti-clockwise
* driving along a preordained route
* driving along a preordained route and simultaneously carrying out other tasks

Different environments

* peaceful and quiet
* sparsely furnished
* contains distractions and other human activity
* empty corridors
* corridors with obstacles and people in motion
* other public rooms
* narrow passageways between several different rooms
* confined spaces, e.g. toilets for the disabled

Particular ideas and experiences

Early awareness level

Individuals who have a severely limited ability to understand the link between their own actions and the effects that these actions produce suffer from an inability to influence their environment or change their own situation. The term 'early developmental level' is commonly used to describe this condition.

Experience gained during studies of powered wheelchair training has led to the use of another term - 'early awareness level'. Developmental level is a term that encompasses a variety of functions - sensorimotor, cognitive, emotional and social. 'Awareness level' relates to alertness, understanding of how the environment can be influenced, and social awareness. The individual's level of awareness to a large extent determines to what degree he can develop and use the skills that are encompassed by the term 'developmental level'.

An individual that functions at an early awareness level has not developed an understanding of simple cause-effect relationships. He is therefore unable to use tools and has a very limited ability to interact with the environment. Infants and individuals with a congenital or acquired disability may function at an early awareness level. The individual may, for example, have developmental delay, profound mental handicap or an acquired brain injury with an associated impairment of vision, perception, memory or language.

Powered wheelchair training for an individual at an early awareness level places particular demands on the trainer's knowledge of human develop-

ment and learning processes. Interacting with an individual that has particular and limited means of expressing himself, and limited understanding of language demands great powers of attention from the trainer, whose ability to observe and interpret the trainee's reactions are crucial to the setting of a suitable and individually tailored level of challenge.

Activating the motion of the chair requires the manipulation of some sort of control device. An individual at an early awareness level may find it difficult to understand how to use the hand to grasp objects. If, in addition, he suffers from a physical disability, he may find it hard to form a useful grip, make voluntary movements or co-ordinate movements into a functional action. He may, therefore, need hands-on guidance to use one or both hands to explore and experiment before he can learn how to activate the motion of the chair. After a period of guided training, the individual may then begin to take the initiative and spontaneously explore the chair by feeling, taking hold of or hitting out at parts of it. He may also start to explore other objects. At the beginning of training, an individual may well keep his arms by his side, to later start reaching out to explore nearby objects, which he may place in his mouth or use to hit other objects.

Many individuals who don't understand how to use their hands seem to experience the sense of touch differently. It is common for an individual with limited abilities of exploration and manipulation to react negatively to touch. He may withdraw his hand, or show his displeasure in other ways. This may be because he may have had so little experience of tactile stimulation that he finds it hard to distinguish between e.g. touch, warmth and pain. Such a person will often show less aversion to a strong, steady grip than a light and variable touch.

Someone who has yet to learn the technique of steering will often drive round in circles or just rotate on the spot. At the beginning especially, these individuals seem to have a high tolerance for rotation, and may spin around for quite a while before showing any displeasure. Those who cannot move independently seem to become dizzy on rotation far less readily than those who are capable of independent mobility. This is thought to be due to poor development of the balance organ's ability to react to postural change in those who have relatively little exposure to movement. It is important to be on the lookout for signs of distress when an individual has spun around for a while. When the balance organ starts to react, warning signs such as sweating, pallor and a fast pulse may be observed. If the individual seems distressed, it is best to stop the movement for a second or two, and then help the individual to compensate for the dizziness by rotating in the opposite

direction - so he can 'unwind'.

Training at an early awareness level is primarily aimed at promoting the expectation of pleasurable experiences with a familiar activity. Signs of pleasure are most often displayed when the individual gets to experience movement that is felt in the whole body via several senses. Movement promotes alertness and arouses interest in how the chair is set in motion. Recognition, and the memory of feelings associated with this activity improve attention and concentration, as each repetition is met with an excited expectation of pleasure.

After a while, an individual may begin to make deliberate attempts to produce a certain effect. That which at first seems like random behaviour can develop to become an obviously deliberate act. The individual may start by moving the joystick entirely by chance, producing movement of the chair. Similar, apparently random actions may be repeated many times before evolving into an action that is directed specifically towards the joystick.

During the period when the trainee has yet to learn what he must do to set the chair in motion, his hand must always be on the joystick at the moment the chair is activated. *The chair must never be set in motion unless the trainee's hand is resting on the joystick.* If the trainee is sitting in the chair when it has to be moved by another person, his hand must be placed on the joystick even, indeed especially, if he needs hands-on guidance to take hold of it. This is because developing an understanding of the causal relationship between the joystick and movement of the chair is strongly dependent on repetition and consistency. It is only when he has experienced sufficiently often that the chair moves when the joystick is moved, whether randomly, with help or deliberately, that the trainee can grasp the causal nature of this relationship. This learning process is impaired if the chair sometimes moves unexpectedly and, apparently, independently of any manipulation of the joystick.

The development of insight

Someone who lacks insight into his own abilities after an acquired brain impairment, may develop better insight after a period of training in a powered wheelchair. This lack of insight may take the form of an underestimate of one's own ability, an overestimate of the same, or a total unawareness of any handicap. Verbal support and discussion play an important part in this type of rehabilitation.

Learning to drive a powered wheelchair is a very tangible skill. It is easy for others to assess what progress is being made. The greatest advantage is that it is more difficult for the user to play down, or play up his achievements. The method of driving and the environment in which it is carried out, can be tailored to the needs of the individual. It should normally be constructed to emphasise the patients abilities rather than confirm any disabilities.

Someone who is unsure and afraid of failure, or who thinks himself incapable of learning to drive, will often show little enthusiasm for training. He declares himself afraid of damaging collisions and is reluctant to let others see him try and fail. He considers himself too old to learn new skills, and can't bring himself to try anything new. He is prepared to give up at the first setback or if he doesn't immediately grasp what he has to do. If, however, he is encouraged to have a go, despite his hesitancy and lack of confidence, he may well find it a positive experience - given a suitable challenge in a secure environment. This may give his self-confidence a boost and improve his motivation to continue training.

Those who overestimate their capability or who lack any awareness of their handicap can react in very different ways when given the opportunity of training. Some are more than willing to try and consider it all very exciting. Others feel that the whole thing is pointless as they are perfectly normal and already accomplished drivers. They also react in different ways when it becomes apparent that they are not as accomplished as they had thought. Some remain untroubled and think that it is all going swimmingly despite the fact that they are constantly crashing into things and knocking them over. Others may look troubled but deny any problems, or put the blame squarely on the wheelchair, claiming that it is out of balance or faulty. Those who appear untroubled often need a great deal of verbal support and discussion, which despite being repeated over a lengthy period may not necessarily result in any improvement. These untroubled individuals often fail to develop insight into their disability as they fail to see that they have a problem. Those who appear troubled and who either deny that they have a problem or blame the equipment are more likely to develop insight in response to discussion as they do, basically, understand that they have a problem.

Discussion and explanation are used as a means of making the trainee aware of strengths and weaknesses in his capability, and of the reasons that he succeeds or fails with a particular aspect of his driving. For example, if the trainee manages to negotiate a narrow doorway without coming into contact with it on either side, one might discuss what is the most important

element in managing that task. As another example: if the trainee drives up against a wall on one side and tries to dismiss it as a result of a faulty steering mechanism, one might want to discuss why the wheelchair isn't always difficult to steer or why others don't have the same problem.

Positive feedback or discussions about concrete issues are usually received with good humour. Negative feedback or comments about deficiencies of function or understanding are much more difficult to give and take. Giving information that can be understood and accepted without being unduly negative or critical is a delicate art. The message can be softened without losing clarity if negative expressions like wrong, bad, poor, must, mustn't, can't and won't are avoided. It is usually possible to find something positive as a counterbalance. For example: 'As your reaction times are slower than they used to be, and you find it hard to take in everything that's going on, it might be dangerous for you to drive in traffic. On the road everything happens at the same time and so quickly, so you have to be able take in, analyse and react very quickly in order to be able to drive safely. Now we can offer you a way of improving your abilities, so that you might eventually be able to drive a powered vehicle in traffic.' The negative, and possibly disheartening message about impairment of function is balanced by a more hopeful message about the possibility of improvement. This coupling can help the individual achieve a balanced view of his problem, gain a realistic insight into what can be achieved and thereby start to come to terms with the consequences of his disability. He may become more aware of alternatives that can compensate in some way for lost skills.

Motivation and frustration

As mentioned earlier, individuals sometimes show signs of irritation, anger, passivity or indifference when expectations aren't met. Frustration may depend on failure to achieve a desired goal, or a feeling of inadequacy when faced with a certain task. It is often possible to attract attention away from the cause of frustration, or encourage further attempts by explanation, discussion or guidance.

The most difficult situation arises when the individual gets so frustrated that he starts to scream, shout or cry. It is easier to re-motivate someone who is quiet, passive and indifferent, or someone who can respond to verbal encouragement and discussion. A practical tip about how driving can be made easier, or a reminder of the benefits of training, is the best way to motivate a frustrated individual who is able to talk.

If the irritation has gone so far as to express itself outwardly in an obvious fashion, explanation and discussion seldom works. Then it is best to come close, reassure, hug, distract and wait for the individual to calm own. Training should not, if possible, be discontinued, only paused for a short while. It is vital for the individual's motivation for the next session that the current session is allowed to finish on a positive note. If the individual gains the impression that exhibitions of frustration can lead to the immediate cessation of training, he will tend to give up more easily in future. Just how long it is suitable to wait for signs of frustration to abate is an ethical matter. It is also a matter of striking a balance between the potential benefits for the individual and the strain caused by training. If the individual himself does not have the intellectual capacity to weigh up the future benefits of his current activity, it is up to the trainer and relatives to decide if the process is worth the effort. One guideline might be that it is reasonable to continue as long as the individual is not unwilling to sit in the training wheelchair, or is himself capable of understanding the significance of further training.

Factors that influence training and its outcome

A person's chances of obtaining training in a powered wheelchair depends on where he lives, the structure of his everyday life, and the belief that those around him may or may not have in the potential benefits of training. The individual's capabilities as judged by others is the crucial factor that determines whether training will be offered, and what form that training will take. Knowledge of the range of available aids and of the benefits that each training method can give is the basis on which a sound choice, tailored to the needs of the individual, can be made. The availability of suitable premises and supervisory staff is another determining factor. The attitude of relatives and carers, i.e. their belief that training can provide benefits, is highly significant. Home circumstances and the structure if daily life has a powerful influence on whether, where, when and how often training for independent mobility can be given. The home circumstances of each individual are different, depending on age, the nature of his disability and the level of contribution made by relatives. He may live with his parents, in a residential home or in sheltered housing, alone or with relatives. He may have access to municipal or health authority daycare, school or leisure activities.

Just how far an individual can progress with the right combination of equipment and methods depends not only on the individual's innate ability, but also to a great degree upon his physical and social circumstances, including the accessibility of the premises, the level of personal support he is given with new challenges, the availability of complementary activities, and the people with whom he interacts.

Questions about factors that help or hinder good results

There are many questions about the individual's capabilities and circumstances that need to be asked to find out about whether a training programme is likely to be successful. Here are just a few: Is it possible to drive a powered wheelchair to the dining room? Are there accessibility problems with lifts, stairs and steps? Can the individual reach objects in which he is interested from the wheelchair? Does the local environment contain things that stimulate the individual's interest and desire to become more mobile? Are there other individually tailored activities available? Is there someone who can give the time needed to support an individual learning new skills? How many different activities are available to the individual? How does he communicate? Can he talk, or communicate his needs and emotions in some way that can be understood by others? Can others understand him, and can they make themselves understood to him? Does he exhibit behaviour that drives others away? Are there others that try to get through to him in order to improve his abilities and behaviour? How many try to communicate with him on his terms? Does he have meaningful relationships with others, if so, how many? Does he know what capabilities he has? Does that tally with the judgement of others? Does he have insight into his disabilities? Does he react to new activities with hesitation, fear or displeasure? Does he have difficulty in understanding new situations? Is he afraid of failure or of making a spectacle of himself? How does he respond to other people's reactions and attitudes? Does he regard something new as a threat or an opportunity? Does he have confidence in his own ability to influence and change his circumstances? Does he have belief in his ability to learn, re-learn, recover and develop?

Summary

The method is based upon partnership and mutual understanding between trainer and trainee. The trainer observes, interprets, communicates and initiates a dialogue between, as far as possible, equals. The analysis of this interaction is the basis upon which the trainer makes an assessment of the trainee's current abilities and likely response to new challenges. A thorough understanding of the trainee's abilities is the key to creating an individual training programme, which also requires familiarity with the signs and stages of progress towards learning the skills of purposeful driving in a powered wheelchair.

The trainee's motivation, level of effort and learning achievements are heavily dependent on the way the training programme is presented, constructed and experienced. Successful learning depends on guidance, verbal encouragement, explanation and discussion. The trainee feels the movement of the chair throughout the body, using all his senses. Exploration and experimentation can provide the experiences of collisions and help to develop an understanding of spatial relationships. The thrill of movement can increase alertness and the ability to remain focused on the tasks in hand.

The level of challenge that driving presents can be varied from very simple to very complex. Complexity can be increased by changing the method of driving, changing the environment, or by combining driving with other activities.

The results of the programme depend not only on the innate capabilities of the trainee, but also on how the trainee himself, and others, view these capabilities. The motivation and frustration felt by the trainee has a strong influence on the efforts made by both trainer and trainee. Other environmental and social factors have a great influence on the extent to which an individual can gain access to training, and what results can be achieved.

By using a powered wheelchair in this unconventional way, training and treatment can offer the individual the possibility of developing from a very simple to a highly complex level of function with the use of just the one piece of equipment. The level of challenge can be constantly adjusted by varying the wheelchair's speed, the training environment and the method of driving.

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