Adapt

The design of
a parametric system
for hyper personalised
sets of Cutlery
for Stroke Patients

Above: Fig 1 Shows the Final Prototype being used in user testing session 2, by User 4.

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by

Ethan Henley
BDI specialising in Industrial Design
Victoria University of Wellington

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School of Design

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Adapt

- make (something) suitable for a new use or purpose.

- become adjusted to new conditions.

To modify, alter, change, adjust, convert, transform, redesign, restyle, refashion, remodel, reshape, revamp, rework, redo, reconstruct, reorganise, customise, tailor, amend, refine.

Abstract

This paper presents a system for digitally manufacturing hyper personalised sets of cutlery for stroke patients. Stroke produces a wide variety of physical, cognitive, emotional and social effects that vary widely among individuals and may include weakness or paralysis on one side of the body, contractures and inability to rotate joints. This design addresses the factors including weakened grip strength, contracted wrist and fingers, limited range of motion in the wrist, hand tremors and lack of control.

Becoming independent again is an essential stage for patients and difficulty performing standard eating tasks is a commonly reported effect after stroke, which is challenging physically and emotionally. There are existing ergonomic eating aids on the market, but none that offer personalisation for the widely different physiological effects of stroke, or that effectively integrate a sense of progression and achievement, which is the key to keeping patients motivated and confident throughout the rehabilitation process.

This study investigates the way design can help reduce product related and social stigma for upper limb stroke rehabilitation patients in the use of cutlery. This research explores the way that a parametric system can be implemented to aid clinicians in identifying the individual needs of patients against a list of criteria. This design study has developed a set of cutlery that assists patients, making them feel confident and comfortable using cutlery in situations outside of their homes, as well as assisting as a therapy device.
This research presents a parametric system that allows for controlling the variables relative to the design criteria based on the patient's physiological abilities.

The variables include the ability to change the diameter and size of the handle, the curve of the utensil in the (x,y) plane, the angle of the handle in the (x,z) plane and the depth of the finger groove which accommodates the index finger. The paper presents the main findings from how participants experienced stigma, clinicians feedback on the appropriateness of the cutlery designs, and how personalisation contributes to motivation within therapy.

These main findings conclude that cutlery designed for stroke patients needs to be personalised, as each patient has very individual needs according to their very individual impairments. Current cutlery does not address them all and even less address them through personalisation. The specific variables in the system need to be controlled and restricted to ensure that all 40,000 of the possible outcomes are effective.

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Introduction

Stroke patients find standard cutlery challenging to use for several physiological, mental and cultural reasons. Using a standard knife and fork at the same time is often too difficult for stroke patients, precisely due to weakness or paralysis resulting from the stroke and the concentration required to operate both concurrently. Wanting to feel normal again, patients will avoid current market solutions in efforts to avoid stigma surrounding existing assistive devices, instead opting to use and struggle with standard cutlery (Bispo & Branco, 2008). Without seeing the benefits from using cutlery designed to assist in daily eating routines, levels of adherence in the rehabilitation often become lower to the point where rehabilitation can cease, and the patient will rely on their unaffected hand to carry out every day activites. (Carr & Shepherd, 2011) This project aims to provide patients with a personalised set of cutlery, making them feel confident and comfortable using cutlery in situations outside of their homes, as well as assisting as a therapy device.

Chapter 1

Background Research

Literature Review

The world's technological advancements in the past quarter-century have accelerated exponentially. Therefore it would be logical to assume that the discoveries made in other industries would naturally trickle their way through into other areas of research. This factor is the case in most instances. However, after researching fields related to healthcare, disability and more specifically the rehabilitation process, it has become clear that this is an industry overlooked by designers, as it is often too challenging or undesirable to design within this market.

With an abundance of knowledge on the field, from years of research, only a few useful products have escaped from the stage where the product has the hospital aesthetic and is surrounded in stigma. What has been implemented by therapists is either crude, one-time use, cardboard mock-ups or costly, unobtainable machines which take more than just the patient to use independently.

This review investigates the potential that a thorough design exploration could have in aiding the rehabilitation of stroke patients suffering upper body dexterity dysfunctionality. Considering themes and areas such as; current and proven cutlery solutions, the kinesthetic criteria of the human upper body, the importance of patient progression and motivation, mass customisation and personalisation in product design and finally the stigma surrounding design for disability.

These areas are especially important to consider because they will provide a thorough understanding of where this research will position itself amongst previous works.

This topic is important because there are no current established consumer sets or personalised tools to aid in the long-term progressive rehabilitation of a stroke patient. There is potential for an innovative design exploration into this field, to this point, dominated by researchers and academics. This research field will benefit from desirable practical design solutions. Removing the stigma surrounding design for disability and giving the patient control of choice back into their lives, bringing something new and desirable to the table in an undesirable situation.

Stroke

A stroke occurs when there is a blockage of blood flow or rupture of an artery to the brain. This results in the sudden death of brain cells due to lack of oxygen. Symptoms can include sudden loss of speech and weakness or paralysis of one side of the body. Stroke is a common problem, with an estimated overall incidence of first-time stroke sufferers of 2.4 per 1000 (McLaren & Perry, 2003). Stroke produces a wide variety of physical, cognitive, emotional and social effects that may persist long beyond the acute phase or hospitalisation. The first three months after a stroke are described

as a phase of early rapid recovery. Individuals retain the ability to respond to therapy later, but significant gains have resulted before six months (McLaren & Perry, 2003). A suspected stroke may be confirmed by scanning the brain with particular tests, such as CAT scans. The earlier the diagnosis and treatment/rehabilitation starts, the better chance the patient has of making a full recovery. Immediate and appropriate medical care can dramatically reduce the death rate and level of disability resulting from strokes. Concerning stroke prevention, controlling high blood pressure and diabetes are the best ways of reducing high-risk factors which can cause the blockage of blood flow or artery rupture in the brain.

Current Solutions

There are various tools and techniques that therapists use to treat patients day to day for bilateral upper limb rehabilitation. However, at the core of each technique is the fundamental principle of using repetition to rebuild the neuron connections in the brain. Stroke rehabilitation is not so much teaching the muscles how to operate again but rebuilding the neurological connections between the brain and the muscles. In most cases the muscles are undamaged after the patient's stroke, it is the connection between the brain and the muscles that have been affected (Carr & Shepherd, 2011). The same way that athletes practise to learn new skills, patients need to repeat movements hundreds of times a day to rebuild the communication between the brain and the muscle. The way that these movements are elicited is where the variations in treatments come into play (French et al., 2016).

In the article "A Systematic Review of Bilateral Upper Limb Training Devices for Post-Stroke Rehabilitation" the authors talk about current pieces of technology used in stroke rehabilitation. Specifically, the ways that machinery can help in the categories of strength therapy, mirror therapy, and electrical stimulation therapy. The solutions listed in the article are at the extreme high end of the market spectrum. These solutions are large, costly, and intrusive. Many require more than the individual patient to operate, due to the way the apparatus is operated (van Delden, Peper, Kwakkel, & Beek, 2012). This is only viable while the patient has the clinician there 100% of the time, therefore is not practical as time with clinicians is a limited resource.

Another article "Repetitive Bilateral Arm Training with Rhythmic Auditory Cueing Improves Motor Function in Chronic Hemiparetic Stroke" explains the benefit of "do it yourself rigs", using household materials such as cardboard, books, and plastic bottles (Whitall, Waller, Silver, & Macko, 2000). It is apparent that there is a niche in between the two extremes of therapy tools. Both clearly have benefits, but neither can be taken inconspicuously out of the house or fit seamlessly into the life of a post-stroke patient.

Human Physiology

Technically, there are hundreds of biological and kinesthetic criteria that stroke patients' upper bodies need to perform to achieve various everyday tasks. These criteria are known amongst therapists as "Essential elements." For example, the essential elements in the shoulder joint are protraction, external rotation and forward flexion. In most cases, the muscles are undamaged after the patient's stroke, and only the connection between the brain and the muscles is what has been affected. An important concept specified in the research by Whitall is the idea that the hand drives the shoulder (Whitall et al., 2000). The only reason the shoulder moves is because the hand wants to interact with something in the vicinity of the person. If any of these links in the metaphoric chain are missing due to the stroke, the way we reach from our shoulder will be different (Carr & Shepherd, 2011). When designing cutlery, a consideration for the whole arm, not just the hand will be vital.

In the article "Reflections on physiotherapy and the emerging science of movement rehabilitation" Shepherd and Carr talk about the methods therapists use to identify which link of the chain is missing when assessing a patient. The theory is that the only way the patient will be able to rebuild the connections between neurons in their brains is to do it unassisted. Emphasis is placed on the importance of a hands-off approach. If the therapist manipulates the hand around an object for the patient, the brain is not required to work, and therefore there are no stimulation or neurons firing in the process. "The patient should always have an object in their hands or be reaching for something themselves." (Shepherd & Carr, 1994). This research justifies cutlery as a potential medium to adopt as a rehabilitation tool in everyday activities in the users daily routine.

Progression and Motivation

Motivation is one of the more difficult topics to talk about regarding rehabilitation. There is no question that patients want to get the full use of their upper bodies back, and many of them do, but often the commitment involved to make the therapy effective, causes physical and mental strain thus making the individual lose motivation. This factor is often caused by the seemingly impossible task ahead of them, and

the minimal progress they see if the appropriate goals and achievements are not in place (Cheng et al., 2015). A typical high-intensity rehabilitation routine should involve 300 reps in an hour of three to four different variations of the exercise (French et al., 2016). These elements are often not as tough as dealing with the stigma of the objects, with it being the most significant factor to the fall-off of a routine and active rehabilitation process.

A sense of progression and achievement is the key to keeping patients motivated and confident, which has influenced the decision to create a custom and personal cutlery set. This will ensure that the patient feels more involved and invested in their rehabilitation. They can have confidence that the product is effective and tailored to them especially, not just a "one size fits all" foam handle. For this design exploration, it will be important to remember there is less value in a single iteration of a product. The value is in the ability to develop and iterate the product into a set, giving the user aims and goals to achieve as well as levels for progression. This will let the cutlery follow and support the patient through their rehabilitation process.

Therapists have expressed concerns that they do not know how often each patient is training for a day. There is a direct correlation between practise and outcome, just the same as the way athletes train to perform better in competition. Since most therapists see value in giving patients exercises to do at home, much responsibility is on the patient to be independent. That is where real progress will consummate (Cheng et al., 2015). The patient must intrinsically feel the motivation to get better since the therapist will only be able to help for a limited time.

One of the largest targeted areas for therapists in bilateral upper limb therapy is the process of eating/drinking. Becoming independent again is a massive thing for patients and having difficulty eating is a huge problem for patients. Albert Westergren conducted a study on 162 patients admitted for stroke rehabilitation over a period of 1 year (Westergren, Karlsson, Andersson, Ohlsson, & Hallberg, 2001). Difficulties in eating were found in 80%, and 52.5% were unable to eat without assistance. 60% would only manage 3/4 of their meal, 56% had difficulty manipulating food on the plate, and 46% had trouble transporting food from the plate to their mouths. Among other factors which are not related to bilateral upper limb patients, such as difficulty swallowing, 32% were undernourished. This shows the importance of working on this skill (Westergren, Karlsson, Andersson, Ohlsson, & Hallberg, 2001).

Stigma

It is an unmistakable fact that objects hold an essential role in the construction of identity, acting as markers of a particular lifestyle. In this process of symbolic construction, to own a specific object entails a particular lifestyle. However, some objects can entail product related stigma, where owning them brings about negative connotations. The use of objects employed to aid in impairment, such as a wheelchair or a walking aid, often act as a symbol of stigma and empathise the prejudices to the people who use them (Bispo & Branco, 2008).

The solution is not to make the designed object as small as possible, transparent or skin coloured to make it invisible. Doing this often impedes the function of the device and causes the patient to feel like they should be ashamed or abnormal for their condition and that they should hide it. As designers in healthcare, we should not focus on designing for the perfect consumer. We should use current technologies and methods to provide a custom and personal experience for patients. This point is the most significant influence in this research's pursuit of a mass customised design.

Articles related to the topic of stigma go into depth in the aesthetic of design for disability. As consumers we are conscious of the image that a product will convey. This point is the reason why we are so careful when we purchase clothes, cars, or furniture for our homes - we expect that the people with whom we have relationships create an image of ourselves that is coherent to our identity. In "stigmatising" objects the same process occurs, but the person has no control whatsoever over the message these objects transmit (Bispo & Branco, 2008). The underlying theme of being "out of control" is a recurring idea throughout rehabilitation texts. Instead, this research aims to give the confidence and control of choice back to the patient in a dignifying way. The proposed personalising and customising system will achieve this.

Being independent is a huge factor in patient persistence in therapy. People who have had a recent stroke are more likely to maintain their ability to carry out daily activities if they receive therapy at home. Therapy-based rehabilitation services for stroke survivors can include input from physiotherapists, occupational therapists or multidisciplinary teams. This review conducted by John Wiley of 14 studies, involving 1617 participants, found that people who had a recent stroke were more independent in personal activities of daily living and more likely to maintain these abilities if they received therapy services at

home (Outpatient Service Trialists, 2003). This point has influenced the decision to have the cutlery set viable as both an eating tool and also a part in the patient's rehabilitation and day to day activities.

Customisation and personalisation

Mass customisation allows customers to actively participate in the design and outcome of products they will eventually purchase. There's a point for most products where the customer will always choose a custom version of a product from a standard version of the same product, if the price, quality and delivery times are right (Piller & Müller, 2004).

Consumers want to show their unique personalities in everything from products in their home to the clothes they are wearing. A few years ago, customised products in mass were not feasible, but the supply chain technology that we have today helps create a more effective process for companies to work with their customers to co-design the end product (de Bellis, Sprott, Herrmann, Bierhoff, & Rohmann, 2016).

Customisation usually requires a designer to be involved and that process is usually specific to the product. This point is part of the reason Amazon does not offer customisation as it goes against their mass selling business model. Companies that are looking to adopt mass customisation processes need to consider the following: how to scale the manufacturing process to produce low prices, how to limit features available to allow single source processes for production, and how to design an intuitive, creative process for the user to interface with (Fiore, 2008).

The ability to work one-on-one with the customer to turn their idea into reality is a massive opportunity for businesses to secure customer loyalty. The consumer needs to know they have the option to be in control (B. Joseph Pine, 1993).

This research has found that there is a trend of uncompleted and poorly designed products in the healthcare marketplace. There is a need for designs that genuinely think about the patient and how they feel during the process, as opposed to just thinking of getting the rehabilitation out of the way as fast, and cheaply as possible. Consumers are becoming tired of simple mass manufactured products due to the exposure we have to the online marketplace. This new development has given the design power to the consumers, allowing them to customise and personalise products within a template.

After researching and discussing the themes of current and proven cutlery solutions, the kinesthetic criteria of the human upper body, the importance of patient progression and motivation, mass customisation and personalisation in product design and the stigma surrounding design for disability, this research has discovered there are no options for custom rehabilitation tools in the market - let alone eating utensils. The eating/drinking disorders have been identified as one of the most significant areas for therapists to target. In bilateral upper limb therapy, there is vast potential for an innovative design exploration into this field. Literature has shown the benefit of having a customisable, parametric system for patients. The system will define and address the physiological criteria, which is necessary for the kinesthetic function of the upper limbs in the eating process.

The healthcare industry will benefit from a desirable practical design solution which helps remove the stigma surrounding design in rehabilitation, individualising consumer cutlery to aid in the long-term, progressive rehabilitation of a stroke patient. These elements will act as the criteria when evaluating current solutions and precedents.

Criteria

Based on Literature

Theme affecting success of the assistive device	*Why is this important?*	*How can this theme be addressed?*
Progression and Achievment	One of the keys to keeping patients motivated and confident.	Develop and iterate the product into a set, giving the user aims and goals to achieve as well as levels for progression.
Personalisation and customisation	They can have confidence that the product is effective and tailored to them especially.	Create a design individual to the patient, or one that can be customised to fit their individual needs as a consumer and as a patient.
Stigma	There is a trend of uncompleted and poorly designed products in the healthcare marketplace.	Create designs that genuinely think about the patient and how they feel during the process.

Above: Table Fig 1 shows the criteria created from the literature findings

Precedent Review

Current market solutions for eating utensils address a wide range of physiological factors, with varying levels of effectiveness. From adding straps to fix the utensil to the hand, to larger ergonomic grips and bendable adaptive cutlery, there are plenty of existing solutions in the marketplace. Immediate themes that are common throughout existing solutions include: the stigmatising aesthetic common with healthcare products; the problem that the eating aids will only address one factor or be specific to one problem caused by the condition (meaning that consumers may need to invest in multiple different products to experience effective relief); there are no current solutions specific for stroke patients (meaning that there is no differentiation between left handedness or right handedness, or if the left side of the body or the right side is affected); current solutions don't promote rehabilitation or try to improve on consumer's current situation; current solutions give the impression that the product will be what the patient needs to rely on and there is no further model to work towards. With that being said, many of these products are successful in the market and do help people perform eating tasks in their day to day lives.

To review current solutions designed to improve upon standard cutlery sets, we must first review and evaluate the standard cutlery itself. This is important because identifying the strengths and weaknesses of normal cutlery can help identify the level of successfulness of current disability products by providing a control for the experiment. The LIANYU 20-Piece Stainless Steel Flatware Silverware Set will be the control set representing the "standard cutlery" subset. The standard set was chosen due to: its average price point in the cutlery market (NZD 27 on Amazon), it's simple aesthetic, shape and appearance which would fit any style of kitchen tableware.

The design of a standard set of cutlery is to fit the hands of as many people as possible. The set itself does one job and does it well for somebody with competent levels of dexterity, with as little extra design as possible. Stainless steel is the most common material used in standard cutlery due to its high quality, resistance to rust, food safety level and durability to scratches and bending while being dishwasher safe. The handle of the LIANYU, set much like all standard cutlery, is broader at the

Above: Fig 2 shows the LIANYU 20-Piece Stainless Steel Flatware Silverware Set, which was evaluated in the precedent review.

base to reduce pressure on the palm when pushing into and cutting different foods and increase the ease of holding it by stopping the cutlery from falling out of the hand when held by the fourth and fifth finger. The handle tapers in towards the eating end which is where the thumb, index and middle finger hold the cutlery for the most control. The centre of gravity is also commonly balanced in this area in the middle of the utensil to aid in the control of the cutlery.

People with issues involving neurological disorders which cause dexterity breakdowns such as a stroke, head injury, severe arthritis, wrist fractures, shoulder dysfunction or cerebral palsy can find standard cutlery challenging to use for a number of reasons. Standard cutlery is often too thin and light for somebody who has problems manipulating their fingers to wrap their hands around and hold. This includes issues with picking up, holding, and manipulating the cutlery to establish a proper grip and correct finger positions without assistance from the other hand or another person. Standard cutlery is also overall straight in shape which can hinder somebody with restricted movement in their shoulder, elbow or wrist to reach the plate. Using a standard knife and fork at the same time is often too difficult for stroke patients specifically due to the concentration required to operate both concurrently. Specific to the fork, standard cutlery can also be difficult in aiding the transportation from the plate to the mouth, this due to the tines or prongs being flat and often not very wide. People that experience spastic muscle symptoms such as shaking, waving or general instability will find that dry or hard foods they have balanced instead of stabbed on the tines will fall off while transporting the food.

Overall, standard cutlery is perfect at doing its job for a user who does not require special considerations for an eating utensil. Generally, standard cutlery sets do not have enough surface area and mass in required areas and therefore do not cater to everybody with special needs.

How have industry professionals, clinicians and engineers already gone about solving these issues to improve the lives in designing assistive and adaptive eating utensils?

Above: Fig 3 shows the *Transition Cutlery set By Mickael Boulay*.

Product A
Transition Cutlery By Mickael Boulay

This set of cutlery designed by Mickael Boulay identifies that there is a transition period involved in the rehabilitation process. This is a project and experiment and not a current manufactured set available for consumers. Boulay addresses the transition period by creating a series of evolving forms - one respective set for a knife, a fork and a spoon. The set starts off being purely functional and blunter than the everyday utensils we are familiar with, designed to simply push food around, hold it down or cut it.
Boulay asked:

"Can we grow the motricity of a disabled hand step by step?"

The occupational therapist who worked closely within the project provided the insight, saying it would be great to be able to get the hand to change from a club fisted grip to something that resembles a refined pencil grip. She then asked Boulay if there was a way you could teach the person to change the way they hold the utensils with a refined grip. She also said that if it is for hemiplegia, it will be more of a challenge. Hemiplegia is the paralysis of one side of the body, similar to that of a stroke patient's symptoms.
Since this cutlery was not designed for stroke patients specifically, it did not directly focus on a neurological reason for a break down in the performance of the hand - and that one side of the body will be affected. Instead, it focussed on the muscle's strength and performance. Using steps means that the muscles are growing and learning together in parallel.

Above: Fig 4 shows the *Kinsman Enterprises K Eatlery Weighted Dinnerware*

Product B
Kinsman Enterprises K Eatlery Weighted Dinnerware $41

Weighted cutlery aims to reduce the struggle with waving or hand tremors common in people with Parkinson's, multiple sclerosis or those who have experienced a stroke. Tremors are an issue in eating since food will fall from the utensil while being transported, the utensils can hit the plate or teeth if not stable which can be a reason why patients choose not to eat with their affected side in public. The weighted cutlery essentially has higher inertia which means it requires more force to move from a stationary position. What this brings to cutlery is the ability to dampen the tremors of the hand to help improve control and stability when eating. The weight can also be a preference for patients who have problems with sensitivity.

With the extra weight establishing more of a presence than standard cutlery, it can be easier to feel and locate the heavier set in the hand. This can aid in establishing a better hold on the utensil and reduce the occurrence of letting go of or dropping the cutlery.

The Kinsman cutlery set has the benefit above all other reviewed products due to it looking like a normal set. This is important for people who are looking to take a set out to a cafe or restaurant to eat with and not draw too much attention to it or themselves. Other than weighing over 200g each compared to the standard 25 grams of a normal set, the Kinsman Weighted cutlery has a large ergonomic handle which is a common theme amongst other assistive devices.

Above: Fig 5 shows the *Good grips Adaptive Utensils*

Product C
Good grips Adaptive Utensils $30 - $50

This style of the assistive utensil is one of the most popular amongst therapists and patients. The factor which puts this particular style of device above a lot of other products is its versatility and ability to cater to a lot of different people.

Models vary between manufacturer but share common characteristics of a thick, black, textured, rubber handle for better grip, and a bendable section to be able to change the form and angle of the steel end. The knife is designed to what is referred to as a "Rocker" style, which is the presence of the half moon or crescent shape to the blade. This allows for the cutting edge to be effective at multiple different angles depending on how the patient feels most comfortable using it. A rocking motion can be used to cut food, which can be more accessible for people with limited arm movement as opposed to a back and forth sawing motion, which requires more upper body strength to perform. A back and forth sawing motion also requires the food item to be held down more securely to counteract the force of the cutting and keep the food still. A rocking motion will apply the force straight down into the food and therefore cause the food to want to slip around the plate less and be easier to control for the patient. This makes eating with both a knife and a fork simultaneously easier for somebody who is effected on just one side and can even enable somebody to cut with just one hand if necessary.

The handle is weighted to 170g in the built-up handle to keep the user's hands steady when eating. Instead of buying multiple devices, such as one with a large handle, one which is weighted and one which is at a right angle, the patient can instead invest in one which does all these things.
The twist built into the metal shaft of the spoons and fork allows it to be bent to the left or right. This allows the user to customise the angle to their specific needs and helps make the transportation to the mouth more accessible. Having the ability to be moulded and personalised to the patient, can benefit the user.

Above: Fig 6 shows the *Adaptive Eating Utensils by CFOX*

Product D
Adaptive Eating Utensils by CFOX $35

These adaptive eating utensils by CFOX are designed with the process of picking up and putting down the cutlery in mind. The handle is self-standing and holds the cutlery steady, up off the table, making them easier to pick up and use than regular silverware.

The negative space under the utensil provides space for the fingers to establish a grip while being able to use the table for support. This can benefit the stroke patient since they often need to pick up required cutlery with their unaffected hand and transfer it into their affected hand. This is seen as poor practice and can result in the patient becoming reliant on the unaffected side too heavily causing the affected side to deteriorate faster.

The black rubber handle follows the trend set by other products in the marketplace and can inconspicuously blend into most table and kitchen settings.

Above: Fig 7 shows the *Sammons Preston Universal Cuff Utensil and Pen Holder*

Product E
Sammons Preston Universal Cuff Utensil and Pen Holder $15

This product focuses on securing the utensil in the hand while trying to make it as easy as possible for anybody with upper limb limitations to hold onto something and, in this case, eat. The product itself is just an aiding accessory for a standard utensil and can accommodate anything long and thin in the pouch, although it is most commonly suited for eating or writing.

Made of cotton, the Universal Cuff fits around the top of the hand and includes a pocket, sewn shut at one end, which holds the handle or shaft of the utensil.

The product is said to be easy to put on and take off by the adjustable velcro D-ring strap, which fits palms measuring 7" to 8" in circumference.

Products such as these are designed for patients with moderate to severe impairments, and would be suitable for somebody who: has difficulty making a fist to grip objects; has decreased sensitivity in the hand causing them to not be able to locate the utensil in their hand; or somebody who experiences tremors or spasticity which can lead to frequent dropping and letting go of the utensil. Patients with mild to moderate impairments would find a device such as this restricting and unnecessary.

Above: Fig 8 shows the *Right-Angle Pockets Utensil Positioning Holder*

Product F
Right-Angle Pockets Utensil Positioning Holder

This utensil accessory is similar to Product E (Norco Universal Cuff Utensil and Pen Holder) but instead focuses on positioning the cutlery at an angle more suited to eating. These lightweight utensils with longer handles are ideal for people with limited range of motion.

The utensil pocket positions utensils at a right angle to the palm to help bridge the gap between the plate and the hand, requiring less rotation of the wrist to reach the plate and mouth. A device such as this is helpful at both ends of the process of eating, meaning that it brings the fork closer to both the plate when picking up food and the mouth when eating.

The right-angle of the sheath demonstrates the appropriate position to hold the fork and supports good habits when using the tool as a rehabilitative device. Similar to product E this device is designed for people with more severe needs where much support is needed to perform fundamental eating tasks.

Overall this device is typical of the design and aesthetic of "Medical devices" and is often seen as undesirable but necessary for most users of this product. Regarding functionality, assessed against the defined criteria for a successful device, this product performs well functionally with elements such as the security in the hand, comfort in the palm and angle of the utensil contributing to its performance.

Chapter 2

Methodology

Situating the Research

Research Question:

How can a parametric system hyper personalise cutlery for addressing individual physiological and aesthetic needs of stroke patients with mild upper limb hemiparesis?

This research aims to provide a desirable and functional set of cutlery based on previous research and precedents in the field and marketplace. Literature identified the potential to implement themes such as progression and achievement into the project's design process and outputs to help increase adherence and motivation levels in rehabilitation.

Themes including the reduction of stigma levels associated with the assistive device also proved to be an area for exploration according to the literature. Evaluating and reviewing current market solutions of existing assistive devices provided insight into themes and designs unique to this project - bringing to light ideas such as the benefits of customisation and personalisation in the design of a set of cutlery for individual needs of a stroke patient.

3D printing has shown its benefit to rapid prototyping applications when producing artefacts where no two are the same. Its possibilities when working alongside parametric software shows it is an appropriate process for the prototyping and manufacture of this researches output.

By normalising the aesthetic and functionality of the new design explorations, a hypothesis can be drawn determining that a patient will be more likely to be accepting of the cutlery if the aesthetic for the therapeutic device is made more functionally appropriate and desirable to the individual user. These claims for progression, personalisation and addressing stigma will be explored and evaluated in the design and testing phases.

Limitations and Constraints

Limitations of this research include the restricted materiality of 3D printed models compared to mass manufactured cutlery products consumers are used to. With prototypes in the early testing phases being made from TPU or PLA plastics, they will lack characteristics such as weight and texture, therefore not being able to replicate the final piece once it is produced in stainless steel. As producing pieces in 100% stainless steel using Binder Jetting 3D printing methods are far more expensive and can take months to be manufactured at a time due to offshore production, this would be difficult to manage while using an iterative design exploration method in the allocated time.

Aims	*Objectives*	*Methods*
Identify and define criteria or variables that can be individualised in the design of a cutlery set for stroke patients, based on their physiological abilities.	Define criteria and variables of what the proposed cutlery could have. Define Physiological factors surrounding the kinematics of the human body post stroke, and how I will address them. Design cutlery to address these criteria and factors.	*Literature & Precedent review based on a full analysis of current cutlery. (Cresswell, 2013, pp. 27-47, Martin & Hanington, 2012, p. 112)* *Semi structured interviews with clinicians (Kuniavsky, 2003; Martin & Hanington, 2012, p. 140),* *Deductive thematic analysis (Boyatzis, 1998)*
Develop a parametric system which produces individualised 3D models of cutlery	Design a parametric system and method for identifying the right set for the patient, based on the criteria. Resulting physical parametric designs	*Research through design based on criteria. (Rodríguez Ramírez, 2017)* *Data Analysis (Bevington., Robinson, Blair, Mallinckrodt, & McKay, 1993)*
Iteratively design and develop a final prototype which is guided by the established design criteria. This final prototype will address the issues of stigma and progression.	Address and design for issues surrounding stigma and how they might be addressed. Address and design for issues surrounding progression and how they might be addressed. I will critically evaluate the developed prototype. Designs will be iterated and refined based on findings.	*Semi-structured interviews (Kuniavsky, 2003; Martin & Hanington, 2012, p. 140),* *Observations (Boyatzis, 1998)* *Research through design based on criteria. (Rodríguez Ramírez, 2017)*

Above: Table Fig 2 shows the aims and objectives for the methods used in this research

Aims and Objectives

1_ Define design criteria for a system to personalise cutlery for stroke patients. Literature review; competitor analysis; and semi-structured interviews with clinicians and patients.

For the initial collection of data, insight and background research the methodologies appropriate to this study, involve reviews of both literature and current market competition as a means to situate and justify the projects design direction and position amongst past products and studies. There will be semi-structured interviews with occupational therapists as well as an interview with a stroke patient. These will take place between the background research stage and before user testing. These methods were chosen as a means to gain perspective into the project and improve understanding beyond what literature can provide. The insight gained in these sessions will provide a base for the criteria to be defined and variables for the system to be designed for, influencing the designs in phase 2 of the research exploration.

2_ Iterative design based on criteria. Usability testing, Thinking Out Loud, and semi-structured interviews. Thematic analysis techniques will be conducted to validate the usability of designs based on the criteria.

User testing sessions have been identified as the most effective method to test the effectiveness of prototypes throughout the design and research exploration stages of this study. User testing sessions are an effective way to gather a lot of qualitative research data quickly. The user testing sessions will involve people who have experienced a stroke using a variety of different designs of cutlery and will be observed through a semi-structured physical testing session format as a means to keep sessions consistent and comparable for a thematic analysis evaluation. Thematic analysis is appropriate to identify insight from sessions by tracking themes and trends which surface in the sessions that then we can use to incorporate in the design.

3_ Research through design

The core method for this research is research through design based on design criteria. Using an iterative design structure which utilises techniques and skills at a designer's disposal, a final prototype will be achieved using sketching, ideation, physical modelling, digital modelling, computer-aided design (CAD) and rapid prototyping manufacturing processes (CAM) such as: Fused Deposition Modeling (FDM); Direct Metal Printing (DMP); and Binder Jetting 3D printing methods.

Using the Rodríguez Ramírez model for research through design based on Design criteria (Rodríguez Ramírez, 2017), the creative process explored in the design phases of this research will be guided by the systematic construction of criteria at certain stages. This specific model has been chosen for this research due to its systematic method of producing definitive knowledge without compromising the designer's freedom of expression. Other research through design models such as Zimmerman's method for interaction in research through design, can restrict the creative process to produce explicit findings out of creative design exploration. The Rodríguez Ramírez model for research through design based on Design criteria helps make drawing conclusions and reflecting on the design chapters easier by focusing on specific factors and isolating certain variables to determine findings.

Chapter 3

Design Research Phase 1

Above: Fig 9 shows the interviewee demonstrating his standard grip and prefered cutlery to use.

Interview with Stroke Patient

A semi-structured interview was conducted with an eighty-two-year-old male stroke patient. Recruited for this study through a past study he participated in, also conducted within the Smart Interactions stream at the Victoria University School of Design. The interview was conducted in the patient's home and lasted an hour.
To begin the interview the patient was asked to walk us through an average day for him, what he struggles with, ways he overcomes these obstacles and what he wishes was easier.
From here follow up questions were asked, detailing his experience with the rehabilitation, for example, the expectations he was told to have and what to expect.

Findings from session
It had been eleven years since his stroke which affected the left side of his body. Luckily he is right handed. He spent six to seven weeks in hospital learning to walk again. He is considered to be moderately to severely impaired as a result of his stroke and hemiparesis. He relies on his motorised wheelchair to manoeuvre` and can't walk on his own. He has little to no movement or control of his affected hand as it has deteriorated over time.
He has a great deal of strength in his affected hand but "it just doesn't work."
The patient was not given anything to aid in eating, only a wheelchair, ramps and a splint for his leg. He meets with a stroke group once a month and says that

"the only thing stroke patients have in common, is that they have had a stroke. They adapt to their life differently and have different outlooks and attitudes towards life."

The exercises given to him were directed at the whole body, and nothing was explicitly to do with hands or wrists, as there was a focus on becoming mobile.
When eating out at a restaurant he uses cutlery provided by the restaurant and then normal cutlery in the comfort of his own home. He avoids meals that require two hands to eat with, due to his caregiver having to cut up his meat for him. Therefore, he chooses foods he can eat with a fork mainly, avoiding the knife.

Some insight he provided was how he has great difficulty eating a salad. "You can poke around in a salad and get half a leaf. Tongs were suggested as a good solution to helping him eat his salad. "Obviously, you do not want to go into a restaurant with a pair of tongs. However, something that looks like cutlery."

Even with his carer he still doesn't feel physiologically comfortable as he has lost his independence. He had some custom shopping bags made for him to fit his wheelchair. He uses them more because they were made especially for him. He feels

"more of a connection to them and more appreciation because they are mine."

User Testing Session one

The procedural method used to guide the structure for the user testing sessions was a cognitive walkthrough. This was chosen as an effective means to format the user testing sessions as it allowed the users to perform a series of tasks while answering questions on the topics of practicality, functionality, and aesthetic. The tasks asked for the user to perform by the examiner revolved around the picking up and using of the various cutleries chosen to be tested. In total three sets were tested.

Recruitment
Patients were recruited through neurologic physiotherapist Dr Nada Signal from Auckland University of Technology. The inclusion criteria for this study were the experience of a stroke at least six months prior to the interview, living at home, an active wrist and finger, the ability to walk independently, age of 40-75 years, and good general health. Exclusion criteria were signs of severely impaired verbal communication, inability to give consent, severe neurocognitive deficits, excessive pain in any joint of the paretic arm, terminal illness, or life-threatening comorbidities.
Four patients were recruited for this study in total and were used on two different occasions, once for phase 1, and again in phase 2.

Above: Fig 10 shows the way the testing sessions artifacts were organised for the participant. Set 2 is pictured here.

Testing session protocol

The goals for the sessions were to:
_To investigate how stroke patients interact with cutlery.

_To define what variables of cutlery design may help stroke patients use cutlery with their affected side.

_To investigate what elements of the cutlery sets were successful and which were unsuccessful.

_To investigate whether the products communicate their intent clearly, specifically how the ring in set two is attached and used. Will the patient know how to attach the accessory? Will they know their index finger goes in it?

Tasks the patients were asked to perform were:
_Picking up cutlery

_Manipulating cutlery into holding/ eating position

_Manipulating/cutting food on the plate
_Transporting food from plate to mouth

_Eating

_Positioning cutlery back onto the table

Questions asked during the test were:
_Before interacting with each set:

_what do you think these are for?

_What's going through your mind as you look at these cutleries, and explain what you think about them initially?

_How do you feel with this cutlery? Was it better or worse than the previous set?

_Could you please demonstrate how you would pick up these items?

_Could you please demonstrate how you would cut food with these items?

_Could you please demonstrate how you would bring the food from the plate to your mouth with these items?

_Now that you have had a chance to use the cutlery, what are your thoughts and how have they changed. Which did you like the most?

Set 1
This set was chosen to be the control for the testing, as a means to have something to compare the different sets against to evaluate their effectiveness. Their effectiveness was evaluated by asking the participant to comment on similarities or differences between this control set and the other two sets being tested. It was also beneficial as a means to validate the criteria developed from the background research in the literature and precedent review stages. No matter what happened with testing sets two and three, the themes and insights gained from observing a stroke patient eat with what is considered a standard set of cutlery were very helpful for future design explorations.

Above: Fig 11 shows an image of Set 1 which was used in testing session One. A standard set.

Set 2
This set is an experimental output from a design experiment similar to this project. It was chosen because it falls at the other end of the spectrum to a standard set, with its unconventional accessory, texture and patterning. Patients were aware that this set was "designed" for stroke patients specifically, so the information gained from the way it was perceived and accepted because of this fact was insightful. The set is 100% stainless steel and slightly heavier than a standard set. There is an additional "ring" attachment for the fork in this set, designed with the idea that it would keep the index finger secured to the top of the fork to practise a more desirable grip while reducing the frequency of dropping the utensil. The ring only fits with the fork and connects with a small pin in the ring which attaches underneath the fork.

Above: Fig 12 shows an image of Set 2 which was used in testing session One. A set from previous research into this topic.

Set 3
Designed specifically with the purpose to gain insight moving forwards in the next design phases of this project. Although it resembles cutlery, this set was not designed to be functional as an eating utensil. Instead, a means for the patients to communicate their thoughts and suggestions for the project physically, and in a documentable way. The testing tools were 3D printed using a flexible filament called Thermoplastic Polyurethane (TPU) and were designed to accommodate two lengths of a soft metal wire used for model making and armature. This gave the models the ability to be easily manipulated through bending and twisting, where they would then hold their new form.

Above: Fig 13 shows an image of Set 3 which was used in testing session One. An adaptive set designed to gather insight.

Bio
Male. Affected on the left side. Right-handed. Mildly impaired.

Main Findings
_Doesn't want to be seen eating differently or draw attention to himself, therefore will tuck affected side away only to use good side.
_Finds more control with having his index finger on top of the fork for the affected side.
_Has no issue with a spoon as he simply uses his unaffected side and doesn't see the need for a special spoon at all.

Above: Fig 14 shows User 1 demonstrating how he would use a standard set of cutlery with Set 1.

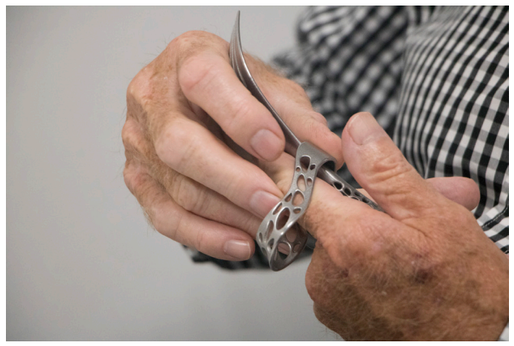
Case one

Set 1
User 1 used his right hand when picking up the knife for the first time, as he is affected on his left side. In his right hand, he opted for the standard grip with his index finger on the top of the knife. His grip on his left side of the fork resembled a closed fist grip with no extension of the index finger. This showed the reliance and habits that he has developed during his life post stroke and the way he has altered the small tasks in his life to seek comfort and to blend in. User 1 continued this trend of only using his right hand to pick things up before transferring them to his affected side unless specifically asked to demonstrate using his left. He knew that he would not be able to pick up the standard cutlery. When questioned about this he commented saying

"You don't want people to see you eating differently."

By simply using his other hand to pick things up, he can effectively blend in easier as it is something that nobody would notice. When using the spoon on the standard set, he simply used his right hand as he is right handed and unaffected on his right side.

Above: Fig 15 shows User 1 explaining an issue he experiences with Set 1 and standard cutlery.

Set 2
Trying the new set and ring attachment offered one main point of insight, and which was to suggest to User 1 that he should have his index finger on the top of the fork. Once the ring was set onto the finger, he commented on how it helped him with the cutting process and it

"didn't feel right without it,"

once it had been taken off. Other than that the second set was described as :

_Too sophisticated
_The process is not simple
_Like losing the ring would be a hassle
_Wouldn't want to use on a regular basis.
_Although the idea is interesting, it simply doesn't work for him.
_Might be useful for practise or therapy but wouldn't use in a restaurant

Above left: Fig 16 highlights the way User 1 holds a fork with his affected side. Attention on his index finger.
Above right: Fig 17 shows how the addition of the metal ring influences his index finger to reposition.
Bottom left: Fig 18 reiterates the way he holds a fork without the presence of the ring.
Bottom right: Fig 19 shows the position of his index finger where he finds the most control.


Set 3
When using the adaptive set, by simply gripping the fork tightly, it moulded to the natural curve of his hand. This natural form was replicated with all four users, as the theme of the contour fitting the hand was desirable. This is due to the cutlery hugging the palm in more than just two places like a standard set would. Larger surface area means that forces applied are more distributed on the palm, which means there will be less pressure exerted on the hand when using the cutlery.

Above left: Fig 20 shows User 1 changing the form of the adaptive Set 3.
Above right: Fig 21 shows a snapshot of the kind of form User 1 created.

Bio
Male. Affected on the right side. Right-handed. Moderately impaired.

Main findings
_Uses unaffected side for both cutting and eating
_Has to stand up to cut to enable the utensil to reach the food
_He is only interested in a knife, as he is fine with a normal fork and spoon
_The heavier cutlery with the larger grip is better, as he prefers the weight and size.

Case two

Set 1
User 2 was the opposite of User 1, in that he required a knife as opposed to a fork, and he was affected on his right side which was formerly the side he was handed. He has trigger finger which causes one of his fingers to get stuck in a bent position, and will suddenly snap between being straight or bent, like pulling a trigger. This condition was unrelated to having the stroke but is still present in his affected side. With these factors, he has trouble holding objects due to having problems with closing his hand completely. Having a limited range of motion similar to that of User 2, he had to stand up and position himself over the top of the plate to have the most control of the knife. When picking up the standard knife and fork for the first time, User 1 picks up both with his left hand and performs both the cutting with the knife and picking up the banana with the fork with his unaffected side sequentially. The grip he demonstrates with his unaffected side resembles the same grip performed by User 1 and 3. Where the index finger is extended on top of the cutlery, and the thumb secures the cutlery against the middle, ring and pinky fingers which are flexed around the handle.

Above: Fig 22 shows User 2 demonstrating how he would use a knife and fork at the same time with Set 2.

Above left: Fig 23 shows User 2 cutting with his unaffected side. Note the difference from Fig 22.
Above right: Fig 24 shows the same task instead with Set 2. Note the change in angle of wrist from Fig 23.




Set 2
This image shows how even though he is using his unaffected side, the curve of the new set fits the form of the hand more than the straight standard set. The gap between the palm and the utensil is removed, and therefore it is more comfortable for the index finger to rest along the top of the cutlery.
Although he does not require a specific fork as he is affected on his right side, he still attempts to fit the ring and test the effectiveness of the idea, but quickly loses patience as it is too fiddly. He comments on how he would never take something like this to a restaurant but would potentially use at home if it worked.

Above left: Fig 25 shows User 2 securing the Knife from Set 2 in his affected hand.
Above right: Fig 26 shows User 2 manipulating his fingers around the Knife from set 2.
Bottom left: Fig 27 shows User 2 attempting to use the ring attachment and fork from Set 2 with one hand.
Bottom right: Fig 28 shows User 2 attempting to position his index finger on top of the fork from Set 2.




Set 3
User 2 grasped the idea of the adaptive set and fixed his main problem which is bridging the gap between his hand and the plate by bending the cutlery out of his hand. This realisation eliminated the need for him to stand so far over the table to reach the food on the plate as the angle of the cutlery was doing the work for him. Bending the cutlery to the right also closed the gap between his hand and the plate as his arm tended to deviate radially and sit in a pronated position. His main thoughts on the two new sets were:

_He prefers them but not enough to justify buying them.
_He acknowledged that everybody would be different and liked the idea of the cutlery being able to be different for everybody.
_The weight of the stainless steel set was good.
_He would love to be able to use both a knife and a fork at the same time so that he could cut his own steak again. This theme was something that all four participants mentioned.

Above left: Fig 29 shows User 2 bending Set 3 to bring it closer to his mouth.
Above right: Fig 30 shows User 2 demonstrating how the change in angle of the knife helps reach the plate.
Bottom left: Fig 31 shows User 2 using the curve in the fork he made to help fix his limited wrist flexibility.
Bottom right: Fig 32 shows User 2 doing the same as Fig 32 but with the knife from Set 3.

Case three

Bio
Male. Affected on the left side. Right-handed. Moderately impaired

Main findings
_Only uses his unaffected side for everything
_Has to move the entire arm from the shoulder down to reach the plate
_Says the larger handle is more comfortable to grip
_Is only concerned with the fork as he is fine with a knife and spoon
_Wants to avoid a “ham-fist” grip, and would prefer to have a finer grip with his index finger extended but doesn’t have enough control to do so.

Set 1
Compared to User 1, User 3 had more impairments limiting the control he had of his affected side. Similar to user 1 he required most attention on the design of the fork, as he used his knife and spoon in his right hand. In a case like this, where the patient is considered to have moderate impairments, the expectation for what they can achieve will be lower. He used the example of simply holding a fork in his affected hand and how he wants to avoid a “ham-fisted” grip. Demonstrating how he would like to hold a fork with his right hand, he indicated how having his index finger on the top of the fork is how he always used to do it, and how the therapists encouraged him to. Having contracted fingers and wrist limits him from being able to open up his hand in a controlled way, and limits him from extending his index finger to try to gain more control.

Above: Fig 33 shows User 3 trying to hold the fork from Set 2

Above left: Fig 34 shows User 3 trying to establish a grip on Set 1.
Above right: Fig 35 shows how he was shown to hold a fork by his physio. Using his unaffected side.

Set 2

Trying to fit the ring onto the fork was too difficult for him, but he liked the idea of it keeping his finger on the top. His other thoughts on the second set of cutlery include:

_It is more comfortable than normal cutlery due to the size of the handle

_The knife and spoon are fine as he can use his right hand to use those

_He says the pattern is "unnecessary" and not what he is used to seeing. Looks like a "zombie spoon."

_Suggests that the cutlery should look like a regular set that normal people could use too.

"required too much concentration and physical exertion"

to keep up for an extended period of time as he needs to work hard to do simple tasks due to the limited range of motion in his arm, with his

"shoulder having to do too much of the work."

Using the bend in the fork he was able to rest his hand on the table beside the plate. From this position, the fork was able to reach over to hold down the food he was cutting. This took a lot of the physical and cognitive effort out of eating with a knife and fork simultaneously and will be an insight to explore and develop in design stage 2.

Above left: Fig 36 shows the struggle User 3 had with adding the ring to the fork with Set 2.
Above right: Fig 37 shows User 3 bracing the fork in his left hand while manipulating the ring with his right.
Bottom left: Fig 38 shows User demonstrating how he can use the back of the fork as a guide.
Bottom right: Fig 39 shows User 3 demonstrating how the curve allows him to cut the banana.

Set 3

When manipulating the adaptive set, User 3 made a similar form to that of User 1. A subtle bend to fit his hand he said would bring the form closer to the plate and closer to his mouth if he flipped it around. When using the test set as cutlery, he commented on how it was too thin and not large enough of a surface area to hold his index finger on the top.

Above left: Fig 40 shows User 3 bending the adaptive Set 3
Above right: Fig 41 shows the form User 3 created with the adaptive set.

Case four

Bio
Female. Affected on the right side. Left-handed. Mildly impaired.

Main findings
_Has ataxia and struggles with picking up cutlery in affected hand and has a problem with dropping things such as cutlery. Ataxia is an involuntary muscle movement caused by a dysfunction in the bodies nervous system, most commonly in the cerebellum which coordinates movement. In this case, where it has been a result of the stroke, it is defined as hemiataxia where it is limited to one side of the body.
_Will exclusively use left hand when eating out
_The weight of the heavier knife reduces waving and tremors
_Has a problem with food falling off the fork
_Likes the fork with the larger surface from the second set as the area on top helps keep her index finger from slipping off
_Likes the curve and rounded handle of the knife as it is more comfortable in the palm

Above: Fig 42 shows User 4 holding Set 2 in her affected hand.

Set 1
User 4 was the only patient of the four, to attempt picking up the cutlery for the first time with her affected side. Only once she had secured it in her hand, then she used her left hand to reposition it to achieve her desired grip. She immediately commented on how she uses multiple products at home to help her and is always looking for new ways to make her life easier as she is a passionate cook. She uses cutlery at home which she has found to be easier to hold. This cutlery is a similar model to product C "Good Grips Adaptive Utensils," from the precedent review chapter. Although she does not like the aesthetic, she says

"the larger grip is easier to hold in her hand, the plastic material helps her grip the utensil and the added weight in the handle helps with her tremors."

The main problem she says she has is picking up cutlery from the table. Once she has it in her hand, she mentioned that cutting things on toast is the most difficult eating task, using poached eggs as an example. She also has found she tends to drop things by mistake.
She adopts the "American way" of eating where you cut and stab separately. This is so she can hide her affected side when she is eating out.
When she is at home, she says it does not matter if she eats slowly or makes a mess because the practice of doing hard tasks is what she hopes will give her therapy and become less disabled.

Above left: Fig 43 shows User 4 using Set 1 to eat with.
Above right: Fig 44 shows User 4 cutting the banana using her unaffected side to assist controlling the utensil.




Set 2

She cannot imagine herself ever using the right but likes the idea of securing her index finger better on the back of the utensil. The stainless steel fork somewhat helps because of its larger surface area on the section where the finger rests.

She liked the weight as it reduced the waving and tremors caused by her ataxia. She liked the curve and length as it did not dig into her palm as standard cutlery did.

Above left: Fig 45 shows User 4 demonstrating how she likes the length of the knife from Set 2.
Above right: Fig 46 shows User 4 trying to rest her index finger along the top of the knife from Set 2.
Bottom left: Fig 47 shows User 4 using the fork from Set 2 without the ring.
Bottom right: Fig 48 shows User 4 using the fork from Set 2 with the ring.




Set 3

When using the adaptive set, User 4 produced the most comprehensive set of forms from her manipulation of the flexible set. She bent the knife in a similar curve to that of set 2's, which indicated her preference of that shape over something straight like the standard set. The forms she created for the spoon and the fork were nearly identical which showed how the same form could be used in two different orientations. The same “S” form can be held in the traditional fork grip with the index finger on top as well as being flipped over and held in a universal pencil grip - common in using a fork for scooping food. This insight helped cement the viability of this form moving forward in the project, as having the fork be used for scooping as well as holding down food items such as steak for cutting was going to be a challenge when designing for both scenarios. Insights like this show the value of a testing tool such as adaptive set 3 used in this research. Having a tool which patients could communicate their ideas through physically rather than verbally set up the design phases of this research successfully.

Above left: Fig 49 shows User 4 holding the spoon from the “Good Grips” set.
Above right: Fig 50 User 4 holding the knife from the “Good Grips” set.
Bottom left: Fig 51 shows User 4 modifying Set 3 to fill the roll of a scooping utensil.
Bottom right: Fig 52 shows User 4 interacting with the form she has just created.

Above: Fig 53 shows the Clinician demonstrating the ideal hand position to use Set 2.
Bottom left: Fig 54 shows the Clinician interacting with the Set 3.
Bottom right: Fig 55 shows another angle of the Clinician interacting with the Set 3.

Interview with clinician

Interviewee has specialised in physiotherapy for eight years, working with stroke patients for the past year, specifically working within muscular for patients, post surgery. She was recruited through neurological physiotherapist Dr Nada Signal from Auckland University of Technology. The interview lasted 30 minutes and involved a similar format to that used in the interviews with the stroke patients. Her opinion was asked on her thoughts about each set before, during and after picking up the three different sets.

"If you can individualise it, you can solve a lot of those problems."

She also talked about the problems patients have with sensation - where they are either very sensitive and experience soreness quickly or have dulled sensitivity where they are not aware of what they are holding, and can often forget they are holding something.
She said that it is hard to identify which side is most commonly affected as there are so many different kinds of strokes a patient can have.

Her opinion was that there is a huge value in having an individualised set,

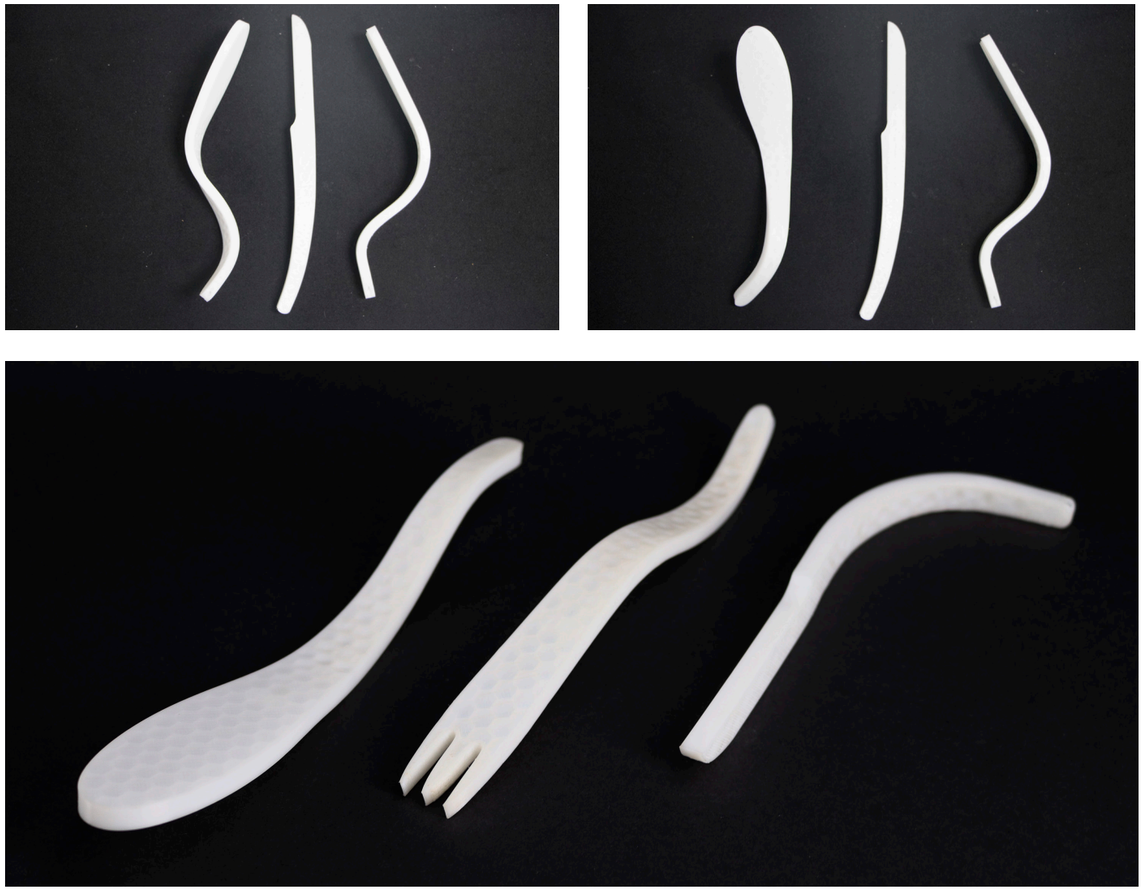
"because every stroke patient is so different, everyone is going to have different issues with their grip, their strength, which parts of their hands are affected."

"a lot of people find that since the hand has become closed, it is now really hard to open, so the grip of actually holding something is not necessarily the problem, it is more getting something into their hand that's making them uncomfortable."

She liked the idea of what the ring from set 2 was trying to do, which was keeping the index finger on top of the cutlery, but she did not agree with the method of having accessories or extra pieces to have to connect. She sees the value and the importance of keeping the finger on top of the utensil and wondered if there would be a better way to achieve that.

"It has to be customised, what fits for me isn't going to fit for you."

Design results



Above left: Fig 56, 57 and 58 all show the results of the forms created by the addaptive Set 3 from session 1.
Above right: Fig 57
Bottom: Fig 58

These forms were created as a result of the testing sessions in phase 1 and informed the designs of initial experiments. The fork and spoon were shaped in a similar way to fit the intricate contours of the hand which follows the path from the tip of the index finger to the base of the palm. The knife followed a similar form to the stainless steel knife in the second set tested - as all patients saw that as successful and comfortable design.

Insights:

"You don't want people to see you eating differently." - User 1

"the larger grip is easier to hold in her hand, the plastic material helps her grip the utensil and the added weight in the handle helps with her tremors." - User 4

"It has to be customised, what fits for me isn't going to fit for you." - Clinician

Criteria

Based on design research phase 1

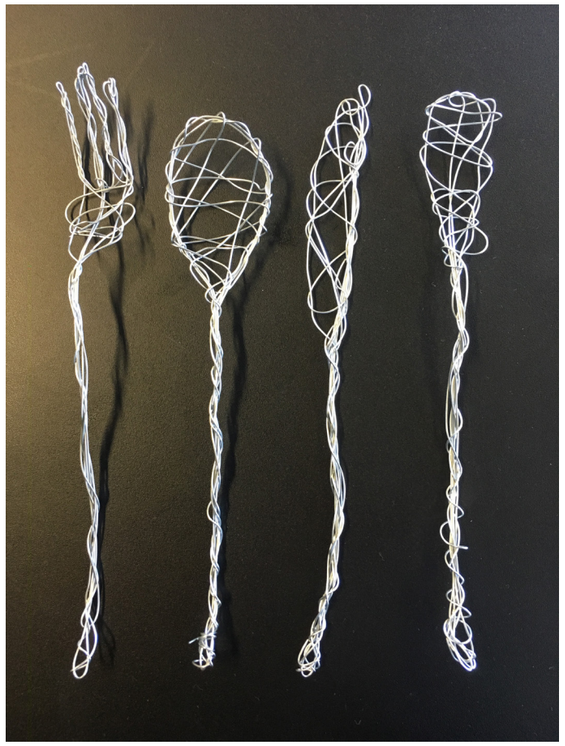
Theme	*Solution*	*Influence on system*
Lack of control	Improve hand position on the cutlery with emphasis on the index finger.	Larger area to accommodate and secure the index finger along the top of the utensil. A potential grove or indentation.
Difficulty picking up cutlery	Improved position of the way cutlery sits on the table.	An area underneath the cutlery could leave space for the patients fingers could be created by a bend in the utensil.
Hard to hold	More ergonomic shape to prevent dropping and improve grip.	Design of ridges and built up areas of mass to fit specific areas of the hands and give the fingers more to wrap around to secure against the palm. System could change the shape of the handles cross section.
Would not use in public	Cutlery should follow an attractive and standard cutlery aesthetic.	System could offer a choice of colours or materials.
Trouble with stability (waving/tremors)	Increase weight of utensil and improved established hand position.	Weight will be proportional to material and density and could both be informed by the system
Food falling off cutlery	Modified tines for better hold on food and increased weight to reduce waving.	Prongs could be modified by the system to create a concave form depending on impairment levels.
Difficulty establishing grip with one hand	Cutlery can be stable on table in its rest position in order to let user position fingers appropriately before picking up.	An area underneath the cutlery could leave space for the patients fingers could be created by a bend in the utensil.
Wrist, arm, and hand position preventing cutlery from reaching plate	Change angle and direction of bend in the neck and handle of the utensils.	The system could change the angle of the handle with the hand in both the x and y planes.
Difficulty using knife and fork concurrently	Cutlery on affected side should be secure and stable enough in the hand to minimise concentration needed to operate both.	The system could implement a left versus right identification method, where it could change the knife or fork depending on which side the user was effected.
Doesn't look normal	Cutlery should follow an attractive and standard cutlery aesthetic.	System will follow a constant curve geometric constraint to keep the aesthetic constant and clean.
Everybody has different needs	The cutlery should be customis-able.	The CAD model should be parametric and customisable.

Above: Table Fig 3 shows the criteria designed from the design research phase 1

Chapter 4

Design Research Phase 2

Conceptual Stages



Above left: Fig 59 shows physical models constructed from wire as a test to quickly produce forms.
Above right: Fig 60 shows the same wire models covered in modelling clay to add weight and detail.

The insight gained from the first design stage provided criteria and starting point for what a set of cutlery for stroke patients should look like. Using an iterative design method as an initial exploratory phase (Rodríguez Ramírez, 2017), different strategies such as sketching as well as physical modelling techniques including sculpting clay, wire and foam models, were used to rapidly produce prototypes in the early conceptual stages. This achieved an efficient system to work out which criteria had the best value. Emphasis was placed on physical modelling as early as possible, which was necessary for such an ergonomically driven research investigation.

Physical modelling techniques were used to evaluate the effectiveness of each criterion and resulting variables from the criteria. Themes such as scale, handle size, depth of finger groove, the curve of the handle and angle of the handle were some of the factors modelled for and evaluated in this stage of researching through design.

Tests

The project moved into the computer-aided design (CAD) space, to help provide the accuracy needed to provide testing models. CAD benefits this project due to its ability to work with incredible accuracy and control fine details of the digital models. A parametric modelling technique was used to facilitate the individualisation element of this research insight. It also allows the production of a high volume of iterations quickly and in a structured and measurable way through 3D printing, which will be important when making comparisons between the models logically and justifiably.

CAD Modelling

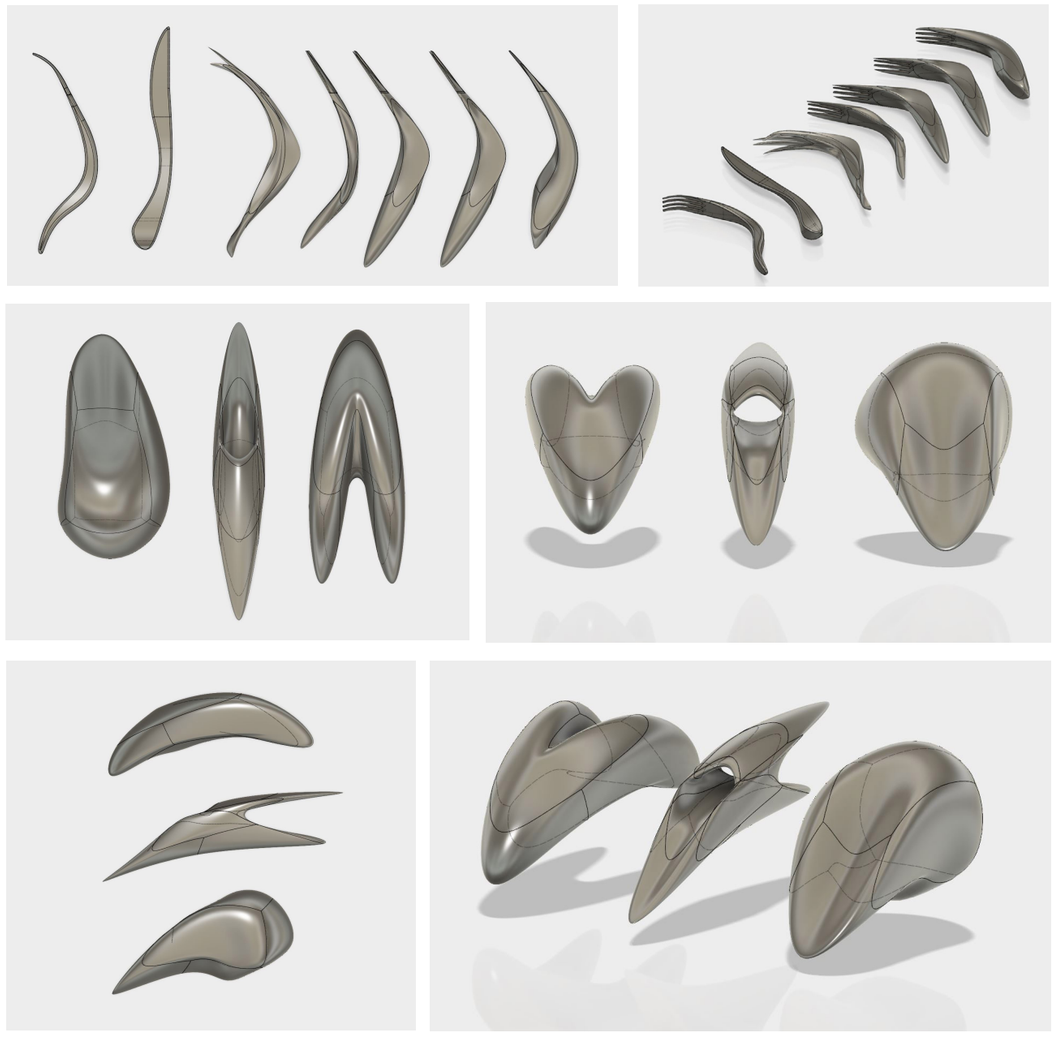
Autodesk Fusion 360 was the CAD software used foremost in this digital modelling exploration. Due to many reasons, but mainly because of its parametric capabilities and freeform modelling features. Fusion 360 also grants the ability to output 3D model files in formats suitable for rendering and 3D printing, which are both critical points to this design research.

Free-form Modelling

A method of surface modelling, free-form modelling at its core involves the process of selecting points, lines or polygons to then manipulate the mesh in a "push or pull" process. This method is incredibly beneficial to an iterative design process when producing multiple ideas quickly - although not as technically accurate as parametric modelling, since the eye of the designer is responsible for a lot of the work. Free-form modelling has the benefit of producing aesthetically pleasing, organic models which match well with the application of designing cutlery and utensils to fit the ergonomics of the human hand. Although these kinds of models can be produced in other CAD software with similar results, this specific software provides the tools and processes which allow for a more powerful, clean and quick process.

Above Left: Fig 61 and Fig 62 show a series of iteratively produced sets of 3D models as speculative cutlery.
Above Right: Fig 62

Iterative testing methods



Above: Fig 63 shows a series of iteratively developed forms which work towards a model ready to 3D print.
Below: Fig 64 shows a design exploration into ways the index finger could interact with the form.

Early stages of the iterative design process involved rapidly producing digital forms using the criteria and insights gained from testing session one as a template to design within. Rapidly producing various models helped quickly narrow down ideas to ones that would be more successful than others. The considerable amount of models produced pushed the ways that the defined criteria could be interpreted, taking it as an opportunity to experiment creatively. For example Fig 64 shows different ways the index finger could interact with the utensil.

Using the tools available, iterations of a chosen idea were quickly explored through the software and tested via 3D printing. In a product where subtle changes can make a significant difference and where the finished system will potentially produce thousands of different models, it was important to iterate to discover potential problems and potential areas of value.

Factors such as the size and shape of the prongs, the finger groove, the handle form and the eating surfaces were all tested and developed into a model which could then be developed further in the 3D printing tests.

3D printed tests

Once a design emerged from the iterative development stage, one which fitted the criteria effectively, further development into ways it could change according to the variables were explored. These models were 3D printed to help determine the success of the design. Ergonomics and feel are things that can not simply be imagined all the time. The bringing of digital models into the physical world was crucial in the development of these prototypes when working towards a final design. This process was achieved through 3D printing. This testing helped the next stage of the CAD modelling process which was creating the parametric system.

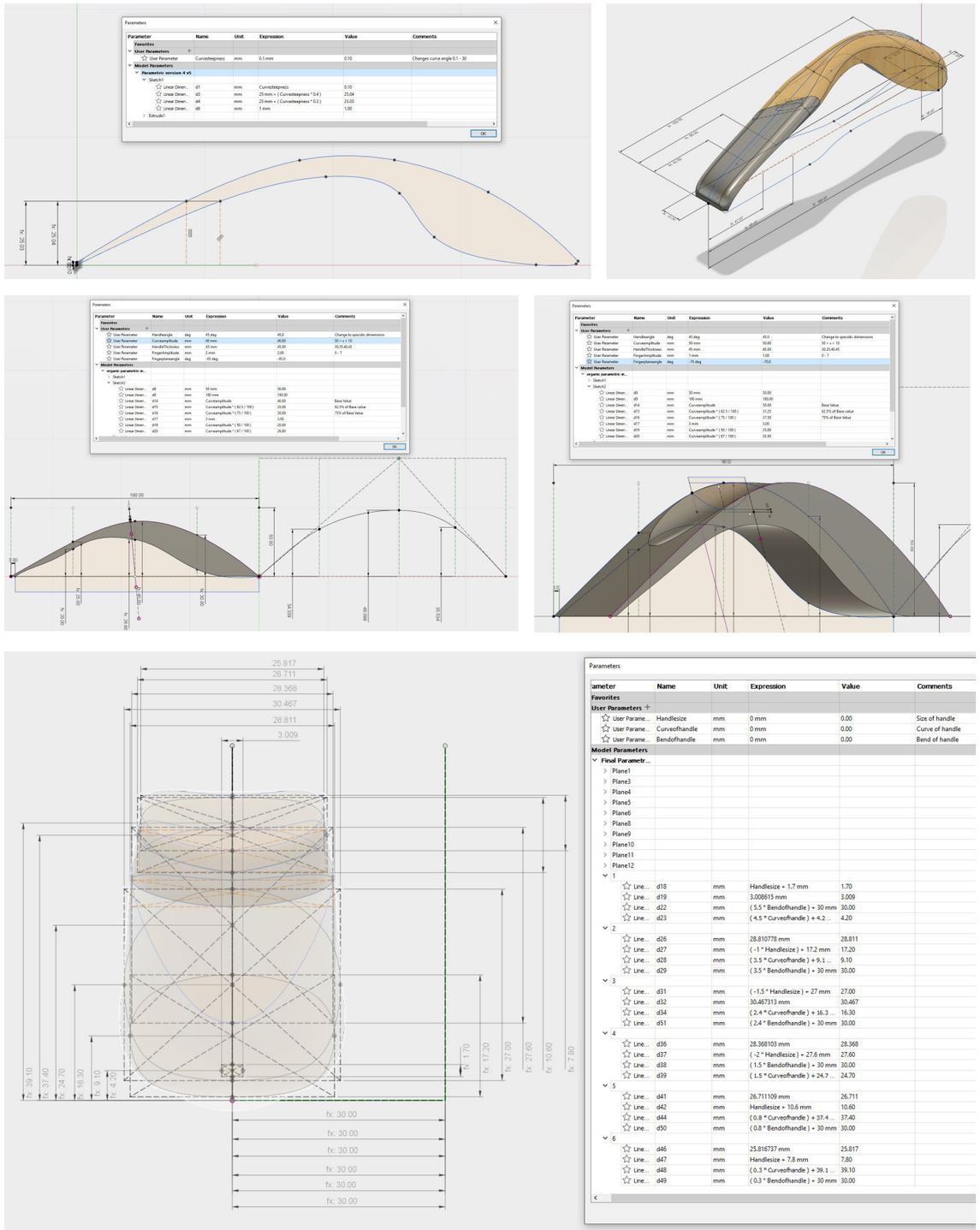
Above: Fig 65 shows a series of 3D printed models. Printed in PLA these models were used in testing session 2.

Main theme/ variable	*Why is this important for the patient?*	*What part of the research validates this?*
Lack of control due to index finger not being on top of the utensil	Being in control of the cutlery is important as it allows the patient to feel comfortable and confident using the cutlery in the presence of others.	A Physical modelling design exploration into ways the index finger could interact with the form, showed the value in having a groove to help secure the index finger. User testing session one validates this claim as patients felt more in control when the index finger was on top of the utensil
Difficulty to hold the utensil and establish a grip	Patients expressed their desire to enjoy mealtimes again and not have to always think of it as rehabilitation. Something that is easy to hold can help take some of that stress away.	The size and shape of the cutlery was one of the main issues raised in user testing session 1 and upon further physical exploration, has proved to be a valuable variable to impliment into the system. Being able to accommodate different size hands, grip strength and finger manipulation abilities.
Angle of wrist inhibits ability to each the plate	Being able to use both hands, even a small, amount means a lot for the patients. Being able to fix this issue brings them one step closer to achieving this during meals.	Models were developed to change the angle of the handle and proved valuable in bringing the utensil closer to the plate and closer to the mouth. Wrist position is one of the major limitations in the patients tested with. Therefore important to implement into the system.
Hard to pick up the cutlery	Something as small as picking up cutlery can be easily taken for granted and is something patients have become used to only using their unaffected side for. Being able to use both hands can free up a lot of opportunities and help the patient rehabilitate.	Three out of the four patients tested in session one picked up their first utensil using their unaffected side, which shows the breakdown in confidence for them to try and use their affected side. Upon further testing, being able to modify the curve has been identified as hugely beneficial as it both creates space underneath the utensil for the patient to establish a grip and creates a comfortable and natural shape to follow the ergonomics of the human hand.

Above: Table Fig 4 shows the criteria produced from the physical modelling test stage

Criteria

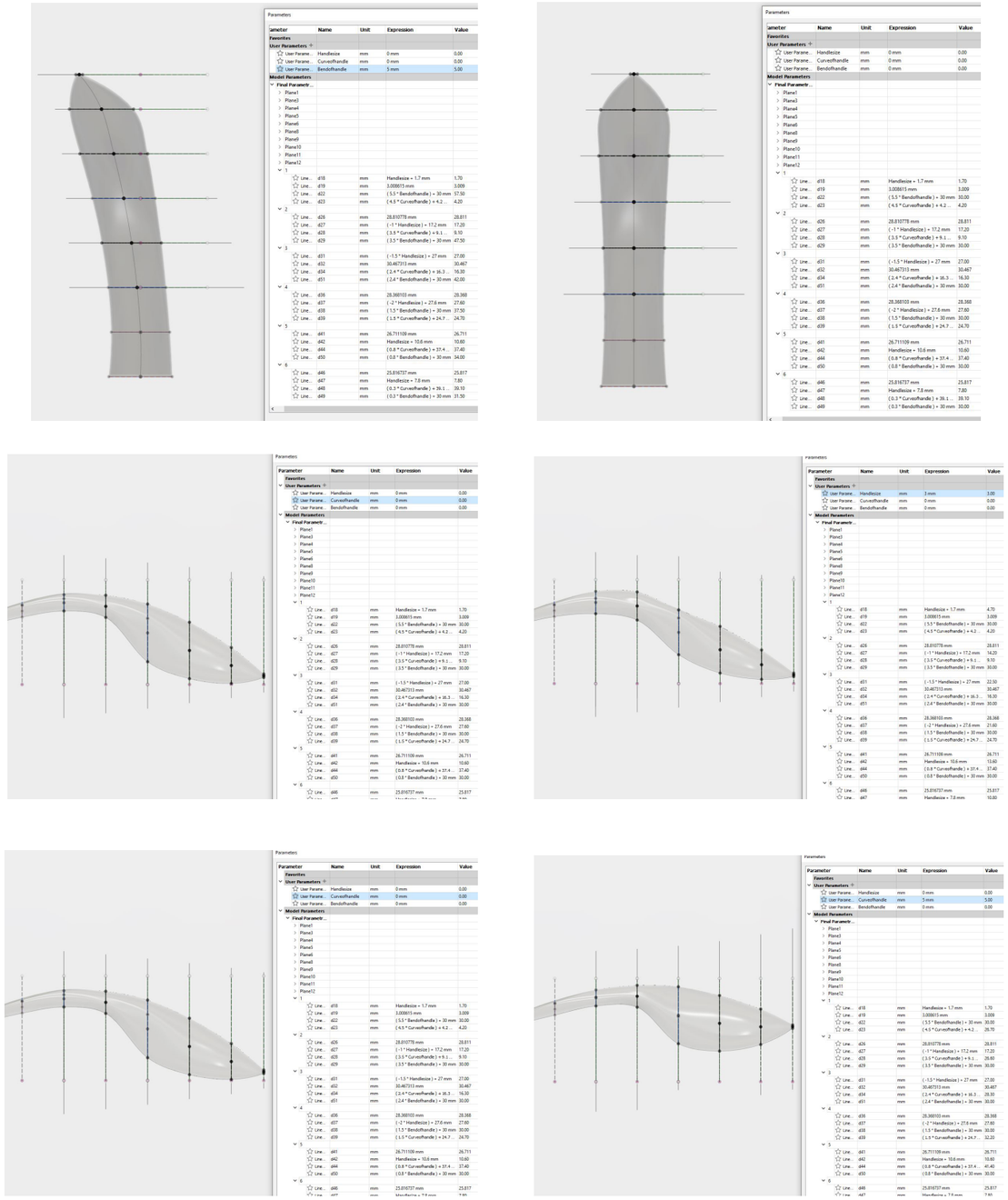
Based on physical modelling tests



Above: Fig 66 shows detail screenshots of the development of the parametric system. Different iterations were developed to test the best method for control of the variables.

Parametric Modelling

A parametric model is one which is restricted and defined by a set of values or parameters. A simple example of parametric modelling versus traditional modelling is giving a line the length of “x” instead of defining it as 30mm. From here “x” can be defined as 30 and the model will be the same except it will update every time the value of “x” is redefined. The value of this is when a designer or engineer uses the value of “x” or “y” or so on, throughout the entire model to influence various geometries, therefore updating the whole model everytime a change is made to “x”. Taking a lot more planning and setting up in the initial design stages, parametric modelling allows for easier changes in the future if design ideas change. The value “x” can also be modified to a label such as “grip size” for the organisation to be structured and easy to follow. A scale can be created using simple algebraic equations to inform these parameters, 1 - 10 for example. This process can give the model the unique ability to have certain geometries change depending on the input given by the user. For example, if the diameter of the grip is mapped on a scale of “x” = 0 > X < 10, the user will be able to choose a value for how thick they need, depending on their individual need or preference, with ten being the largest and one being the smallest. We can create a valuable interaction between the user and the model, using these parametric capabilities in creative and innovative ways. The handle of the cutlery will house most of the parameters and variables to be manipulated. The variables to be such as grip size and handle direction/ angle in both the x and y plane.



Above: Fig 67 shows the final prototype of the Parametric system working. Demonstrating how it changes the angle, grip size, and curve of the handle.

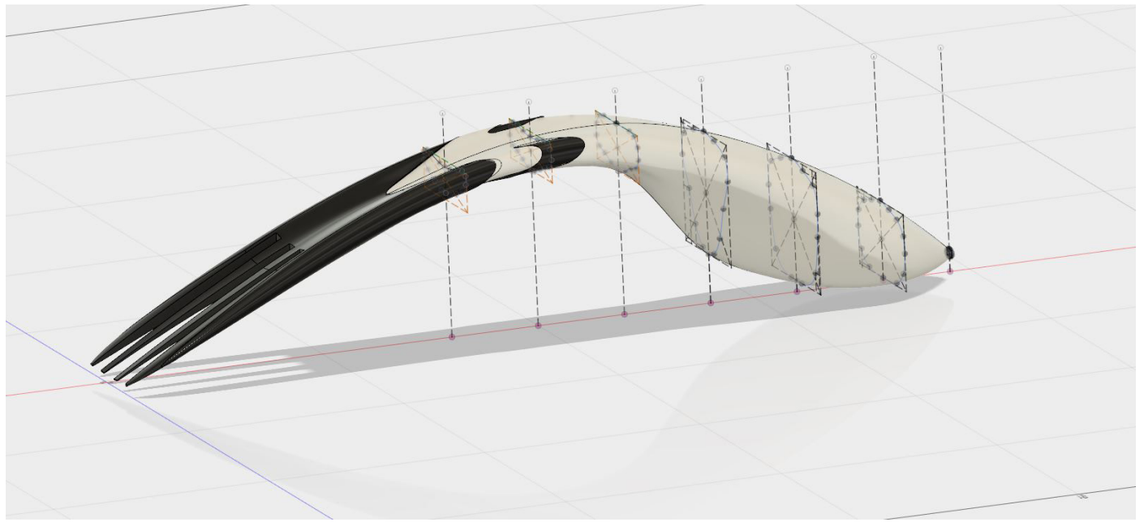
The Parametric System

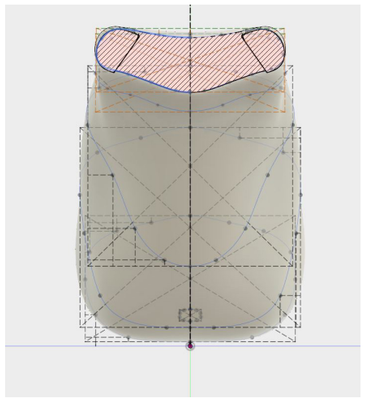
The setting of goals and aims in the rehabilitation is already an established way to help the patients. This method of design will work into that process. This research does not want to disrupt the system for treating stroke patients, instead work within the process, giving the clinician more tools at their disposal to help new patients. This is the rough process for new stroke patients, people who have already had strokes will still be able to benefit from the set by following the same process, time just won't be as much of a factor.

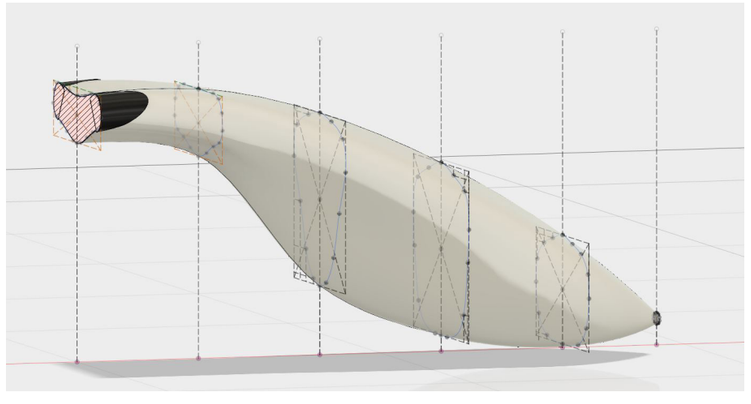
The process that I have envisaged the procedure taking from the stroke happenin is as follows:

_Stroke happens
_Patient is hospitalised to recover
_Once the initial recovery from the hospital has happened and the patients are discharged, the rehabilitation will begin hopefully asap to achieve the best results,
_The doctor or clinician will identify the physiological factors which are breaking the chain allowing the patient to eat normally,
_This can be evaluated against the set of criteria
_The cutlery can be produced by inputting the information given by the clinician into the parametric system,
_The patient will have input into the set as well, set is then 3D printed and given to the patient to begin using.

The value in control

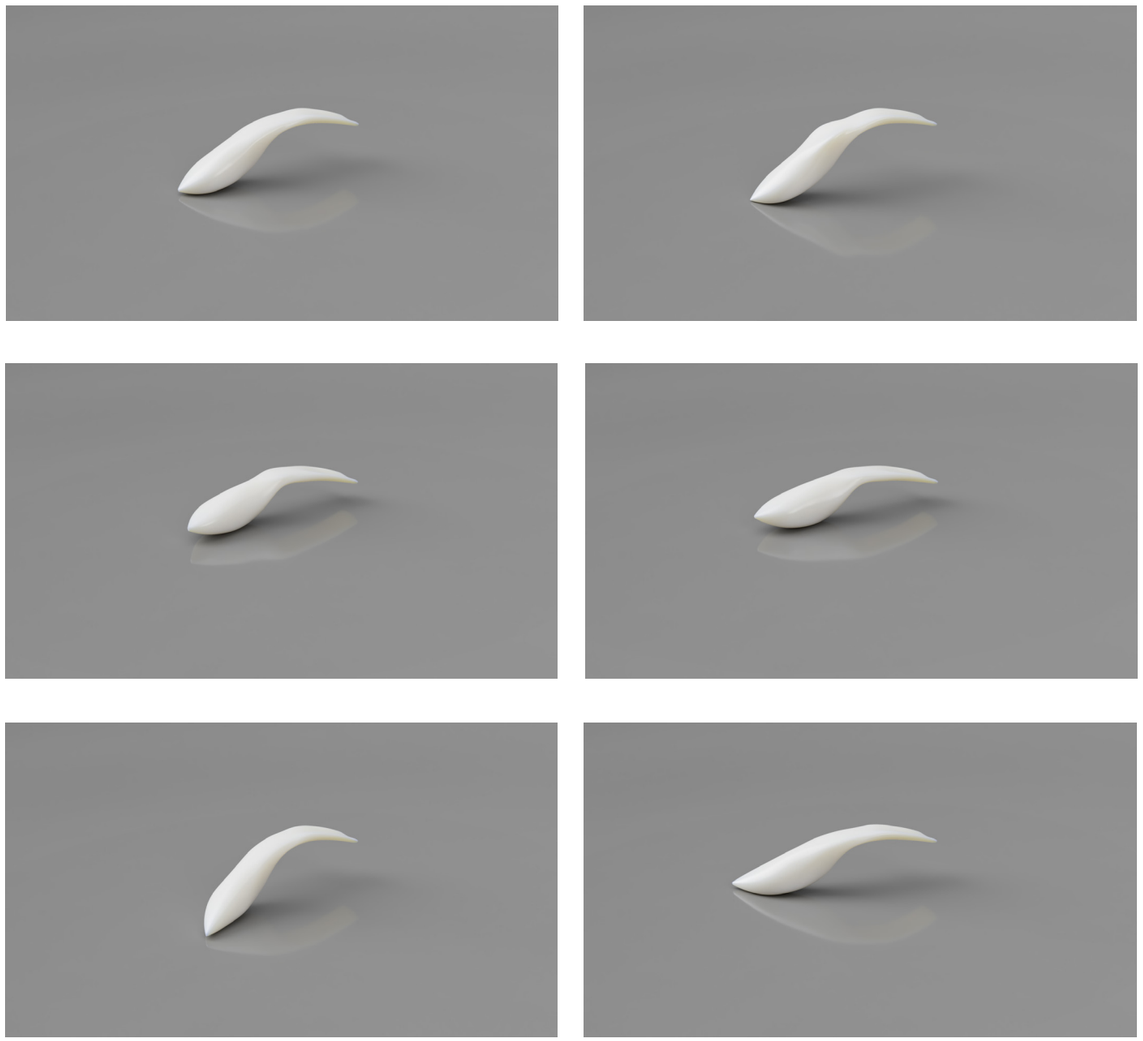






Above: Fig 68 shows the structure of the 3D system and how it allows fine control of the grips geometry.

Being able to effectively control certain variables has been identified as the key to creating a valuable system for the patients involved in this study. The slightest changes can make a huge difference for the way the utensil feels and looks in the hand as shown in the user testing session. The parametric system has been carefully put together to create a smooth and aesthetically pleasing form everytime, no matter how the variables change the outcome. Having limitations of the values and controlling the maximum and minimum boundaries for what can be input into the system has ensured that every outcome is valuable and just as individual as the patient it has been designed for.



Above: Fig 69 shows 6 of the 40,000 possible outputs of the parametric system. These forms have been varied by the manipulation of their handle size, and angle, groove depth and handle curve.

The value in options

Clinician's quote about a personalised system

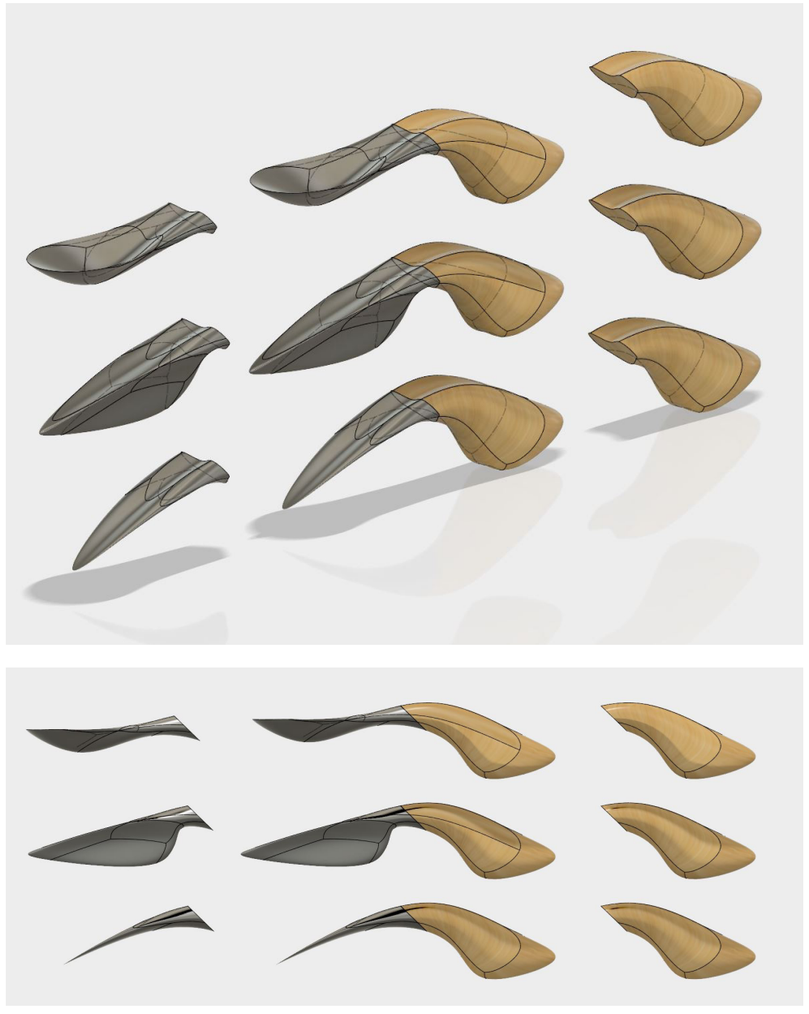
- "Because every stroke patient is so different, everyone is going to have different issues with their grip, their strength, which parts of their hands are affected."

- "It has to be customised, what fits for me isn't going to fit for you."

Stroke patient quote about his custom shopping bags for his wheelchair

- "I have more of a connection to them and more appreciation because they are mine."

Practicality



Above: Fig 70 shows a series of CAD models experimenting with split materials and practical connections.

The idea that influenced the decision to create an interchangeable handle was to make it a progression-based system. As the patient makes improvements in their rehabilitation and doesn't require the old handle anymore, they can move onto the next set, where the handle will now be updated to help them in their new stage of rehabilitation. The patients will find motivation knowing that there is a system in place for them to improve into and that they are expected to improve.

Having an interchangeable handle brings with it many design opportunities as well as a practical and cost-saving production element. Half of the cutlery can be made from stainless steel which will be the food safe eating part of the utensil, the other half will be made from Nylon Plastic which is both strong and durable. The specific material for the handle is dishwasher safe, heatproof to 163C, skin friendly and has good chemical resistance. The idea that influenced the decision to create an interchangeable handle was to make it a progression based system where the patient would start with a design that helps them in their initial state, and it may not look as elegant, but it will get the job done as best it can. This quality was investigated by Michael Boulay in his Transition Cutlery series which was Product A in the Precedent review chapter in this thesis. Boulay designed this set after identifying that there is a transition period involved in the rehabilitation process and designed a series of forms to get the hand to change from a club fisted grip to something that resembles a refined pencil grip.

What this research adds to this quality of Boulay's Transition cutlery is the idea that the patient makes improvements in their rehabilitation and doesn't require the old set anymore.hey can move onto the next set, where the handle will now be updated to help them in their new stage of rehabilitation- however the clinician sees they need change. Changing the handle will not require the whole piece to be remanufactured, as the steel half remains the same. This is due to all of the parametric workings only affecting the handle. This will keep a sense of familiarity for the patient when transitioning onto an updated set but also add manufacturing practicality to the system. Allowing the most expensive stainless steel parts to be mass manufactured, and the parametric parts to be 3D printed individually for the patient's individual needs.

The final prototype

The final set is angled to help the patient pick up the utensil from the table, while also bridging the gap from the hand to the plate and hand to the mouth. The “Bridge” between the handle and utensil is wider and shaped with a groove to influence a proper grip on the utensil by guiding the index finger. The cutlery is designed to stand on the table to allow the user to get their fingers around the form before having to lift it. The stability also helps with putting down the utensil smoothly. The final prototype is heavier than a normal set as the increased weight was shown to benefit the users during both testing session, especially participants who experienced tremors.

The parametric system which drives the internal workings of the model influences the depth of the finger groove, the size of the handle grip, the handle of the utensil left to right and the curve of the form.

From the first user testing session, the model was refined from the results of the participants’ input as shown in fig 73.

There is no spoon in the set as Users identified no need to have a specially designed one as they use their unaffected hand 100% of the time.

Above left: Fig 71 shows the final prototype of the knife in the set.
Above right: Fig 72 shows the final prototype of the fork in the set.
Bottom: Fig 73 shows the development of the design from the adaptive set, through to the final prototype.

Testing Session two

The patients were given a set of cutlery which was designed based on findings from phase 1. This set is parametrically produced to address the specific issues from the individual patients.

The same four patients were given the same standard set as a refresher and as a control to compare the new sets against. The reason for using the same four participants was to test the effectiveness of the system for designing in real-world circumstances with stroke patients. Using the same four participants helped to draw conclusions and evaluate the success of the new designs as there was a baseline to compare to due to the consistency. When creating new criteria from session 2 direct comparisons can be drawn to that produced in session 1 and valid conclusions can be made to fulfil the methodology of research through design. This is the benefit of testing within-subjects as opposed to between-subjects. It allows examination of the change of the individual's perception and interaction for the different cutlery sets between the two sessions. For example, user four struggled to pick up set 2 from session 1 but was able to pick up the sets tested in session 2. This is the comparison of value for this study. Opposed to between-subjects which compares the difference between users in the testing. It is already clear that each patient is different from the next and this is what the system is designed to accommodate.

Above: Fig 74 shows how Testing session two was organised and the models which were tested.

Testing Session protocol

The goals for the sessions were to:
_To investigate how stroke patients interact with the new cutlery.
_To define what variables of cutlery design were the most successful for the stroke patients, to help them use cutlery with their affected side.
_To investigate what elements of the cutlery sets were successful and which were unsuccessful.
_To investigate whether the products communicate their intent clearly, specifically how the design features such as the way the cutlery stands up on the table or that the groove designed for the index finger are perceived. Will the patient know how to pick up the cutlery as intended? Will they know their index finger goes in the groove?

Tasks the patients will be asked to perform are the same from session 1 and include:
_Picking up cutlery
_Manipulating cutlery into holding/ eating position
_Manipulating/cutting food on the plate
_Transporting food from plate to mouth
_Eating
_Positioning cutlery back onto the table

Questions asked during the test are the same from session 1 and consist of:

_Before interacting with each set ask what do you think these are for?
_What's going through your mind as you look at these cutleries, and have them explain what they think about them initially?
_How do you feel with this cutlery? Was it better or worse than the previous set?
_Could you please demonstrate how you would pick up these items?
_Could you please demonstrate how you would cut food with these items?
_Could you please demonstrate how you would bring the food from the plate to your mouth with these items?
_Now that you have had a chance to use the cutlery, what are your thoughts and how have they changed. Which did you like the most?

The sessions were run the same way with the subject being asked to perform basic eating tasks using a banana as a representation of food. In total there were seven 3D printed plastic models to test form, comfort and functionality based on the criteria outlined previously. Additionally, a knife and fork finished to the level where the consumer would receive the final product were also tested, to investigate the ways the subjects responded to the aesthetic and materiality of the cutlery.
Each session took 30 minutes per patient and consisted of questions and testing. Patients were asked to pick up and hold the different sets while making comments and thinking out loud throughout. Again a banana was chosen for testing consistency as well as its properties of being both firm enough to resist the stabbing and cutting of the utensils, while soft enough to require finer control to manipulate it on the plate.

Case one part two

Bio
Male. Affected on the left side. Right-handed. Mildly impaired.

When testing with the normal set and similar to the results from the first session, user 1 again held the fork in his affected hand without having his index finger extended and in control of the fork. Although he made it look easy he made comments on the restricted movement he experienced in his upper arm.
Starting with the plastic forks, user 1 picks up the fork on his affected side much easier than the standard cutlery, as it is stable on the table and he could get his thumb and index finger under it effectively. While holding it in his grip his index finger naturally finds the grove in the top of the fork and his hand and fingers resemble the grip recommended by the clinician from phase 1. When placing the fork back down on the table he uses the base of the cutlery and stands it upright, in the way it was designed to rest, and not on it's side.

_User 1 prefered the fork which tapered in towards the bottom of the grip, where it was more narrow in the palm, saying it gave him more control and "agility."
_ He comments on how the larger grip means his wrist movement isn't as free He felt more in control of the one with the largest finger grove.
_When going back to a standard fork he says there's not enough grip.

_Says even the smallest change makes such a big difference to the way it feels in his hand.
_He preferred a slightly longer handle as it allowed him to utilize more of his hand and even his fifth finger more
_Likes the grove because it gives him somewhere to put his finger. When holding standard cutlery he states "this finger (index finger) wants to take control but it can't."

The cutleries in which the angle changes left to right made no difference to user 1, which is due to the fact that he experiences no problems with contracture in the wrist or any other major restrictions. His wrist is straight so it makes sense that the cutlery should be also. With the finishes sets, User 1 immediately prefers it to the lighter plastic set which was to be expected, even going as far as stating he feels like he could control a steak now, which is something he would normally avoid doing. He says:
_It feels more solid and reliable and that he prefers the heavier weight.
_The weight of the knife was too heavy for his affected side so would prefer something closer to that of the forks weight.
_The weight of the knife is "fine" for his left hand which is his unaffected side, but he "doesn't require a special knife."

Above: Fig 75 shows User 1 holding the final fork prototype.

Above: Fig 76 shows user 1 interacting with the groove on the form.
Bottom: Fig 77 shows how the larger groove is more helpful for User 1, as it secures his index finger better.

Above: Fig 78 shows User 1 demonstrating how the final fork prototype keeps his finger on the top of the fork.
Bottom: Fig 79 shows the refersed “Pencil” grip used on the new set when scooping food on the plate.

Above: Fig 80 shows the groove on the final fork protoype supporting the index finger of User 1.

_Said even if it meant he could eat a steak out in public he still wouldn't use them, simply because of the way he is and how "vein" he is.

He truly believes that if he keeps using the cutlery he has at home, which is a standard set, that he will adjust to those, and that if he keeps hanging in there he will eventually be able to use a normal knife and fork. This goes back to how strongly he feels about the way people perceive him and how he doesn't want to be seen as being different. He would however use the final set if he was eating completely alone because he does prefer it over a standard set.
One of his last comments was that, for him, eating is a time for enjoyment and pleasure, so he's not thinking about having to do his rehabilitation.

Results from User one

Above: Fig 81shows the form designed for User 1 by the parametric system based on his session two findings.
Bottom: Fig 82 Shows a top down view of this personalised model.

From the session with User 1, using the design criteria and inputting patients preferences with their impairments into the parametric system, this is an example of an individualised set customised for this person.

Needing a fork User 1 will benefit from:

_A thinner grip due to his level of dexterity
_A large groove to secure his index finger and provide him with the control he prefers
_A longer handle for the size of his hand
_No deviation in angle due to his mild level of impairment
_Medium to heavy weight as his preference

Case two part two

Bio
Male. Affected on the right side. Right-handed. Moderately impaired.

Above: Fig 83 shows User 2 using the final prototype set.

User 2 required a knife to be made for him since he is affected on his right side. Before the test he mentioned that if he cuts something today, it will be "brand new for him." Using a standard set, he was almost able to cut through the banana with the knife but couldn't quite make it due to the angle between his hand and the table being too far away. With a patient like User 2, where the problem causing these issues is mostly in the shoulder and upper arm, the angles and lengths of his specific set are far more important than the likes of User 1, where the focus was more on his grip.

In regards to the plastic cutlery tested, the angle of the fork immediately remedies this problem, as he can reach the food on the plate with the utensil without having to move his whole body to make up the distance. He comments after testing the first one and not quite being able to lift it to his mouth were "At least with this one I could fork it on, which I could not do with any other." Other findings and comments while testing the cutleries include:

"Feels good to hold."

"Looking at them I think they will all be quite good."

_Instead of placing his index finger on the top, he instead locks his thumb down onto it to gain control, even though he knows that is how he should be doing it.

_Prefers the heavier one
_Prefers the larger grips in his hand
_He would benefit from a longer and more curved handle to help him reach the table even easier
_When picking up the fork with the largest groove, he commented: "Ooh that's nice."
_He then commented on which was his prefered set by saying that

"There's so little in it, but they're infinitely better than those (pointing at the standard set)."

Describing them as being,

"pointed more down. Not having to get his arm all the way up there makes a huge difference."

When comparing the ones that curve to the left or right, he preferred the one which allowed him to get closer to the plate, which was the one curved to the right. This followed the logical theory that he would prefer this one, as his arm tended to contract to the left. The cutlery solved this physiological issue for him. The only drawback with the curve bending away from his body and towards the plate, is how it made it harder for him to reach his mouth while still keeping the same grip on the fork. This was something he had the biggest problem with. This was a difficult situation to design for, as improving one aspect would decrease the effectiveness at the other end.




Moving onto the knife which is what User 2 would use in this hand if it were not for his impairment. He was able to cut the banana with the knife and fork, using them at the same time, as he did this he exclaimed: "I got it!" When asked to compare the knife to the standard knife he said it

"was better without a doubt, doesn't even need to try."

He said it was better because it was:

"Locked into my hand securely."

_The normal knife comes straight out, so he has to push further down with his arm. Whereas the curve of the newly-designed knife points downwards, solving this problem for him.

"First time I've cut something in ten years," "This is quite exciting."

Demonstrating how he used to cut food, just by using his unaffected side, he commented saying "I can cut things better using two things (how he had just done it), than like this."As a final statement he commented,

Above left: Fig 84 and 85 show User 2 using the final fork prototype.
Above right: Fig 85
Bottom left: Fig 86 shows User 2 using the final protoype set.
Bottom right: Fig 87 shows User 2 using the 3D printed prototype set.




"They are infinitely better than the things I tried last time."

Which is referencing the stainless steel set tested in Session 1. In regards to the final set, he prefered the weight and shape of the plastic knife but preferred the final designed metal fork. Stating

"If they work, he does not care how they look,"

and he would use them at home because they work for him, and would consider them as a useful rehabilitation tool. When asked about taking the cutlery out to a restaurant he responded by saying it depended on what he would be eating. He used the example of going out for Indian, where the amount of cutting is minimal he would not take them there. However, if he were going out somewhere that might involve more cutting, then he would be more inclined to. Since he has taught himself to eat using just one hand and can do that without standing up, he commented saying he probably would not go to the hassle.

Above left: Fig 88 shows User 2 struggling to bring a standard fork to his mouth.
Above right: Fig 89 shows User 2 benefiting from the extended length and steeper angle of the new fork.
Bottom left: Fig 90 shows a detail of User 2's thumb being secured in place by the groove.
Bottom right: Fig 91shows another detail of User 2's thumb being secured in the groove of the knife.

Above: Fig 92 shows how a standard fork struggles to reach the plate with User 2.
Bottom: Fig 93 shows how a fork with a steeper angle helps User 2 reach the food easier.

Above: Fig 94 shows the absence of surface area for User 2 to control when using a standard fork.
Bottom: Fig 95 shows how a new fork gives User 2 more surface area to secure the utensil in his grip.

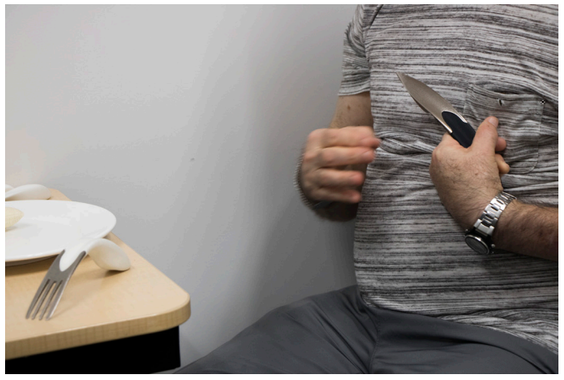
Results from User two

Above: Fig 96 shows a knife designed for User 2 by the parametric system based on his session two findings.
Bottom: Fig 97 Shows a top down view of this personalised model.

From the session with User 2, using the design criteria and inputting patients preferences with their impairments into the parametric system, this is an example of an individualised set customised for this person.

Needing a knife User 2 will benefit from:

_A large handle which tapers at the end to help him put it into his fist
_A large groove to accommodate and secure his thumb
_The largest value for the bend in the curve to help the fork reach the plate
_A 10-degree curve to the left to fix the angle created by his wrist and take the rotation out of his shoulder
_Heavyweight



Bio
Male. Affected on the left side. Right-handed. Moderately impaired.

Above left: Fig 98 shows User 3 using his unaffected hand to grip the final knife protoype.
Above right: Fig 99 shows User 3 gripping the knife in his affected hand.

Case three part two

User 3 was the most challenging to find a solution for by using the capabilities of the parametric system, as he was the most impaired out of the four participants. When picking up and using the fork he mentions the hypersensitivity and what he describes as "almost painful" to touch. This isn't something highlighted by the system other than the importance placed on reducing textures and hard edges on the designs.
When using the plastic utensil with the largest grip, he felt "clumsy."
User 3 prefered to have his chair far away from the table so that he could keep his elbow straight similar to User 2. However, this puts a lot of strain and tension on his shoulder and performing the intricate movements required to eat with just the shoulder is extremely difficult even for somebody who has no physical impairments.
The form does offer some help in guiding his fingers around the utensil, but the limited control he has over them causes them to act independently of one another. The groove does lock his finger onto the top of the utensil, but doing this causes the rest of the fingers to knuckle up as a result.
Concerning the aesthetic, User 3 commented:

"he wouldn't want to be seen eating with them, and would instead just use his right hand for both the knife and the fork."

The weight for both he says feel good. He is worried about using his affected side as it could result in the "food and cutlery ending up all over the floor."
Keeps saying he is used to normal cutlery so doesn't want to change his ways.

"If he didn't do something before his stroke, why should he have to do it now?"

Says the aesthetic is quite smart and prefers the black handle out of the two finished options. This just shows not everybody can be helped, solidifying the idea that no two patients are the same.

Above left: Fig 100 shows User 3 holding the final prototype set.
Above right: Fig 101 shows a detail of User 3 establishing a grip on the final knife prototype.

Above left: Fig 102 shows the groove helping User 3 position his finger correctly.
Above right: Fig 103 shows User 3 holding the fork in a way comfortable to him.

Results from User three

Above: Fig 104 shows a fork designed for User 3 by the parametric system based on his session two findings.
Bottom: Fig 105 Shows a top down view of this personalised model.

From the session with User 3, using the design criteria and inputting patients preferences with their impairments into the parametric system, this is an example of an individualised set customised for this person.

Needing a fork User 3 will benefit from:

_A large grip to provide more surface areas for his fingers to wrap around.
_The largest value for the finger groove to secure his index finger on the top of the utensil.
_A longer handle for the size of his hand
_The curve would be the largest possible to help him pick it up and reach the plate easier.
_The angle would be set to the left at 30 degrees to correct the angle of his wrist, helping him reach the plate.
_ Medium weight.

Case four part two

Bio
Female. Affected on the right side. Left-handed. Mildly impaired.

Above: Fig 106 shows User 4 using testing the final prototyped set.

User 4 uses the back of the fork to help guide the knife when using a standard set. When she is out and about, she will eat with two hands and eat the way which is most natural for her. When she is home or alone, she will practise eating just with her affected side to give herself the exercise. She tends to swap the knife and fork depending on the task. For example, if the task is cutting she will hold the knife in her unaffected hand since it is doing most the work, which is a theme unique to her, as it was undiscovered with testing the other participants.
When moving onto the plastic set, she comments on how:

"It is much better because of the place for her forefinger."

Which she says is the problem with standard cutlery.
For her:
_The shorter one is better because it fits into her hand
_The ataxia tremors increased because of the light plastic models
Since she has smaller hands the smaller handle is her preference
She comments on how the groove is:

"Quite good because it keeps her finger in place."

_She likes the rounded and soft edges instead of the hard edges, which is what she does not like about standard cutlery when made from metal.
_Thesteepergrooveisnotascomfortable because she feels restricted by it, so the shallower groove is more appropriate
_The tines of the fork are good for picking up and holding food
_For her, the knife feels more usable, but her finger starts to feel uncomfortable, but she cannot depict why this is. When going back to the ordinary knife, it is clear to see how much harder it is for her to locate her finger along the top of the spine. She comments saying the new version is much better.
She comments on how it might,

"be easier to turn the curved forks and get it to her mouth."

Specifically, the model which curves to the left and towards her body. Picking up the fork was much easier due to the stability on the table and the position of the gap for her fingers. She commented saying:

"That position is quite good, it does not need to be chased, and it is quite stable."

The weight in the fork is good, as she says:

"the heavier, the better because it will not wave around so much."

She uses the base of the knife to rest on the table to provide more stability. She identifies the primary benefit of the new set compared to the standard knife and fork is the wide "shoulder" or place to put her finger in the groove.
Aesthetically she says she quite likes the look as they look elegant like new cutlery should. She says

"they look normal when you hold them and all you can see is the steel part, but they do not look the slightest bit normal sitting on the table."

She prefers the black coloured handle

Above left: Fig 107, 108, 109 and 110 show various details of User 4 testing the 3D printed cutlery.
Above right: Fig 108
Bottom left: Fig 109
Bottom right: Fig 110

over the white and if asked if she would use the cutlery if it were available to purchase she responded by saying yes she would. She

"would take it out to a cafe or restaurant to eat with because it makes eating easier for her."

"Considerably superior, both style wise and function wise" was what User 4 answered when asked how these utensils compare to any devices she uses at home or has been able to get hold of. Describing products which are currently available as "truly awful but somewhat functional."

Above: Fig 111 shows User 1 using the added length and changed angle to help reach her mouth.

Above: Fig 112 shows User 4 reaching out to pick up the final fork prototype.
Bottom: Fig 113 shows User 3 picking up the fork from the table, using the gap to get her fingers around it.

Above: Fig 114 shows how User 4 is able to rest her index finer along the top of the knife.
Bottom: Fig 115 shows User 4 using the base of the knife to rest on the table surface to hold her hand steady.

Results from User four

From the session with User 4 using the design criteria and inputting patients preferences with their impairments into the parametric system, this is an example of an individualised set customised for this person.

Needing a knife User 4 will benefit from:

_A smaller, shorter handle due to her hand size and level of dexterity
_A subtle groove to keep her finger in place, as she found the larger groove restricting
_A medium curve, with just enough space to get her fingers underneath to pick it up
_Heavy, to reduce tremors
_Straight in angle, as she has no deviation in her wrist

Above: Fig 116 shows a knife designed for User 4 by the parametric system based on her session two findings.
Bottom: Fig 117 Shows a top down view of this personalised model.

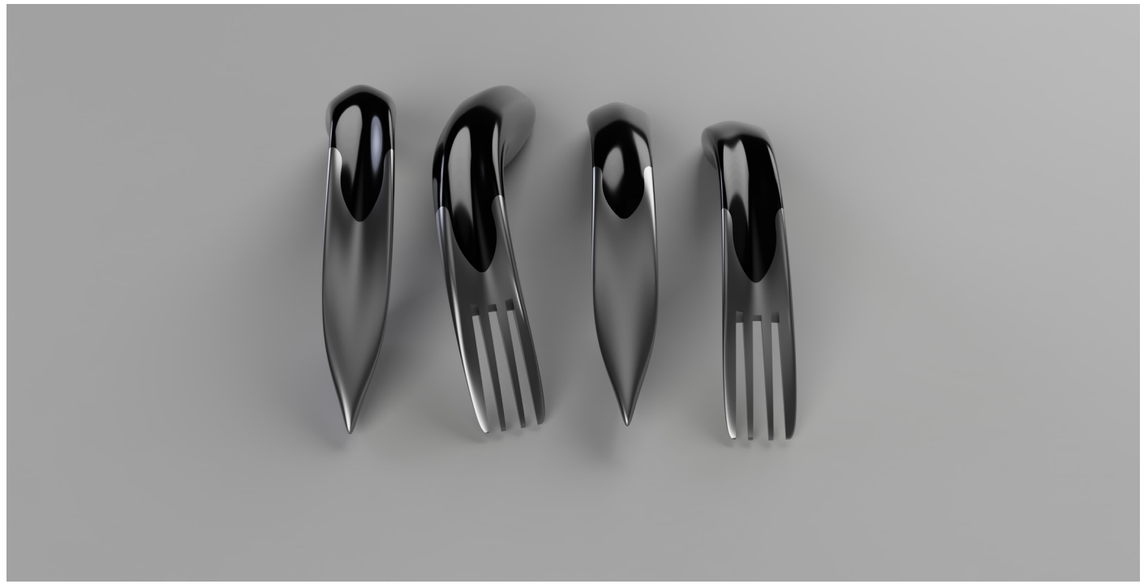
Chapter 5

Discussion

Design Results

Above: Fig 119 shows the four individual models designed for the four individual participants in user testing.

Above: Fig 118 shows a detail image of the final physical set.



Above: Fig 120 and 121 show a detail of the four individual models designed for the four individual participants.
Bottom: Fig 121

Above: Fig 122 and 123 show a detail of the four individual models designed for the four individual participants.
Bottom: Fig 123

Qualifications

Data retrieved during the testing sessions and interviews were strictly qualitative. User testing sessions were limited to four patients in total, with the same four participating in both Phase 1 as in Phase 2. Interviews without testing were limited to one stroke patient and one clinician. Results from the thematic analysis of the sessions were subjective and only representative of the limited participant pool.

A theme which proposed certain obstacles to the succession of this research included the major conflict which was helping the patient immediately, by designing cutlery which will address a lot of their impairments now, versus helping them in the long term by designing a set which may push them into the direction of discomfort in efforts to aid in their rehabilitation. Initially, the aim was to design a single set which will help all stroke patients eat.

A quick exploration into literature and design precedents revealed that there is no value in a single set or iteration of the cutlery designed for stroke patients. The value is in having something personalised and custom to the patient's physiological needs. Having a personalised set makes the patient more invested in their rehabilitation, improving adherence, motivation and therefore long-term rehabilitation results.

The main conflict behind this issue is that there are two ways a design exploration can be conducted with this brief. The cutlery could be sufficient to the point it fixes the major problems the patient is experiencing but causes the patient to become reliant and therefore doesn't provide them with any practise or rehabilitation.

On the other hand, the cutlery could be designed in a way to help the patient by targeting their rehabilitation, purposely putting them in a position of discomfort with the goal that when they practise with this set, it will make the use of a regular set easier. It was essential to find a balance between the two to address the issue of rehabilitation versus reliance. To create a way to change between focusing on rehabilitation and then to switch back to enjoying a meal.

There is more value in creating a set which helps the patient eat easier right away, as the patient should be getting enough rehabilitation outside of the meals. This theme will help them see results quicker and bring a level of positivity back into their lives. The ability to customise the set and have stages of the individualised set which address progression in rehabilitation was a large part of solving this problem.

The final limitation involves the primary research process of Research through Design, as it is the level of success depends majorly on the designer conducting the research methods. As I was the only designer involved in the ideation, development and production of this researches designed outputs, the results reflect solely on my ability and taste as a designer. Although the results of the output may appear different if this research was conducted by a different individual or team of individuals, the processes, methodologies, insights and findings recognised would objectively result in an equally as successful conclusion.

Improvements

This research could be improved with the addition of more participants for initial interviews and user testing sessions. When analysing qualitative data from user testing sessions thematically, having a larger pool of participants and results would have rewarded this study with more concrete evidence to support its claims, helping to remove the objectivity and subjective reporting which resulted from having fewer participants. Another benefit to having more participants involved in the testing, especially in the final sessions, would have been the ability to more effectively show the benefit of having a fully parametric and customisable system. The system can output around forty thousand unique combinations of the variables identified as being the most important in this study. However, only four have been outlined and discussed as per the four patients who participated in the study.

Extensions

This research has begun the discussion by opening the door for future investigations to explore customisable products in healthcare. Going beyond merely customising artefacts with colours and materials, it is identifying factors and themes which offer the most value to the user. Patients feel special for all the wrong reasons, spending a substantial amount of time hiding their impairments and going out of their way to feel normal again. This research is not suggesting the celebration of a stroke, and it is devastating repercussions, however, what it does suggest, is the value in realising that no two people are the same and that we all have very different and specific needs. These needs should be identified and addressed, not ignored.

From here, this research would benefit from further exploration into ways that the other criteria identified in this study can benefit stroke patients. Developing on the four explored: the depth of the finger groove, the size of the handle, angle or grip and steepness of the curve of the cutlery.

For the people that this research is unable to help, due to the severity of the stroke or breakdown of the upper limb over time, another insight found in the later stages of this project identifies the opportunity for a new utensil which can have more uses for a patient. Specifically, a patient who only uses their unaffected side to do everything while eating and who cannot be helped in eating with two hands or even using their affected side. This suggested a utensil could give a user who solely depends on one side of their body the ability to perform a more extensive variety of tasks when eating, making for a more comfortable eating experience. As for how this is accomplished, this research suggests potential explorations into a design which takes ideas from the ways that the industry has combined spoons and forks to create sporks, or forks and knives to create knorks.

Implications

This research has identified the importance of recognising that no two stroke patients are the same. Therefore no two patients will benefit from the same set of cutlery in the same way. An individualised set of cutlery produced by a parametric system has been proven to address this issue innovatively and effectively. Precedent reviews have found the lack of current solutions which address this issue. Majority of these current solutions discussed are cheaply produced, unappealing and stigmatising for the patient. This theme is a valuable insight which should inform future investigations due to its implications on patients adherence to the product and their commitment to their rehabilitation.

Applications

This research has proven itself to have real-world applications, and as per the results from user testing sessions, there is a real desire for a product like this in the industry and on the market as indicated by both the clinician and patients involved. The cutlery was designed with potential production and manufacture in mind with the metal half being mass manufactured in stainless steel just like any regular cutlery, and the handle to be 3D printed to cater for the mass customisable business model.

Chapter 6

Conclusion

Above: Fig 124 shows the Final Prototype being used in user testing session 2, by User 4.

Conclusion

There is a trend of stigmatisation and cheaply designed products in the healthcare marketplace. After researching and discussing the themes of current and proven cutlery solutions, the kinaesthetic criteria of the human upper body, the importance of patient progression and motivation, mass customisation and personalisation in product design and the stigma surrounding design for disability, we identified a gap for custom rehabilitation tools in the field. The eating/drinking disorders are targeted as one of the largest areas for therapists with stroke patients, in bilateral upper limb therapy.

The main findings from this study conclude that cutlery designed for stroke patients needs to be personalised, as each patient has very individual needs according to their very individual impairments. Current cutlery does not address them all and even less addresses them through personalisation.

People who have been affected by a stroke in their lives will benefit from a desirable practical design solution with a personalised set of cutlery that assists them to feel confident and comfortable using cutlery in situations outside of their homes, as well as assisting as a therapy device. Helping remove the stigma surrounding design in rehabilitation, individualising consumer cutlery to aid in the long-term, progressive rehabilitation of a stroke patient.

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Figure list

Figure	Title	Source
2	LIANYU 20-Piece Stainless Steel Flatware Silverware Set	Lianyu. (2018). 20-Piece Silverware Flatware Cutlery Set. Retrieved from https://www.amazon.com/LIANYU-20-Piece-Silverware-Stainless-Dishwasher/dp/B06XK6PXX8
3	Transition Cutlery By Mickael Boulay	Boulay, M. (2018). Transitions. Retrieved from https://www.pinterest.nz/pin/276408495854783663/?lp=true
4	Kinsman Enterprises KEatlery Weighted Dinnerware	Kinsman. (2018). Keatlery Weighted Utensils. Retrieved from https://www.amazon.com/Kinsman-KEatlery-Weighted-Utensils-Teaspoon/dp/B003IGRL3W
5	Good grips Adaptive Utensils	Cook Fusion. (2018). Adaptive Eating Utensils Set. Retrieved from https://images-na.ssl-images-amazon.com/images/I/31NPbTjW7VL.jpg
6	Adaptive Eating Utensils by CFOX	CFOX. (2018). Adaptive eating utensils. Retrieved from https://www.amazon.com/Adaptive-Silverware-Stainless-Arthritis-Parkinsons/dp/B07B1HNR13
7	Sammons Preston Universal Cuff Utensil and Pen Holder	Sammons Preston. (2018). Universal Cuff. Retrieved from https://images-na.ssl-images-amazon.com/images/I/711rQf-lthL._SL1500_.jpg
8	Right-Angle Pockets Utensil Positioning Holder	Performance Health. (2018). Right-angle pockets utensil positioning holder. Retrieved from https://www.rehabmart.com/product/rightangle-pockets-for-use-with-universal-cuff-and-other-holders-9853.html
1, 9-124, Table fig 1-4.	Various images, renders, tables and figures.	Made by author.

Appendix

This appendix includes the consent form, and participant information sheets handed out to the participants.

TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI
VICTORIA
UNIVERSITY OF WELLINGTON

Designing a System for Stroke Rehabilitation

CONSENT TO INTERVIEW

Researcher: *Ethan Henley, School of Design, Victoria University of Wellington.*

- I have read the Information Sheet and the project has been explained to me. My questions have been answered to my satisfaction. I understand that I can ask further questions at any time.
- I agree to take part in a video recorded interview.

I understand that:

- I may withdraw from this study up to *four weeks* after the first interview or up to four weeks after the second interview reviewing the designs, and any information that I have provided will be returned to me or destroyed.
- The information I have provided will be destroyed *5* years after the research is finished.
- Any information I provide will be kept confidential to the researcher and the supervisor. I understand that the results will be used for a *Masters/PhD* report and a summary of the results may be used in academic reports and/or presented at conferences.
- My name will not be used in reports, nor will any information that would identify me.
- I would like a summary of my interview: Yes ☐ No ☐
- I would like to receive a copy of the final report and have added my email address below. Yes ☐ No ☐

Signature of participant: _____

Name of participant: _____

Date: _____

Contact details: _____

VICTORIA
UNIVERSITY OF WELLINGTON
TE WHARE WĀNANGA
O TE ŪPOKO O TE IKA A MĀUI

Participant Information Sheet

Study title:	**A Set of Cutlery for Stroke Survivors**		
Locality:	**Wellington**	Ethics committee ref.:	[redacted]
Lead investigator:	**Brian Robinson**	Contact phone number:	[redacted]

You are invited to take part in a study the design of a set of cutlery for stroke survivors. Whether or not you take part is your choice. If you don't want to take part, you don't have to give a reason, and it won't affect the care you receive. If you do want to take part now, but change your mind later, you can pull out of the study at any time.

This Participant Information Sheet will help you decide if you'd like to take part. It sets out why we are doing the study, what your participation would involve, what the benefits and risks to you might be, and what would happen after the study ends. We will go through this information with you and answer any questions you may have. You do not have to decide today whether or not you will participate in this study. Before you decide you may want to talk about the study with other people, such as family, whānau, friends, or healthcare providers. Feel free to do this.

If you agree to take part in this study, you will be asked to sign the Consent Form on the last page of this document. You will be given a copy of both the Participant Information Sheet and the Consent Form to keep.

This document is 6 pages long, including the Consent Form. Please make sure you have read and understood all the pages.

WHAT IS THE PURPOSE OF THE STUDY?

This study is to develop a set of cutlery that can be used by people who are recovering from stroke.
We are wanting to know how you find using the new set of cutlery. Our aim is that these will be easy to use and understand.
This set of cutlery is developed by students as a requirement for a Masters degree. This research is funded by the School of Design at Victoria University of Wellington. Any other questions you have can be answered by Dr. Brian Robinson [redacted] This research has been approved by the Health and Disability Ethics Committee.

WHAT WILL MY PARTICIPATION IN THE STUDY INVOLVE?

We asked you to take part in this research because you have had a stroke that affects one of your arms and hands. You do have some use of this hand..
The research study will take place at AUT Akoranga North Shore, Physiotherapy Department.
We will ask some questions about you such as how old you are, your ethnic background, how long ago you had the stroke and how the stroke affects you now.
We will show you a set of cutlery.
You will be asked to use the set of cutlery.
You can use it for as long as you like and can tell us when you want to stop.
We will take a video and photographs of you using this set of cutlery. This is to make sure that using the set of cutlery will be useful and not cause harm. Stroke rehabilitation physiotherapists will review these recordings. We will keep the video and photographs securely in the University. Because other researchers will be interested in our research we may show the photographs or a video of you. Your involvement in the study will only be known by the researchers. All photographs and videos will be taken using cameras belonging to the School of Design. The images and videos will be taken off these cameras and immediately after this session and then kept secure in the University computer system.
If we do use photographs or videos of you for presenting our research we will not show any part of you, such as your face, that can tell other people that you have taken part. We will do this by blurring parts of the images and videos.
Your participation requires your concentration using the set of cutlery. We realize that this can be tiring for you so we ask you can tell that you are wanting to rest or to stop the session.
You may be invited to take part again if you would like to help us test changes.

WHAT ARE THE POSSIBLE BENEFITS AND RISKS OF THIS STUDY?

We know that people who have had stroke cannot access stroke rehabilitation therapy regularly. They have to travel to clinics or hospital. We also know that rehabilitation is more effective when it is carried out for several hours throughout the day, every day.
This study is to support people who have had a stroke to provide stroke rehabilitation therapy in their home. This can be by themselves or with the help of carer support or family members.
We are wanting to find out whether this set of cutlery may be useful in stroke rehabilitation.
This research is finding out whether you can use it and what you think of it.
This does not replace any other therapy you may be receiving. We are not using the set of cutlery as part of your therapy at this stage. We want to find out whether this might be usable for stroke survivors.
While you are using the set of cutlery you will be sitting in a chair. We will want you to stay sitting.

WHO PAYS FOR THE STUDY?

This study is funded by Victoria University of Wellington and the School of Design through medical technology research grants from the Centre of Research Excellence of Medical Technologies.
You will not incur any costs by taking part and we will travel to you.

WHAT IF SOMETHING GOES WRONG?

If you were injured in this study, which is unlikely, you would be eligible for compensation from ACC just as you would be if you were injured in an accident at work or at home. You will have to lodge a claim with ACC, which may take some time to assess. If your claim is accepted, you will receive funding to assist in your recovery.

WHAT ARE MY RIGHTS?

You are volunteering to take part. You do not have to take part in this study and you can withdraw at any time.
We can show you the video recording and photographs of you we have collected. We can also give you a copy of what we have recorded you saying to us about using the computer device and game.
It is unlikely that participating will affect your health but if it does, we will contact you immediately.
We will not identify you in any of the students work or presentations of the work.

WHAT HAPPENS AFTER THE STUDY OR IF I CHANGE MY MIND?

After you have taken part and change your mind about being involved, please contact the researcher (the design student) or the lead investigators (Brian Robinson, in the first instance, or Edgar Rodriguez) and any data, information and images associated with your participation will be destroyed.
We will securely store the information and data you have provided for five (5) years and it will then be destroyed.
We can present the findings of this study at stroke clubs within a year of conducting the study.
We can also send you a summary of the student's thesis describing the outcome of the study.
We may also present this study with other similar studies we are conducting at conferences or in books or journals.

WHO DO I CONTACT FOR MORE INFORMATION OR IF I HAVE CONCERNS?

If you have any questions, concerns or complaints about the study at any stage, you can contact:

Dr Brian Robinson, Senior Lecturer, Graduate School of Nursing, Midwifery & Health, Victoria University of Wellington.
Work phone: [redacted]
[redacted]

24 Hour contact numbers: Dr Robinson: [redacted]
If you cannot contact Dr Robinson, please contact
Associate Professor Edgar Rodriguez: [redacted]

If you have other questions, concerns or complaints and wish to contact a Māori support person, you can contact:

Katherine Reweti- Russell, Research Advisory Group – Māori, CCDHB
Work phone: [redacted]

If you want to talk to someone who isn't involved with the study, you can contact an independent health and disability advocate on:

Phone:
Fax:
Email: [redacted]

For Maori health support please contact your health provider and they will refer you to the representative Maori health support group.

You can also contact the health and disability ethics committee (HDEC) that approved this study on:

[redacted]

Consent Form

If you need an INTERPRETER, please tell us.
If you are unable to provide interpreters for the study, please clearly state this in the Participant Information Sheet

Please tick to indicate you consent to the following

I have read, or have had read to me in my first language, and I understand the Participant Information Sheet.	Yes ☐
I have been given sufficient time to consider whether or not to participate in this study.	Yes ☐
I have had the opportunity to use a legal representative, whanau/ family support or a friend to help me ask questions and understand the study.	Yes ☐
I am satisfied with the answers I have been given regarding the study and I have a copy of this consent form and information sheet.	Yes ☐

I understand that taking part in this study is voluntary (my choice) and that I may withdraw from the study at any time without this affecting my medical care.	Yes ☐
I consent to the research staff collecting and processing my information, including information about my health.	Yes ☐
I understand that my participation in this study is confidential and that no material, which could identify me personally, will be used in any reports on this study.	Yes ☐
I consent to the research staff taking pictures or video recordings of me and I understand that if used in presentations, these will be altered so that I or my involvement cannot be identified.	Yes ☐
I understand the compensation provisions in case of injury during the study.	Yes ☐
I know who to contact if I have any questions about the study in general.	Yes ☐
I understand my responsibilities as a study participant.	Yes ☐

I wish to receive a summary of the results from the study. Yes ☐ No ☐ **Declaration by participant:**
I hereby consent to take part in this study.

Participant's name:

Signature: Date:

Declaration by member of research team:

I have given a verbal explanation of the research project to the participant, and have answered the participant's questions about it.

I believe that the participant understands the study and has given informed consent to participate.

Researcher's name: Ethan Henley

Signature: Date:

Designing a System for Stroke Rehabilitation

INFORMATION SHEET FOR PARTICIPANTS

Thank you for your interest in this project. Please read this information before deciding whether or not to take part. If you decide to participate, thank you. If you decide not to take part, thank you for considering my request.

Who am I?

My name is Ethan Henley and I am a Masters student in the School of Design at Victoria University of Wellington. This research project is work towards my thesis.

What is the aim of the project?

This project aims to design a set of cutlery aimed at improving the lives of upper limb stroke rehabilitation patients. This research has been approved by the Victoria University of Wellington Human Ethics Committee [redacted]

How can you help?

If you agree to take part I will interview you in your office, a meeting room in the School of Design's campus or in a public place, such as a café. I will ask you questions about stroke rehabilitation. I will video record the interview and write it up later. We will construct a set of criteria and designs that facilitate stroke rehabilitation based on the findings from the research. In a second interview, we will seek your feedback about the new designs. Each interview will take 60 minutes. You can stop the interviews at any time, without giving a reason. You can withdraw from the study up to four weeks after the first interview. After this time, we will use the information you provide to design new objects. You can also withdraw your information for the second interview up to four weeks after it occurs. If you withdraw, the information you provided will be destroyed or returned to you.

What will happen to the information you give?

This research is confidential. I will not name you in any reports, and I will not include any information that would identify you. Only my supervisors and I will read the notes or transcript of the interview. The interview transcripts, summaries and any recordings will be kept securely and destroyed *3* years after the research ends.

What will the project produce?

The information from my research will be used in my Master's thesis. You will not be identified in my report. I may also use the results of my research for conference presentations, and academic reports. I will take care not to identify you in any presentation or report.

If you accept this invitation, what are your rights as a research participant?

You do not have to accept this invitation if you don't want to. If you do decide to participate, you have the right to:

- choose not to answer any question;
- ask for the recorder to be turned off at any time during the interview;
- withdraw from the study up until four weeks after your interview;
- ask any questions about the study at any time;
- receive a copy of your interview recording (if it is recorded);
- read over and comment on a written summary of your interview;
- agree on another name for me to use rather than your real name;
- be able to read any reports of this research by emailing the researcher to request a copy.

If you have any questions or problems, who can you contact?

If you have any questions, either now or in the future, please feel free to contact either:

Student:

Name: Ethan Henley

University email address:

[redacted]

Supervisor:

Name: Dr Edgar Rodriguez

Role: Programme Director Industrial Design

School: School of Design

[redacted]

Human Ethics Committee information

If you have any concerns about the ethical conduct of the research you may contact the Victoria University HEC Convener: Associate Professor Susan Corbett. Email

[redacted]