

Supplement 1 – Interview Questions

S1.1 Interview Questions for Participants with Impaired Hand Function

Design Criteria Questions:

- 1) If a hand exoskeleton was available, how would you like to use it? What types of activities would you like to perform? What types of hand grasping patterns would you most likely use?
- 2) If you had a hand exoskeleton, what types of objects would you want to grasp and hold? How heavy of an object would you like to be able to grab and hold?
 - *A range of weighs from ~100g to 1kg will be brought to the meeting for the participant to manipulate (if they are capable) and add context to this criterion. If not, useful data can still be gained from the description of objects they wish to be able to manipulate.*
- 3) If you were able to use an exoskeleton, how long each day do you think you would like to use it?
- 4) How wide would you like to be able to open your hand and how far would you like to be able to close your hand?
 - *If the participant has a hand with unimpaired function, they will be asked to demonstrate. If not, a researcher will demonstrate for them. The researchers will bring a goniometer and measuring tape to fully quantify any demonstrated movements.*
- 5) We have prepared a demonstration of different hand opening/closing speeds. Would you be able to watch these videos of a hand opening and closing and tell us which speeds seem acceptable, and which would be too slow?
 - *The researchers will show a video of a hand opening and closing over different timeframes (1 second to open/1 second to close, 2 seconds to open/close, 4 seconds to open/close).*
- 6) How large do you feel this item can be on the hand?
 - *The researchers will bring a measuring tape, digital calipers, example electronics enclosures, example actuators, and example battery packs to provide context to the interviewees.*
- 7) Do you think you would have any issues with placing parts of the device on your forearm or closer to your body?
- 8) How heavy to we think is too heavy? If we moved some of the weight to your forearm or closer to your body do you think you would have any issues?
 - *A range of weighs from ~100g to 1kg will be brought to the meeting for the participants to manipulate and add context to this criterion.*
- 9) We have brought a number of small motors with us today. Would you be able to listen to them and tell us which you think make an acceptable amount of noise if they were to be used in a hand exoskeleton that you wore daily?
 - *The researchers will demonstrate the noise produced by four different actuators:*
 - 1) *Firgelli L12-100-210-6-I*
 - 2) *HiTEC HS 40*
 - 3) *HiTEC FS90R*
 - 4) *Dymond D47 Power*

Guided Discussion Questions:

- 1) What do you think would be some of the most important factors for you to want and to use an exoskeleton during your day?
- 2) In your opinion, what would make this device a “success” for you? What functionality or options would make you want to use this device or not want to use it?
- 3) Today we spoke a lot about hand exoskeletons, what about this technology seems most promising to you? What about it makes you the most doubtful?
- 4) Have you used advanced rehabilitation technology before (automated or computerized assistive or rehabilitative technologies)?
 - a. If so which technologies? What were your impressions and why? Can you elaborate on its strengths and weakness and why they are strengths and weaknesses?
 - b. If not, why? What barriers have prevented you from accessing such technologies?
- 5) How would you foresee yourself using a hand exoskeleton system? Would you wear it all day or just sometimes?
- 6) Do you have any additional comments that you would like to express?

S1.2 Interview Questions for Clinician Participants

Design Criteria Questions:

- 1) How large do you feel this device can be on the hand? Should we aim to “minimize size” or do we want to settle on a hard number?
 - *The researchers will bring a measuring tape, digital calipers, example electronics enclosures, example actuators, and example battery packs to provide context to the interviewees.*
- 2) Are there foreseeable issues with placing componentry proximal, perhaps on the forearm?
- 3) How heavy to we think is too heavy to be functional? Again, are there foreseeable issues with moving componentry more proximal?
 - *A range of weighs from ~100g to 100kg will be brought to the meeting for the interviewee group to manipulate and add context to this criterion.*
- 4) How do you foresee the user using this device? What types of hand grasping patterns to you predict as being the most beneficial to the user?
 - *Here the concept of digit actuation and the number of actuators required to achieve various grasp patterns will be discussed.*
- 5) What range of motion do you see as being functional? Do you feel the ability to achieve a fully closed fist is necessary, or can it be a “loose fist,” or partially closed hand? What role do we see the thumb play? Should it be splinted, manually moved or actively moved with a motor?
 - *Members of the interviewee group may be asked to demonstrate their view of a functional range of motion. The researchers will bring a goniometer and measuring tape to fully quantify any demonstrated movements.*
- 6) What types of objects do you predict your clients may want to grasp and hold? How heavy do you predict these objects may be?
 - *The concept of balancing grip strength and actuator size/power requirements will be highlighted here.*
 - *A range of weighs from ~100g to 100kg will be brought to the meeting for the interviewee group to manipulate and add context to this criterion.*

- 7) What are your thoughts on battery/device runtime? How many hours of the day might you predict a patient may use an exoskeleton device?
- 8) We have a number of ways we can trigger such a device to open and close (such as push buttons, EMG sensors, flex sensors and motion sensors). Do you have any particular thoughts on how a client may want to activate their device? Can you identify any obvious limitations?
 - *Here the researchers should also address the idea of modularity in which different triggering mechanisms may be applied for different patients.*
- 9) How adjustable or modular would you like an exoskeleton device to be? Do you prefer one size fits all, or is some customization acceptable? If so to what degree?
- 10) In terms of technical specifications (mechanical, electrical or otherwise) do you feel that we have overlooked anything? If so, please let us know and explain the significance.

Guided Discussion Questions:

- 1) Have you used advanced rehabilitation technology before (automated or computerized assistive or rehabilitative technologies)?
 - a. If so which technologies? What were your impressions and why? Can you elaborate on its strengths and weakness and why they are strengths and weaknesses?
 - b. If not, why? What barriers have prevented you from accessing such technologies?
- 2) How would you foresee yourself and your patients interacting with a hand exoskeleton system in the clinic or at home?
- 3) What specific requirements do you believe are necessary to allow this technology to be successful in the clinic and at home?
- 4) Today we spoke a lot about hand exoskeletons, what about this technology seems most promising to you? What about it make you the most apprehensive?
- 5) If we were to brain storm some outcome measures to evaluate the success of this device, what types of activities would we perform? What types of tests would you like to see? What do you think these test may show?
- 6) Do you have any additional comments that you would like to express?