Field Study 1: MERU

1. Data Collection Method: Semi-structured interviews with Susan Brompton (CEO) and three design engineers: Graham Race, Tim Wilson and Dmitri Gour, and Facility Tour.

2. Profile: MERU is a large MERU is usually described as a 'medium' size charity (annual incomes between £250,000 – 999,000) that exists to *"help disabled children and young people achieve aspirations"* by giving advice on appropriate assistive equipment and providing a custom-made solution if the suitable device does not exist.

MERU is a regional charity supporting people living in Southeast England (including Kent, Sussex, London and Surrey). The main sources of income are annual grants and fund-raising activities. The charity has 12 permanent staff (equivalent to eight full-time staff and around 40 volunteers (equivalent to five full-time staff). It has in-house design engineers, design studios and workshops for producing prototypes and manufacturing custom-made devices (see Figure 1). MERU works closely with other charities offering similar services in other regions, e.g. Bath Institute of Medical Engineering (www.bath.ac.uk/bime), Remap (www.remap.org.uk) and Demand (www.demand.org.uk). CEOs and design engineers meet up at least three times a year.

Figure 1: MERU's workshop space

3. Services: MERU originally offered two main services: advice service and custom-made service. The charity has an in-house physiotherapist who provides advice to anyone (e.g. parents and carers) who are struggling to find a suitable assistive device to match a child or a young person's needs. If the appropriate equipment does not exist, the charity will co-design the device with service users and other stakeholders (e.g. parents, carers and social service officers) – see the custom-made process in Figure 2.

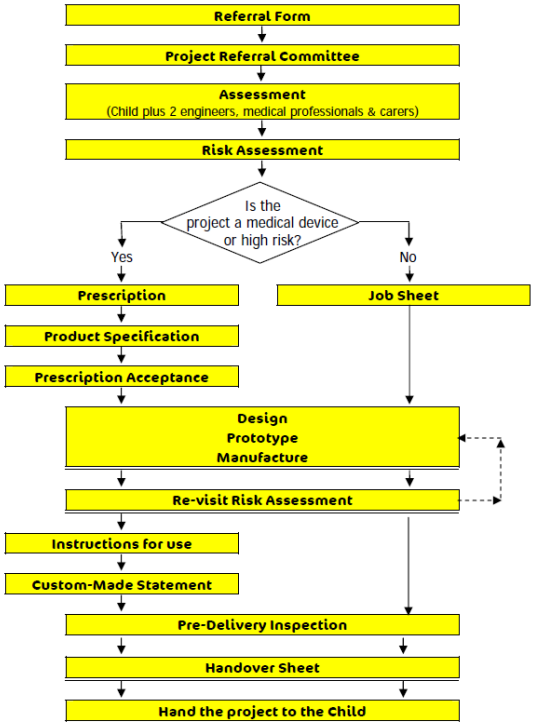

Figure 2: The Custom-made Process

MERU recently began providing ready-made devices, e.g. a school chair, a wheelchair and a non-slip button holder. This additional offering resulted from frequent requests for the same products. Thus, the charity has decided to produce and sell ready-made products.

4. Service Development/Improvement: The charity does not have a formal process for developing a new service or improving the existing one. A new service is often initiated by staff as a result of close collaborations with beneficiaries – see case study 1.

Case Study 1: Wheelchair Lending Service
Bugzi, a toddler wheelchair for children aged 0 – 5 years old (Figure 3) was developed and sold as a ready-made device. Although, it is clinically proven that immobile toddlers have a slower cognitive development due to the

inability to explore the world around them, MERU struggled to sell Bugzi (£5,000). It took MERU some time to realise that the main problem was not poor marketing, but most parents cannot afford it. By the time parents manage to raise sufficient fund, their children might be close to five years old, which makes the purchase not worthwhile.

After finding out that most purchasers were nurseries and schools, the charity decided to introduce a lending service free of charge for parents. MERU organised several fund-raising programmes to support the manufacturing of 20 wheelchairs for lending. The CEO reflected on the experience of identifying a new service opportunity as: *"It took us a long time to get our head around."*

Figure 3: Bugzi – a powered indoor wheelchair for children aged 0 – 5

The service improvement is also driven from internal staff as a result of collaborations with its beneficiaries – see case study 2 below.

Case Study 2: Assessment Process
For all custom-made products, the process begins with a request/referral from beneficiaries, e.g. users, parents, healthcare professionals and/or social service officers (see Figure 1). All requests will be thoroughly assessed by the project referral committees (including an occupational therapist, a physiotherapist, an engineer and a project administrator) to establish that there is no other suitable device available in the market.

Next, the assessment will be carried out to co-create the design brief that capture users' needs and aspirations. The current paperwork is a subject of many years of refinement. Unnecessary questions (e.g. questions that are irrelevant to most users) have been removed and new questions have been added to capture detailed requirements and emotional needs. For example, a list of aspirations (see Table 1) has been included to find out and prioritise users' aspirations.

Table 1: List of Aspirations

	Primary	**Secondary**
	Select 1 only	Select max 3
Feeling healthy		
Being comfortable & safe		
Looking after myself		
Get around by myself		
Express myself		
Learn & achieve		
Have fun		
Make friends		
Feel Liberated		

Beneficiaries are not currently involved in the service improvement process. They may make suggestions to staff who then take the ideas further in the organisation. At present, there is no designated leader for a service development/improvement project.

4. Service Quality: Most of MERU's ready-made and custom-made products are considered medical devices. Therefore, they are regulated by the Medicines and Healthcare Products Regulatory Agency (MHRA) under the Medical Device Directive. Thus, good service from MERU's perspective means satisfying the user and meeting requirements of healthcare professionals.

4.1. Pre-project Stage: The co-creation of the design brief is crucial to the quality of the service. Unrealistic requirements must be identified and eliminated at the early stage:

"For example, one girl wanted clutches that are adjustable and light. To make it adjustable, materials have to be added to make it strong enough to bear the weight. At the end, the product is considered too heavy

for her. Some requirements are not feasible. It is important to find this out from the beginning."

Due to a thorough co-creation process of the design brief, it is very rare that the design team misses any important requirements.

"There was only one case that we missed an important aspect in the design spec. We were asked to design a toilet seat. The mother forgot to mention that it must be operated by one hand (another hand holding a child). She approved the brief, but raised the point after the design has been done."

4.2. Project Development Stage: Although all stakeholders are considered co-decision makers, healthcare practitioner(s) often make the final design decisions.

"For example an engineer might have to decide where to place a switch for operating a computer… This child cannot sit up straight. If we place it here where he could easily bend down and operate it, this will result in him sitting in a wrong posture. However, if we put the switch here, he might not be able to operate it as easily, but it will encourage him to sit up straight. We are not qualified to make this judgement. We must listen to the child's healthcare professionals."

Getting all stakeholders involved in the design process is challenging, especially in a case where several professionals are involved and cannot agree on what is "best" for a child.

4.3. Post-project Stage: To ensure the quality of the outcome, the product will be assessed by another design engineer whether it fulfils all the requirements in the design specs.

4.4. Areas for Service Quality Improvements: To enhance the quality of its custom-made service further, we would like to speed up the process, if this is possible, (currently, each project takes at least two months to complete) so the waiting period can be reduced. Some requests, which are considered low priority (e.g. an adapted Xbox controller), may have to wait for a few years. Due to limited staff, the charity can handle around 10 – 12 projects at one time.

5. Service Costs: The major cost is staff time, especially design engineers – taking the total running cost of MERU divided by the number of engineering hours, an hourly rate for a design engineer will be around £50. Although the total cost varies from one project to another, it was noted that all projects cost at least £1,000 (even with support from volunteer design engineers). Most machines and materials are donated by local businesses or bought at the discounted prices.

6. User Involvement:
Beneficiaries are occasionally involved in a new service development – see case study 3

Case Study 3: TravelChair
TravelChair is a unique seating aid designed to provide postural support for disabled children aged 3 – 11 that can fit into a standard airline seat (Figure 4). The idea started from a request from service users. Upon realising that there is a large demand for a seating aid for air travel, MERU decided to develop it as a ready-made product for the airline industry. The product is a result of co-creation of MERU, users, key airlines and the European Aviation Safety Agency and Balform Ltd. TravelChair is now available on a number of leading airlines, such as Virgin Atlantics.

Figure 4: TravelChair – a seating aid for moderate/severely disabled children

This co-creation also led to the new service idea, 'Tryb4ufly'. Recognising that users need to try this seating aid before deciding whether to fly or not. MERU worked with Queen Elizabeth's Foundation for Disabled People

(QEF) to provide a free aircraft seating assessment service for disabled children.

6.1. Key Activities: Currently, users and other beneficiaries (e.g. parents and carers) are mainly involved in the custom-made service. All custom-made products are a result of a co-design process between a design engineer and beneficiaries. A process of matching a suitable design engineer with a project starts at the Project Referral Committee. The design engineer who has skills and expertises required for the project will be involved in assessing the request/referral. If the request is approved, the design engineer will start working with the user. At least three face-to-face meetings will be held at the user's home or where the product will be used, e.g. a school. The three meetings include:

1. **Assessment meeting** will be held to co-create the design brief with the user and/or other beneficiaries.
2. **Inter-fit meeting** will be organised to co-evaluate the design and/or prototype with the users and other beneficiaries
3. **Handover meeting** will be held to after the project is completed for the final assessment. Normally, the project leader will contact the user again three months after the handover meeting to check whether everything goes well and whether the user is fully satisfied with the product.

In a complex project, a design engineer may have up to 8 – 9 face-to-face meetings with a user. However, in most cases, a design engineer will communicate with a user via an email/phone. Since most users have mobility impairments, it is not practical to ask them and their carers to work with design engineers at MERU's design studio and/or workshops.

If users do not have any severe cognitive imparements , they will be involved in all key stages in the co-design process: defining problems, creating the brief, developing design concepts, selecting concepts, finalising details and testing the product – see an example of a design idea from the user below:

"This is a piano pedal controller… The girl who requested for it used to practice piano until she lost ability to control her legs. She only wanted to a device that enables her to control the sustaining pedal. When we asked how she wants to control the device, the engineer noticed that she did not move her head that much while she plays. So she would like the switch to be placed on her glasses, so it is controlled by tipping her head back."

Design engineers observed that users like to be involved in aesthetic aspects of the design, e.g. choosing forms, colours and patterns. They are less interested in functional and technical aspects, e.g. product mechanism. Most children prefer fast visualising techniques, e.g. sketches and mock-ups. However, they often get bored with a slow process, e.g. CAD drawing.

6.2. Problems: The problem occurs when a child cannot communicate his/her requirements – this may due to cognitive impairments or lack of confidence. Some children are used to having people around them (e.g. parents, carers and/or healthcare practitioners) making decisions for them. Therefore, they cannot express themselves or are unable to make their own decisions. To overcome this problem, it is important to *"treat them like a human being – listen to them and avoid any preconception."*

According to the design engineers, the worst case scenario is working with a child who cannot express himself who surrounded by people with conflicting opinions who do not care about the child – just doing their jobs.

6.3. Tools & Techniques: The design engineers did not use any co-design toolkits. They mainly rely on communicate skills. Semi-structure interviews and observations are useful to get to know the user. In some cases, brainstorming and props, such as real products for a user to try, are useful for problem defining and ideation stages.

The design engineers pointed out the many users are used to waiting for various services,

e.g. treatments, for months or years. As a result, they are grateful when someone makes custom-made products for them. Some children find it difficult to criticise the design, especially when they establish good relationships with design engineers. The engineers have to encourage them to critique.

6.4. Advantages and Disadvantages: The user involvement is crucial to the success of the custom-made service and has helped the charity come up with several new service ideas. However, the co-design process requires a lot of staff time. This means MERU can only deliver a certain number of products per year. It also makes the waiting list rather long. Currently, some design engineers work on 3 – 4 projects in parallel, while some prefer to work on one or two projects at a time.

The CEO suggested that having technicians working alongside engineers could free up engineers from basic jobs, e.g. painting, to concentrate on more demanding tasks, e.g. fine-tuning a controller. This might enable a design engineer to carry out more projects at a time or finish the project quicker. Besides, technicians cost less than design engineers.

7. Design Involvement: Trained engineers, especially design engineers, are essential to MERU. Their job titles are design engineer project leaders because all the custom-made projects start and end with the design engineers. They lead all stages of the co-design process. MERU also works with other design disciplines on a voluntary basis, e.g. graphic designers and website designers.

All design engineers working for the charity are passionate about their work. Most of the full-time or permanent staff started as volunteer designers or placement students. They applied for a job at MERU as soon as there was a job vacancy. Since they are highly motivated and understand the nature of the work and beneficiaries, they outperformed other candidates and got selected.

The CEO pointed out that the main challenge of working with designers is making the best use of their talents and problem-solving skills – the charity must apply design thinking and the design process in other areas – not just service development or service delivering. Being trained as a designer herself, the CEO observed that there are a lot of similarities between the design process and charity management – it is about identifying and solving real problems.

8. Final Thoughts: In order to achieve a successful collaboration, it is important to recruit beneficiaries with the right attitude (e.g. interested in creative experience or the co-design process) and sufficient time.

"Don't expect that everyone wants to be involved and don't be too upset if people don't want to participant in the process. When involving people, expect blue sky ideas… The key is being able to explain clearly and tactfully why some ideas will not work… Set the brief clearly or it may go off on a tangent"

Main Lessons Learned

1. Communication skills are crucial for building a good relationship, which form a basis for successful user collaboration.
2. Some disadvantaged people may lack confidence to co-create and/or make decisions. It is important to help them express themselves and their ideas.
3. It is not practical to expect service users and other beneficiaries to be physically present at all stages of the design process.
4. The co-design process requires a lot of staff time, which is considered high cost for charities and voluntary organisations.
5. By breaking down the co-design process into three key stages: 1) co-creating of the brief, 2) co-designing the concepts and 3) co-evaluating the outcomes; it is easier for users to understand and get involved.
6. Putting designers at the frontline could help identify new service opportunities.

Acknowledgement: The researchers would like to thank all interviewees for their kind co-operation and valuable information.