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CAPABILITIES AND ACCESSIBILITY: A MODEL FOR PROGRESS

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Abstract: Accessibility is seen to be a core issue which relates directly to the quality of life: if a person cannot reach and use a facility then they cannot take advantage of the benefits that the facility is seeking to provide. In some cases this is about being able to take part in an activity for enjoyment, but in some it is a question of the exercise of human rights – access to healthcare, education, voting and other citizens' rights. This paper argues that such an equitable accessibility approach requires understanding of the relationships between the capabilities that a person has and the capabilities required of them by society in order to achieve the accessibility they seek. The Capabilities Model, which has been developed at UCL is an attempt to understand this relationship and the paper sets out an approach to quantifying the capabilities in a way that allows designers and implementers of environmental construction and operation to have a more robust approach to their decisions about providing accessibility.

Keywords: Accessibility, Biomechanics, Capabilities, Modelling, Multisensory perception.

Introduction - Models

This paper argues that in too many cases the issue of accessibility is seen as a problem for people with mobility deficits, rather than as an opportunity for society to ensure that quality of life is maintained. Yet it is not only a duty for society. Each person also has a responsibility to act in a way that ensures that the burden of accessibility is spread fairly and that all benefit from equitable access. This is a shift from the so-called 'social model of disability' coined in

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the late twentieth century to follow the previous 'medical model' in which disability was emphasised as something to be cured or treated.

Especially in the case of younger disabled people (often with disabilities caused by trauma as a result of military action, traffic accidents etc. rather than with underlying medical conditions), the question of treatment was secondary to the question of how they were going to arrange their new life in order to maintain the quality of life to which they had previously aspired. As a result, the concept of the role of society in disability became more apparent; treating the disability was simply dealing with the symptoms of the problem and left the core issue – the inability of society to design an environment which could accommodate disability – untouched. It is this call on society to play a more active role that became the nub of the 'social model' – "I am not disabled, Society disables me by its inability to accommodate my needs". This is all very well, but it also fails the individual: neither the medical model nor the social model considers the actual relationship between the person and their immediate environment and thus neither will provide a realistic approach to determining what should actually be done, either in terms of treatment or therapy or in terms of (re)design of the environment, to make the situation better for the person.

To return the person to the centre of the opportunity to improve their quality of their life, we started to consider what actually comprises the relationship between a person and their immediate environment. Starting in a very simplistic way, we considered elements of the environment that could be changed and the thresholds at which change could yield a significant change in outcome. The width of a ticket gate at a metro station, for example, could preclude some people from using the metro system as a whole (Cepolina and Tyler, 2004). It soon became clear, however, that in order to make a usable model – one which could help people design and use a more accessible environment – we would need to understand a lot more about capabilities. This paper aims to set out where we have reached in this task.

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First, we will set out the Capabilities model in a little more detail in the next section. Section 3 will then describe how this has been applied in two example cases and Section 4 will discuss these outcomes and what the next steps will be.

The Capabilities Model

The core elements of the Capabilities Model

The Capabilities model consists of three core elements:

- The person wishing to undertake an activity;
- The activity the person wishes to undertake;
- The environment which needs to be encountered in order for the person to undertake that activity.

The person

The person is considered to be the centre of the model. They present themselves with a desire to undertake an activity which takes place in a given place and with their own set of capabilities which are relevant to the activity and the place. In many cases these capabilities are measurable (strength, for example, or the ability to raise a leg above a certain height, or a certain level of visual acuity) and we call these capabilities 'Provided Capabilities' to indicate that these are what the person brings to the issue on the day and at the time required. Provided Capabilities are personal to the individual and can change at any time.

The activity

The activity is the set of tasks the person wishes to undertake. These tasks are made up of a set of actions which require certain capabilities on the part of the person in order for the tasks to be completed. Buying a newspaper is such an activity. It will require the ability to choose the correct newspaper and deal with the money transaction in order to buy it. This suggests that there is a need to have a capability to choose, to deal with money, and maybe to reach out and pick up the newspaper from the shelf in the shop. These are capabilities that

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are required by the activity of buying a newspaper and we call them 'Required Capabilities'.

The environment

Buying the newspaper could require other tasks such as walking along the pedestrian footway, crossing a road, entering the shop, dealing with money and so on. To take one example, 'crossing a road' requires a set of actions such as looking each way to detect oncoming traffic, being able to calculate a moment when it is safe to step into the carriageway, being able to step off the footway onto the road surface, being able to walk across the road, and being able to step up from the road surface onto the footway. The other tasks can be broken down into actions in a similar way. Each action requires a set of capabilities on the part of the person before they can successfully complete it and so the task – and eventually the activity – requires a set of capabilities of the person in order that they can successfully achieve their desire. These are also 'Required Capabilities', although they pertain more to the environment in which the activity takes place, including the means of reaching the activity. Required Capabilities indicate that these are levels of capability that need to be provided by the person if they are to achieve the activity. The overriding point is that in order to buy the newspaper, the person will have to be able to provide sufficient capabilities to counter the capabilities required by the activity itself and the environment.

It is important to realise that the activity could be achieved in a number of different ways, each of which could have a different set of Required Capabilities, and so a person whose Provided Capabilities are insufficient to achieve the activity in one way might well be able to assemble sufficient Provided Capabilities in order to achieve it in another. This is known as the 'Coping Strategy'.

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The model process

In very simple terms, the Capabilities Model compares Required and Provided Capabilities in respect of the activity at hand (or some task/action within the activity) and the resulting comparisons show where an intervention might be required in order to increase the accessibility of the activity.

For example, it might be impossible for a person to catch a bus because the timetable is printed in a font which is too small for them to read. The intervention could be to increase the size of the font in the timetable, to introduce a new aural timetable service – thus changing the Required Capabilities – or it could be to provide the person with corrective spectacles or other eye treatment to enable them to read the font in its present size – thus changing the Provided Capabilities. Deciding which should be done is a matter of making a decision on the basis of the knowledge about the capabilities and how these spread across the population, the feasibility of amending the format of the timetable or introducing a new service or the reality of the prospects of treatment. Knowing where the problem is provides a good start for considering these issues in a knowledge-based way rather than simply assuming that one or the other is the only way to solve the problem.

The key is therefore to know how to measure the capabilities. We now discuss two examples where such a consideration could be helpful.

Capabilities Examples

We now consider two examples: one relating to vision and one relating to wheelchair propulsion.

Vision

In 2008, as part of the culmination of some 15 years of work to develop a gene replacement therapy for Leber Congenital Amaurosis, evaluation experiments were required in order to show the efficacy of the therapy (Bainbridge et al. 2008). It was important to show that the therapy was not just delivering an improvement in eyesight, but that this improvement would be meaningful for

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the person in terms of improving their quality of life. The research team from the Institute of Ophthalmology (IOO) approached the Accessibility Research Group at UCL to set up some before-and-after experiments to test where the therapy was able to deliver such an improvement. Accordingly we worked with the IOO research team to design a set of experiments in our laboratory (the Pedestrian Accessibility and Movement Environment Laboratory – PAMELA) where we could set up street environments under different controlled lighting conditions. The results are reported in Bainbridge et al. (2008), but put simply, they showed that at a lighting level similar to that found in residential streets in suburban areas in the UK (about 4 lux at ground level), the participant who, in the before study had progressed through the maze in 1 minute 20 seconds, with several collisions with the walls of the maze and two complete disorientations, was able after the administration of the treatment to complete the maze task with no collisions and no disorientations in 17 seconds. Why is this important and what does it mean for the Capabilities Model?

It is important because the improvement in the patient's eyesight meant that he could now see well enough to be able to go out at night and to play his guitar with his friends without the need to have his parents present to guide him along. From the perspective of the Capabilities Model, it is an example where, in this case the comparison between the medical treatment and the alteration of the lighting levels yielded a solution through a change in the Provided Capabilities – the lighting levels remained the same in his residential street, but his capability to deal with them had been changed. What the Capabilities Model did on this occasion was to show the research team that simply testing the medical benefits of the therapy was not sufficient to tell what the actual benefits to the person could be. If the therapy had not delivered this outcome, would it have been worth pursuing further?

Wheelchair Propulsion

Nearly every footway in the world has a transverse slope (called a crossfall) to facilitate drainage. According to engineering practice and a number of standards, the crossfall should have a gradient of approximately 2.5%. Many do

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not comply with this standard – partly because it is relatively difficult to lay a surface with such a precise transverse gradient, partly because it is believed that, for drainage, if there is to be an error it should be to increase, rather than to decrease, this gradient and partly because over time, vibrations from local traffic, changing weather, soil settlement and so on, the footway settles to provide a steeper gradient.

Holloway (2011) set out to examine this issue to see if this presented a problem for wheelchair users.

To propel a wheelchair along a transverse slope requires not only the force required to move the physical mass of the wheelchair and its occupant, but also to compensate for the gravitational forces which tend to force the wheelchair down the slope. This compensation can be provided in a number of ways and the opportunities and challenges are different depending on whether or not the wheelchair is being propelled by its occupant or an attendant.

In general terms, to keep the wheelchair travelling in a straight line on a transverse slope will require additional force to be applied to the side which is lower on the slope (the 'downslope side') and relatively less force to be applied to the other side (the 'upslope side'). This can be applied, for example, through lots of small pushes on the downslope side relative to the upslope side, or a few large strong pushes on the downslope side. The difference of force could also be applied though Bbraking on the upslope side of the wheelchair also requires different forces to be applied to the downslope and upslope sides. In all, although while the amount of work done to propel the wheelchair (i.e. the force applied over a given distance) remains constant regardless of crossfall gradient, the presence of a crossfall means the wheelchair user must have a second provided capability to produce the difference of work needed to counter the effect of gravityis considerably more on a crossfall than on a flat surface. The Capabilities Model recognizes this as an increase in the Required Capabilities – both in terms of having the strength required to provide this larger force overall and also the capability of being able to apply a different

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force on each side at the same time and also there is some sense of needing some form of coping strategy.

The second case is the wheelchair which is being propelled by an attendant. This is different from the self-propelled case just discussed because the attendant is in constant pushing contact with the chair (the wheelchair occupant supplies intermittent pushes via the hand rim on the wheel, thus there are periods when there is no pushing contact with the chair). The force and work issues involved are as before as the core issue is the propulsion of a given mass along a given distance on a given surface at a given crossfall gradient, but in this case the continuous nature of the push and the fact that in effect these are being delivered by one arm makesincreases the work – and the control – required to move the chair rather more difficult. In fact in some cases the force required of the attendant exceeds the legal limits for pushing within the UK's Health and Safety legislation.

In both cases, the problem becomes worse as the crossfall gradient is increased.

Holloway (2011) showed that measuring the forces required to move the wheelchair yielded a quantified version of some of the Required Capabilities. The force transducers, whether applied to the wheel or the push-handles, measured the forces required at those points to overcome the gravitational forces and inertia acting on the chair and its occupant. They did not measure the work actually put into delivering those forces at that point. It was evident that there some force is applied downwards on the handle, and the extent to which this is useful in terms of propulsion or stabilityis an interesting question to explore. We could also expect that there could be some loss of output as a result of flaccidity in joints and muscles which mean that the amount of force put in by the occupant or attendant is greater than the forces actually required to move the chair as required. This is work that remains to be done.

Considering the Capabilities required to respond to the crossfall gradient helps to determine the extent to which current standards are appropriate, whether it would be beneficial to exert a more strict control over construction and design,

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or whether we should be seeking to deal with drainage in a different way – one that does not require crossfalls. Or, should we be seeking to develop technology to assist the wheelchair user (occupant or attendant) in propelling a wheelchair along a transverse slope? What the Capabilities analysis shows is that crossfalls are a problem for people in wheelchairs and one that does limit their ability to undertake the activities they would like to achieve. The likelihood is that it would be easier in this case to address the problem of assisting wheelchair pushers to handle transverse gradients rather than change all the crossfalls in the world, but that a suitable approach to standards would help to reduce the problem in the long term.

Discussion

The two examples described above show that the Capabilities Model is a useful way of comparing the relationship between a person and their immediate environment and considering whether improvements to quality of life might be delivered by changes to one or the other. The Capabilities Model is a way to look at the environment through the capabilities of the person trying to interact with it while simultaneously looking at the person themselves to see what they can achieve.

The key problem at the moment is how to measure the capabilities. The examples discussed here suggest that one way to do this is to use Provided Capabilities as a means of finding out what the Required Capabilities are. However, this needs a comprehensive evaluation of the 'capability losses' within the person that indicate that the person is being required to put in more effort than is actually required in order to deliver the Required Capabilities.

Although the two examples considered here both relate to a person and their interaction with the physical environment, they are otherwise different. One involves the sensory perception of the environment whereas the other is much more involved with the physical response to the environment. However, they can both be considered with the Capabilities Model and this gives rise to two thoughts.

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First, the usual situation is that accessibility involves a test for more than one type of capability (dealing with a gradient and poor visual perception at the same time for example). So how do we work out what the Provided Capabilities are in cases where multiple capabilities are required, what are the issues in terms of coping strategies and how do we measure these? By assessing the capabilities compared with the achievement of a single outcome – achievement of the activity, for example – we are already combining the capabilities in one sense. However, should we be measuring the capabilities independently of the task in question and then determining which are core to the activity, and thence which are the crucial elements in determining the accessibility of the activity? An example of this could be how we determine where it is safe to walk in a street environment. It is a combination of cues – visual, hearing, balance, tactile, experience, and so on – that tell us where we are in relation to vehicles. Reducing or removing one of these places a stronger need on the information yielded by the others, but the actual information is still obtained from a combination of cues. Can Capabilities model this type of interaction?

Secondly, how do we rate capabilities in comparison with each other? The question is whether there is some notion of 'capability' that is independent of the actual ability being considered, and which could therefore yield a quantifiable objective measure that would enable us to compare directly the benefits that could be gained by acting in different ways to improve the situation for people with different disabilities.

Conclusions

This paper has described the Capabilities Model being used in our search for an equitable way to develop a more accessible society. We have discussed two examples in which the consideration of capabilities has enabled us to think about quantifying what is meant by accessibility and how we might ensure and check delivery of an accessible society through a combination of changes to the environment in which we live and the treatments and therapies that will continue to be developed and become available to us in the coming years.

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We conclude that it is possible to determine ways of measuring capabilities, but that there are still questions to be asked, in particular about the details of measurement and in the combination of capabilities.

Nevertheless, the Capabilities Model does provide a coherent and objective basis on which to consider the accessibility performance of infrastructure and environment design.

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