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# Neuro-Inclusive System Design: Rethinking How We Build for Real Human Behaviour

## Abstract

Most systems today—whether digital platforms, transport environments, or public infrastructure—are designed with a narrow assumption of how people think and behave. In reality, human cognition varies widely. This paper explores how neurodiversity can be meaningfully integrated into system design, not as an afterthought, but as a core principle. By focusing on predictability, reduced cognitive load, sensory awareness, and adaptive interaction, the paper proposes a practical framework for designing systems that work better for everyone. The discussion connects behavioural understanding with real-world applications, showing how inclusive design can improve safety, usability, trust, and adoption across domains.

**Keywords:** Human Behaviour; Cognitive Diversity; Neuro-Inclusive System Design; Neurodiversity; Sensory Awareness; Behavioural Design; Human Interaction.

**Research Article**

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## Introduction

We often talk about inclusion in terms of access ramps, assistive tools, or policy frameworks. But inclusion at a deeper level is about how systems feel and behave when people interact with them. Most systems are designed for an "average user." The problem is, that user does not really exist.

People process information differently. Some people need structure and predictability. Others struggle with sensory overload. Many disengage when systems feel confusing or inconsistent. These are not edge cases, they are everyday realities.

Research in human-centred design has increasingly shown that systems work better when they align with real human behaviour rather than forcing people to adapt to rigid environments [1]. Similarly, neurodiversity research argues that cognitive variation should be understood as a natural part of human diversity rather than something outside the norm [2].

This paper explores what happens when those realities are taken seriously in system design.

## Where Current Systems Fall Short

Across digital systems, transport environments, and public infrastructure, the same issues appear repeatedly.

### Systems Assume Everyone Interprets Things the Same Way

Instructions, interfaces, and signals are often designed as if meaning is automatically obvious. In practice, interpretation varies depending on stress levels, cognitive style, familiarity, and environment.

### Too Much Unpredictability

Changing layouts, inconsistent navigation, unclear feedback, and unexpected interactions create friction and anxiety. Predictability is often underestimated, even though it is essential for confidence and usability.

### Sensory Overload Is Ignored

Noise, clutter, excessive notifications, bright visuals, and information density can overwhelm users—especially in high-stress or unfamiliar environments.

Research around sensory processing has shown that overstimulation can directly affect concentration and usability [3].

### High Cognitive Load

Many systems require people to constantly interpret, compare, remember, and decide between multiple pathways.

Cognitive Load Theory suggests that excessive mental effort negatively affects learning and usability [4].

Importantly, these issues do not only affect neurodivergent individuals. They affect almost everyone under stress, fatigue, pressure, or unfamiliar conditions.

## A More Practical Way to Think About Design

Instead of treating inclusion as an add-on, it helps to think about how people actually interact with systems in real conditions.

From that perspective, a few principles become obvious:

- People prefer clarity over cleverness
- Predictability builds confidence
- Simplicity reduces errors
- Control reduces anxiety
- Consistency improves usability

These are not “special needs.” They are basic human needs.

**Predictability**

Systems should behave consistently. When changes happen, users should clearly understand why.

**Clarity**

Information should be structured and easy to follow. Avoid unnecessary complexity or overloaded communication.

**Low Cognitive Load**

Reduce the number of decisions and steps required from users wherever possible.

**Sensory Awareness**

Design environments and interfaces that avoid unnecessary sensory overwhelm. Where possible, provide quieter or simplified alternatives.

**Adaptability**

People interact with systems differently. Systems should allow users to adjust settings or interaction preferences based on comfort and need.

## Real-World Applications

**Mobility and Transport**

SPD system - NeuroNav - Clear navigation, predictable layouts, and consistent signalling can make transport environments easier and safer to use.

For example, metro systems with colour consistency, structured way finding, and predictable announcements can reduce confusion for both neurodivergent users and the general public.

**Digital Systems**

Interfaces that are structured, predictable, and forgiving tend to reduce errors and improve engagement.

Examples include simplified onboarding flows, consistent interface patterns, distraction-reduced dashboards, and adjustable notification settings.

**Public Infrastructure**

Hospitals, airports, schools, and government facilities can become cognitively overwhelming because of cluttered layouts and inconsistent information systems.

Simple layouts, intuitive signage, quiet spaces, and reduced environmental overload can significantly improve accessibility and usability.

## Why This Matters Beyond Inclusion?

Designing for cognitive diversity does not only help a specific group—it often improves systems for everyone.

**Potential benefits include:**

- Fewer mistakes
- Reduced frustration
- Faster learning
- Better user trust
- Higher adoption rates

In many cases, systems designed around vulnerable or cognitively stressed users become more usable for the broader population as well.

This reflects broader ideas found in universal design approaches [5].

## Rethinking the Role of Design

Design is not only about functionality or aesthetics. It shapes how people experience systems, whether they feel confident, confused, stressed, excluded, or in control.

When systems align more closely with real human behaviour, they do not just function better, they become easier to trust and easier to use.

Neuro-inclusive design is therefore not just an accessibility discussion. It is a practical systems-level approach to im-

proving usability, resilience, and human interaction.

## Summary

If systems are going to become genuinely effective, they need to move beyond designing for an "average user" and start designing for real human variation.

Neuro-inclusive design is not a niche concept. It is a practical framework for building systems that are safer, simpler, more predictable, and more reliable.

As technology and infrastructure become increasingly integrated into everyday life, designing around real human behaviour will become increasingly important.

### Future Direction

Future work could explore:

- User testing and behavioural validation
- Measurable neuro-inclusive design benchmarks
- Integration into engineering and infrastructure standards
- Large-scale implementation across digital and public systems

There is also scope for collaboration between behavioural science, engineering, accessibility research, and infrastructure planning to further strengthen neuro-inclusive system design approaches.

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