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Stress and Exclusion – principles and tools for inclusive design

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Abstract
The Journey Stress Calculator is one of the tools that Loughborough University is developing as part of the Accessibility and User Needs in Transport for Sustainable Urban Environments (AUNT-SUE) project. The ambitious aim of this tool is to model the psychological stress that 100 people would experience during any public transport journey. Assessing whole journey accessibility in this way has been born out of a fresh perspective on the causes of social exclusion.

This paper provides an introduction to psychological stress theory and proposes two key principles. The *exclusion transaction* explains how individual instances of exclusion occur, whilst *stressor elimination* is the mechanism that reduces exclusion. The potential benefits of understanding exclusion in this way are discussed and it is suggested that the aim of inclusive design should be the elimination of stressors that associated with products and systems.

Practical implementation of this approach would rely on the availability of techniques that can be easily integrated into design and policy making processes. The Journey Stress Calculator is one example of how this may be achieved, but simpler and more generally applicable tools are also proposed.

Keywords
Inclusive Design, Social Exclusion, Stress, Transport

Introduction
Public transport has great potential to provide freedom of movement to all in a way that is economical and sustainable. Inclusiveness is therefore an essential in the design of transport facilities. However, the ideal of totally inclusive public transport is a long way from being a reality and the complexities involved mean that progress is not always straightforward.

The Accessibility and User Needs in Transport (AUNT-SUE) project was conceived to investigate new ways to inform the socially inclusive development of urban environments and transport infrastructure. Teams based at Loughborough University, London Metropolitan University and University College London are developing and testing tools that assist in designing-out both practical barriers and the perceived problems that may contribute to exclusion.

One of the main difficulties encountered when trying to assess or predict exclusion in is that it is rarely black and white. Just as an apparently disabled people may develop coping strategies that mean they are not excluded, an apparently able person can be excluded without meeting any practical barriers. One line of enquiry pursued at Loughborough University has attempted to bring some clarity to the fundamental concept of exclusion and find new approaches that are better

suited to dealing with the subtle forces at work. This began with the assertion that people find travel stressful and, through the formation of principles and techniques, has become a fully-fledged philosophy for inclusive design.

Stress Theory

Before describing the principles that relate exclusion to psychological stress it is necessary to define the well established concepts on which they are founded.

The Transactional Model of Stress

The accepted definition of stress is the transaction between a stressor and response (Cassidy, 1999). The related term distress refers to the negative emotion (anxiety or depression) that accompanies this transaction. Any internal or external stimulus that could put the person at risk of harm or failure is a stressor. Perception of a stressor stimulates an ordered coping mechanism made up of physiological preparation (e.g. increased heart rate), cognitive enquiry and behaviour, all of which feedback into reassessment of the stressor (Cox, 1981).

Stressors

While major life events such as bereavement may be considered to be stressors, daily hassles have been found to be better predictors of psychological symptoms and health (Cassidy, 1999). Such stressors fall into three distinct categories; acute, ambient or anticipatory:

- Acute stressors are events that are current and the person is directly conscious of such as being attacked (e.g. being in heavy rain), causing a problem (e.g. spilling some coffee) and attempting a difficult task (e.g. trying to open a jam jar).

- Ambient stressors are aspects of the environment (e.g. vandalism, background noise, darkness or unpleasant smells) that are perceived as risks because the person associates them with harmful events.

- Anticipatory Stressors arise through internal thought processes in which a person considers the possibility of future difficulty. Stress experienced before a giving a presentation or making a journey is caused by such anticipation.

Responses

People respond to stress with a mixture of direct and palliative behaviour (Cox, 1981). Direct action changes their relationship with the stressor and can classically be described as fight or flight, whereby the person either attempts to overcome or avoid the stressor. Inability to take direct action is known as freezing. Palliation is behaviour that reduces the emotional distress and physiological stimulation. This is particularly useful when the stressor is beyond the persons control and can help to prevent collapse.

Deferent people respond differently to stress and there are strong social variations in distress levels (Mirowsky and Ross, 1989). For example; distress is higher in People of low socioeconomic status because they may be exposed to more frequent stressors without access to resources that could help them cope. High anxiety in young adults has been linked to stressors associated with increased independence which diminishes over time as the person develops coping strategies. Different levels of stress can also be attributed to lifestyle and employment factors. Costa et al

(1988, quoted in Cassidy 1999, p50) found increased levels of psychological illness in commuters. The automatic emotional and physiological responses to stress mean that frequent or prolonged exposure can result in chronic distress and is linked to conditions such as heart disease.

The Exclusion Transaction

It is clearly inadequate to describe a product or system as inclusive solely on the basis of practical usability. Many able people are excluded from activities that would benefit them despite being fully able to participate. Describing individual occurrences of exclusion as a particular form of stress transaction makes this phenomenon easy to explain. The *exclusion transaction* can be described as follows:

1. A person anticipates the potential to fail an activity.
2. This is anticipatory stressor and causes emotional distress.
3. The person chooses to respond by flight from the activity.
4. The person behaves in a way that enables them to avoid the activity.

The important principle here is that exclusion results from an anticipatory stressor. Crucially anticipatory stressors do not need to be definite problems. They can result from previous experience, second-hand knowledge, imagined scenarios or prejudice. As a result, people who are fully able to use a product or system can easily become excluded. The following example of the *exclusion transaction* can be observed at train stations every day.

1. A person anticipates that they may make a mistake when using a ticket machine.
2. This anticipation means causes them anxiety.
3. The person chooses not to approach the ticket machine.
4. The person joins a long queue for the ticket office.

There are two important points to make about this transaction. Firstly, this coping strategy leads them to a situation that may also be stressful they could react in the same way causing complete exclusion from the system. Secondly, the anxiety will be worse if the person's believes that using the ticket machine will be effected by their reduced vision or manual dexterity. As such, the *exclusion transaction* is sympathetic to the disproportionate exclusion of disabled people.

Stressor Elimination

Given that exclusion can be described as the result of the anticipatory stress associated with an activity, aim of inclusive design must be to prevent this *exclusion transaction* from occurring. If designers are to take responsibility for reducing exclusion they must acknowledge such anticipation originate acute and ambient stressors that are innate to the product or system. Taking a public transport example; it might be reasonable to anticipate standing in the rain, getting on the wrong bus, standing on a moving vehicle and being in a noisy environment. Just as exclusion could result from any of these stressors, inclusion could be increased by designing-out each one. *Stressor elimination* is the principle that a product or system is only fully inclusive if all stressors for all people have been eliminated from it.

The Journey Stress Calculator

Psychological stress theory can explain the process by which people are excluded and the mechanism that allows exclusion to be reduced. However, the objective that led to the development of these principles was to find a new way to assess the accessibility of public

transport journeys. The result is the Journey Stress Calculator.

The Journey Stress Calculator is a tool for the identification and prioritisation of improvements to public transport infrastructure. It works by comparing the stressors that are present in a given journey against the differing abilities of 100 people to cope with them. These people are part of HADRIAN, a database and 3D human modelling system that has also been developed at Loughborough University for the AUNT-SUE project (Sims et al., 2006). HADRIAN enables virtual trials using a varied and richly described set of real people as an alternative to using population data which lacks personal definition. HADRIAN is therefore an ideal resource for predicting cases of exclusion.

The Journey Stress Calculator contains a library of predicted stress responses for each participant to 58 standard journey stressors, such as climbing steps, crossing a road, navigating an unfamiliar route or being in a crowd. The practitioner enters a journey by specifying the occurrence of stressors at different stages throughout a known journey. The software then generates results. The total journey stress for each person is the sum of their responses to each stressor that occurs in the journey.

$$total\_journey\_stress = \sum \left(stressor\_occurence_n \times stress\_response_n \right)$$

The Journey Stress Calculator will predict which people are excluded from any journey, which stages of the journey cause greatest stress (Figure 1) and which stressors are responsible for greatest exclusion. This should help decision makers to prioritise the least inclusive journeys and target resources to eliminate stressors within the route.

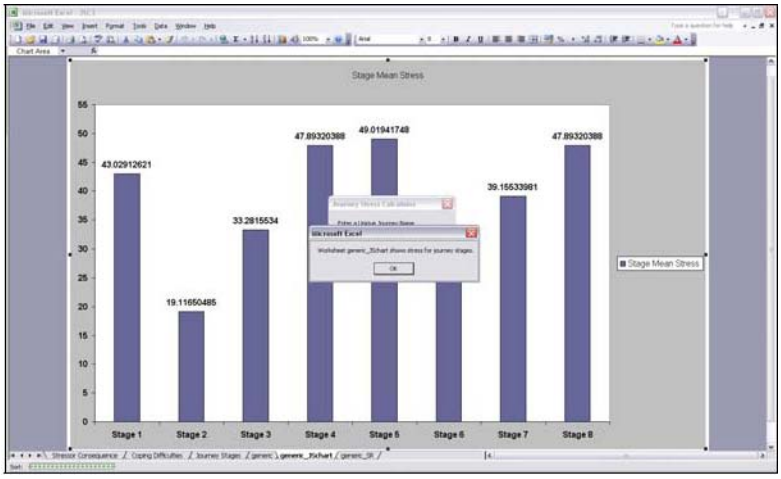


Figure 1: The Journey Stress Calculator showing variation in stress for the HADRIAN sample at eight different stages during a journey.

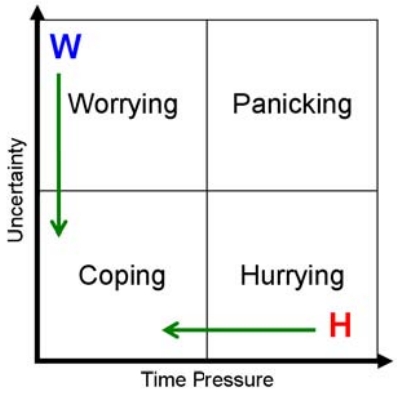
Stress Based Tools for Inclusive Design

The journey stress calculator may prove to be a useful tool within the field of public transport and could be a model for similar tools applied to different contexts, such as workplaces. However it is not generally suitable for inclusive design. Designers need universally applicable tools so that *stressor elimination* into the design process.

Figure 2: The Panic Matrix.

A design project that is trailing new *stressor elimination* tools is the Inclusive Journey Planner

(Porter et al., 2006). This is another outcome of the AUNT-SUE project and aims to demonstrate best practice in the design of internet journey planners. One simple tool that has been applied in this design process is the Panic Matrix (Figure 2). This tool encourages design for the needs of stressed users; the 'Worrier' and the 'Hurrier'. The designer should identify any aspects of their design that may increase time pressure or uncertainty and improve the design so that the user can cope with the interaction. Two are Human Systems Stressor Analysis (HSSA) and Stress as a function of Time, Uncertainty and Difficulty (STUD Tables) which are tabular for the objective assessment of stressors and the selection of interface devices based on the level of stress (Davis et al., 2008).



Conclusion

This paper advocates the application of psychological stress theory to the design of inclusive products and systems. Uptake of this approach could occur in different ways. Some designers and researchers may embrace the principles and develop their own ways of integrating them into their work. Alternatively practitioners may adopt specific *stressor elimination* tools, such as the Journey Stress Calculator or Panic Matrix, if they can see that they produce useful results.

However it is applied, relating exclusion to psychological stress has some appealing qualities. It explains why able people can be excluded and enables comparison of multivariate problems on the basis that they all cause stress. By reducing the stress suffered by people using products or systems, inclusive designer has a role in bringing health benefits to all people who endure stressful interactions on a daily basis.

As yet, no studies have been undertaken to demonstrate the *exclusion transaction* and the tools are not tried and tested. The Journey Stress Calculator will be tested to establish whether it can usefully predict either stress levels or likelihood of exclusion. This may go some way to proving that it is valid to relate exclusion to stress. However, it may be enough that the principles are consistent with accepted psychological theory. Ultimately the test is whether using the principles or the tools associated with them is helpful to designers and researchers seeking to produce more inclusive products.

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