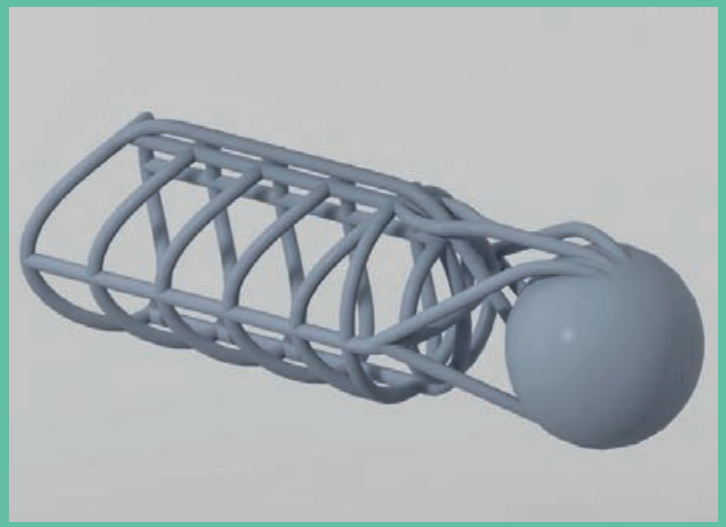
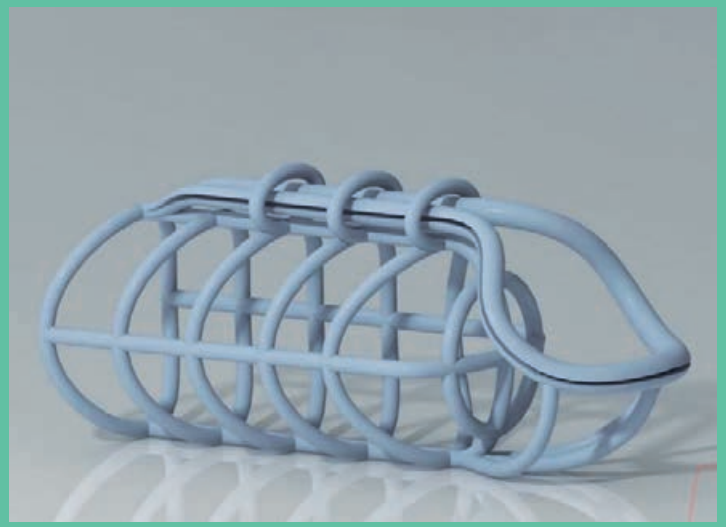
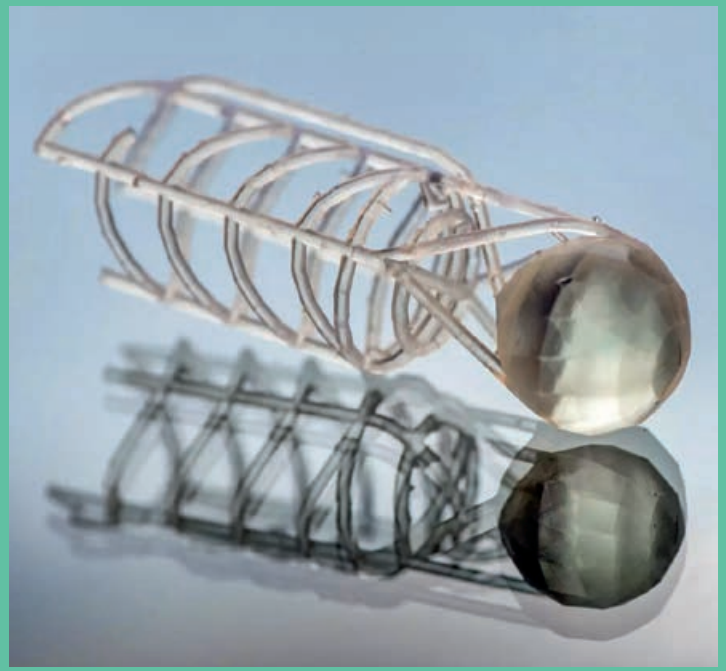
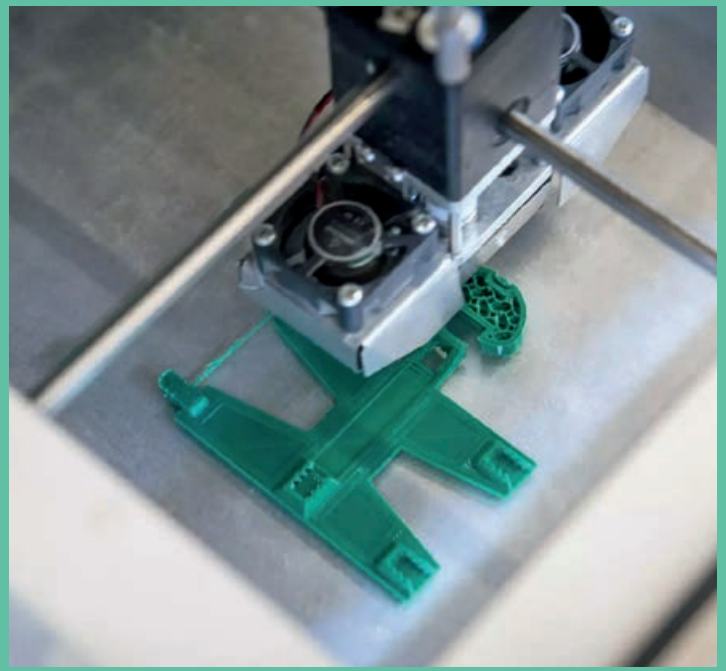








Project Report **Aesthetics**

From day one, our team was united by one common goal: the opportunity to give people who have lost a finger phalanx a piece of their old life back. Losing a phalanx can be a life-changing experience. Our solution to this is to research and prototype accessible, appealing and simple prostheses.

Preface by the Supervisors 40
Journalistic part 42
Scientific part 44
Self-reflection 48
Process description 50

Team	Ioan-Daniel Craciun Nina Dieminger Mohamed Zied Jaber Sophia Leiß Matthias Pixner Kathrin Schmalzl Christina Schwalm
Tutors	Monica Déchène Dorina Siebert
Supervisors	Prof. Dr. Anna Keune Prof. Dr. Cristina Piazza

Preface by the Supervisors

Prof. Dr. Cristina Piazza and Prof. Dr. Anna Keune

Throughout the project, we had many opportunities to connect with the team and to exchange ideas for improving the quality of their work. As the project progressed, we provided input and comments on the team's research instruments, which were critical steps to establish a clear direction for the team's work. We were pleased to see that the team took our feedback into consideration and adjusted their approach, project goals, expectations, and timeline. This helped them outline a plan and keep track of their progress towards team goals.

For the whole project duration, we provided guidance, feedback, and support to the team. We were particularly impressed by the team's energy and creativity, as well as their dedication to working on such an impactful topic. We also had the opportunity to exchange ideas during lab visits to the laboratories of both professorships, which provided the team with a clear and in-depth overview of the supervisors' research activities.

Our interactions with the team were not limited to laboratory environments. For example, we had the opportunity to spend an afternoon at the Lenbachhaus Museum, where we toured an exhibition and spoke with the curator. Additionally, we supported the Junge Akademie Hackathon in which the project team participated, which helped to foster connections to other professionals in the field. These were great opportunities to foster more personal relationships with the team members, which helped to create a supportive and open team environment.

As the project approached its conclusion, we attended the presentation of one team member, who was invited to present the outcome of the team's Aesthetic project at the Seminar Series of the TUM Chair of Cognitive Systems. This was a great accomplishment for the team and we were impressed by the student's ability to communicate the impact and importance of the project to a diverse audience. We also commented on the team's final project report, which helped to ensure that their work was communicated effectively and accurately. We believe that providing feedback on different aspects of the project is an important element of the mentorship. It makes it possible to guide the team in developing the necessary skills for successful future careers.

As mentors, we also learned a lot about each other's research activities through this project. Our lab visits provided an opportunity to exchange knowledge and expertise, which we believe is a critical aspect of interdisciplinary mentorship. Our complementary expertise allowed us to provide more comprehensive guidance and support to the team, which in turn helped them to develop a more impactful and complete understanding of the problem.

Our experience supervising the team Aesthetics was incredibly rewarding and provided valuable insights for us as mentors. We are pleased to have guided the team in designing a solution for a real-world problem and with a strong societal impact. This experience contributed to creating the foundation for a strong synergy between the mentors, which will certainly lead to further collaborations.

Supervisor insights

What does mentoring the team mean for your own research?
Mentoring the team was a lot of fun because of the energy the team brought to our interactions with them. We saw the team bring together different disciplinary perspectives toward designing, developing, and testing responsible and socially meaningful prosthesis technologies. It was insightful to experience the value of bringing together perspectives from robotics with social sciences, including systematic qualitative inquiry and co-design, through their collaboration.

What special experience from your studies/career would you like to share with the scholars?
We have had interdisciplinary team project experiences at the intersection of design, engineering, and social sciences throughout our academic careers. These experiences have contributed to understanding the potential for high-gain results and long-term human learning that collaborative projects across disciplines can have. These experiences can expand young people's sensibilities about the opportunities for societal advancement through responsible technology design long beyond one single project. Some of the unique skills the team gained from participating may only become apparent to the team much later. We wish all of the team members the very best for their future endeavors.

The human side of the project

Who we are
The members of our team come from diverse backgrounds: Architecture, Biochemistry, Engineering, Health and Sport Sciences, Informatics and Physics. At the beginning, we thought that this could hinder the effectiveness of our communications, but in the end it proved to be our biggest asset. The diversity of our backgrounds allowed us to treat every subject with a myriad of different approaches. Ultimately, we saw that we were able to tackle every aspect of our project gracefully, from the more technical-based tasks like researching the available literature, designing and printing prototypes, and simulating different designs, to creating art for the prosthesis and interacting with persons who had lost limbs.

Our mission
Our team was united by one general goal from the first day we met: the possibility of giving people who have suffered an amputation procedure a part of their old life back. Obviously, these surgical procedures result in lower degrees of freedom for their movement, but this can influence even the most minuscule day-to-day tasks we are accustomed to. For example, drinking a cup of tea or taking your dog for a walk in the park can be hugely influenced even by the loss of the tip of a finger. Our solution for these problems is the production of easily accessible and simple prosthetics.

“For the people, by the people”
In order to create a prosthesis that would serve the people that need it the most, we decided to get in contact with potential users. The search for participants for our survey was not an easy one: we started by creating online forms, then we tried contacting bigger organizations with agricultural or more technical profiles, but all these attempts proved unsuccessful. Happily, in the end we managed, through our own connections, to find persons who had suffered a finger amputation during their lives.

Below, we reproduce an interview we conducted during the research. Frau Müller is a 58-year-old woman working in the cleaning domain.* Like any other person, she enjoys going abroad during her holidays, where she likes to read, especially crime novels. However, there is one aspect of her life that she is reminded of every single day.

Frau Müller, could you please tell us what led to you losing your finger?
Frau Müller: Well, it was in ’98, I was working at the time with a milling machine for a personal project, that, mind you, had 2000 rpms; at that speed you don’t even feel it. Just a moment of inattention and … the upper part of my index finger was gone. Sadly, they could not reattach it.

Even though I knew of the missing finger from the beginning, hearing it from you now, gives me a taste of the impact it can have on one's life. One of the first questions I’d like to ask is, do you have phantom pains?
Frau Müller: No, not any. Actually, never had one, now I come to think of it.

I see. You are not wearing any prosthesis. Why is that?
Frau Müller: At the time of the accident, I was not offered any. I suppose I got used to it the way it is now and … did not think of ever getting one afterwards.

If you were to get, let’s say, a state-of-the-art prosthesis. Would you prefer it to be a static or a mov…
Frau Müller: A moving one. Yeah, a moving one.

What is the main argument, in favor of or against, you getting a prosthesis?
Frau Müller: Well, it’s a question of habit, you know. Once you get used to something … you know 25 years have already passed. It’s been the normal for a quarter of a century.

Did you ever want to get a prosthesis?
Frau Müller: I’d say no. Again, one-finger prostheses were not that popular back in the day.

* The persons we have interviewed have wished to protect their privacy so the interview we have presented is made in such a way that the personal data have been modified.

But if you were to wear one, what would be the first thing you would consider about the prosthesis?
Frau Müller: Pfff… the price.

Say the functional aspects of the prosthesis are achieved. What about the aesthetics of the prosthesis. What aspect would you prefer? Would you like to have a technical model, that does not aim to replicate the looks of a biological finger, let's say a more technical look? Or would you rather have something that imitates the real aspect of the finger?
Frau Müller: The one close to the real one. I mean, the rest of them are still real.

Alright. What about the color then?
Frau Müller: My skin's color.

Logically. What kind of material would you prefer? Metal, silicon or a rigid form of plastic?
Frau Müller: I'd say silicone.

And if you had to choose only one. What would you choose between: functionality, comfort and mobility?
Frau Müller: Functionality.

I'd think that that is the most important part when it comes to daily tasks. Frau Müller, would you be available to test one of our models?
Frau Müller: Yes!

Well, that was the interview. Do you have any other suggestions for us?
Frau Müller: No.

Frau Müller, we are really grateful that you took the time to talk to us. We hope we keep in touch.

Thoughts for future

Even though it was completed at the end of our journey in this big project, the interview phase brought to our attention an important detail: the human side of the project. Humans are complex creatures and, happily, diverse. This means that there will never be a one size fits all solution. Each person has a different type of injury, which requires a different type of approach. *Every generalization is wrong, including this one* (a quote which is usually attributed to Mark Twain) is one of the conclusions we have arrived at during our project.

Our experience on this project was a first for all of us. It showed us at first-hand the complexities of trying to combine scientific and technical solutions, which are inherently *cold* and exact, with humans, creatures defined by their complex feelings and emotions. We hope that we will be able to take this experience and make use of it in our future projects.

Everyday impairments caused by the loss of a phalanx and remedy by a newly developed 3D-printed finger prosthesis

Abstract

In order to assist people with a partial hand amputation with a helpful prosthesis that is also aesthetically pleasing and affordable, the current study aims to make an initial contribution. Although research has revealed that partial hand amputation is relatively common in amputations, research literature in this area is relatively sparse compared to the literature on more proximal amputation levels. This qualitative case study examined the challenges and obstacles faced by people with a missing finger phalanx, the extent to which a loss of a finger phalanx affects their daily lives, and the extent to which wearing a prosthesis can help minimize or compensate for the identified challenges of a missing finger-length and pressure pain. Two affected individuals were interviewed about how their everyday practices and quality of life had changed compared to the time before they were missing a finger phalanx. After transcribing the interviews, a descriptive approach was used to identify the main challenges and barriers mentioned. Since the study participants were able to acquire some coping strategies, such as taking a different hand position while playing the guitar, many things were still possible, but wearing a suitable finger prosthesis can provide relief in many (everyday) situations and, thus, can contribute significantly to improving the quality of life of the wearer. These aspects are in need of clarification and should therefore be used as starting points for further research, as a significant reduction of the identified challenges might help affected individuals in the long run.

Background

Calling an amputation of fingers or hands (i.e., a partial hand amputation) a minor upper limb loss or minor amputation, as is sometimes done, trivializes the day-to-day functional and aesthetic problems faced by an affected person (Kim, Powell, et al., 2022). A loss of a finger can have terrible psychological issues and a drastic negative impact on an individual's life, especially if the loss of function results in the loss of a job (Gavrilova et al. 2010). Many people lose a finger. We need to do something to make life better for these people. About 3.6 million people in the United States will be affected by an amputation by 2050 (Ziegler-Graham, MacKenzie,

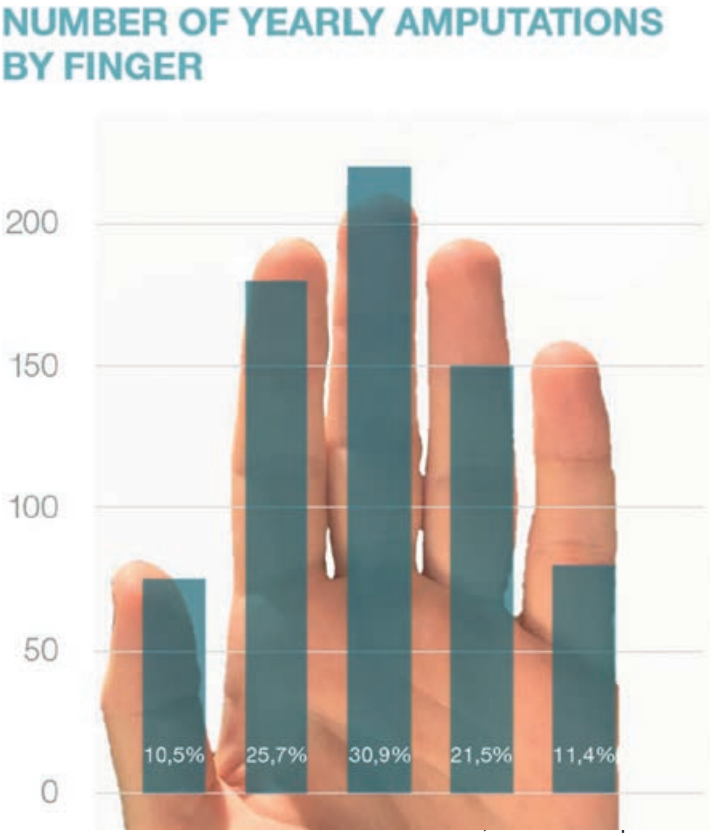


Figure 1: Number of yearly amputations by finger (Harris et al., 2018)

of different grip patterns used by the anatomical hand, the technological complexity of the prosthetic replacement, the durability and self-repairing capacity compared to the anatomical hand, and the restoration of sensation. As a result, many of the affected people need more than one prosthesis (Kim, Powell, et al., 2022). In addition, prosthetic devices also have a major role in the adaptation process to amputation (Kuret et al., 2019).

Goals and Methods

The purpose of the current study was to develop an in-depth understanding of the extent of the impact of a loss of a finger phalanx (LFP; including phalanx amputations and phalanx losses due to, e.g., unintentionally getting into a cutting machine), in everyday life from the perspective of affected individuals through a qualitative case design, as their perspective provides first-hand information. In addition, the extent to which prostheses help minimize or compensate for the challenges of everyday life was investigated. Therefore, the following research questions were developed: (1) What physical and psychological challenges do people with an LFP face compared to their life before and to what extent does the LFP affect their everyday life? (2) How and to what extent can a prosthesis help reduce or compensate for the challenges in daily life of a person with a missing finger phalanx?

Therefore, we developed different prototypes. The first prototype called Sputnik (Figure 2) was created for the first test purposes. Right from the start we observed 4 main factors crucial for our design: (1) Attachment to the finger, (2) Mobility, (3) Sensitivity, and (4) the type of material. Creating a prototype requires a fast, but also functional, method of manufacturing. The first prototype was further developed (Figure 2) and reprinted on the basis of the new findings from the test runs and the interviews with those affected. We were able to print some of the early models by using commercially available 3D printers, such as the TUM Maker Space facility in Garching. This not only allowed us to test implementations of the prosthesis quickly, but also to test the first type of personalization by printing with different filament colors.

A purposive sampling (Sparkes & Smith, 2013) was conducted according to the following inclusion criteria to control for confounding factors: persons affected by an LFP, aged 18 to 60 years, willing to participate in our interview about their individual situation. Initial contact with potential participants was made by phone to inquire about study participation. The potential participants received an information sheet, including the study procedure and purpose, but no further details to avoid bias. The participant agreed to the consent form, including rights and data handling. Both participants (N = 2) were female (mean age = 42.4 years) and one participant was missing the first phalanx of the right hand index finger and the other was missing the first phalanx of the left hand ring finger. All study materials were written in English and German to suit the language of the

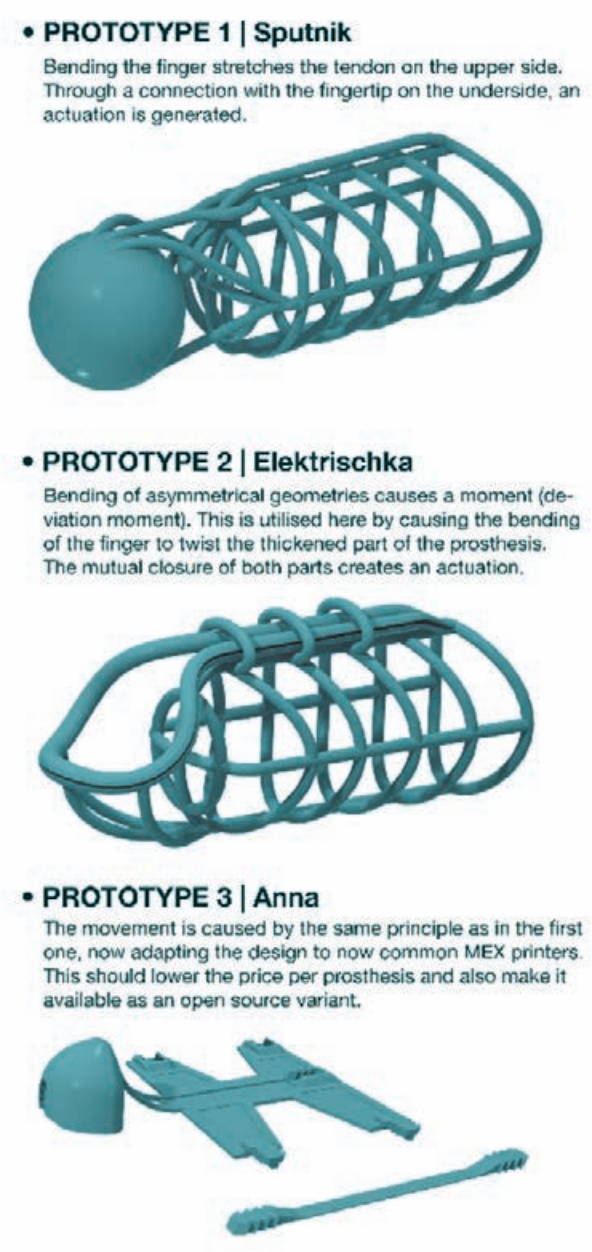


Figure 2: Prototype development

participants. To maintain anonymity, personal data were redacted unless relevant to the research questions.

A qualitative case study design was chosen because it allows for an in-depth understanding (Crowe et al., 2011) of the perspective of persons affected and, therefore, greater focus on the impact of the individual life situation of the respective participants. This design was particularly appropriate since persons affected are difficult to reach for research purposes, as they often do not want to show themselves. An online video-call was used to discuss with the participant the main guidelines of the interview before asking the relevant questions. A general questionnaire was used to collect background information about the study participants, such as demographics. An interview was conducted using a semi-structured interview guide with non-leading, open-ended questions. This approach focuses on the relevant issues through predefined main questions and provides the flexibility to deviate in order to pursue a more detailed response (Gill et al., 2008). The questions are generally specific yet still remain open-ended. An example of such a question is: "What is more important to you? Functionality, mobility, or comfort? Why?"

The main outlines of the interview are as follows: (1) Identity and demographic, (2) prosthetic usage, (3) prosthetic preference, (4) prosthetic impact, and (5) suggestions. The data collection, including the questionnaire and the interview, took place in person between December 2022 and February 2023. This method was most appropriate for creating a comfortable atmosphere for the interviewee and clearly enabled both the interviewer and the interviewee to elaborate and explain their questions and answers directly. This format is also suitable for complex questions and allows for queries and clarifications. All participants opted to carry out the interviews online and anonymously. The interviewer also had an interview schedule in order to evenly distribute the time spent on single questions between participants. The interviews were recorded digitally and then reproduced in an edited transcription. The audio recordings and interview transcripts are only available to the researchers. A descriptive approach was taken to analyze the data and synthesize it with the literature. An inductive approach was used to analyze the data collected.

Outcome and Discussion

In the following, the information from the interview was analyzed in terms of the research questions – (1) what physical and psychological challenges do people with a loss of a finger phalanx face compared to their life before and to what extent does the loss of the finger phalanx affect their everyday life; and (2) how and to what extent can a prosthesis help reduce or compensate for the challenges in daily life of a person with a missing finger phalanx? – and then synthesized with the literature.

One study participant reported problems playing an instrument such as the guitar because the affected finger was not long enough to easily reach the guitar strings. This is an important factor for the study participant, as she is a music teacher by profession. According to Burger and colleagues (2007), in general, less than 50 percent of those affected were actually able to do the same job after a partial hand amputation as they did before the amputation. In addition, people who did not perform manual tasks at work were more easily able to keep the same employment after the amputation (Burger et al., 2007). This underlines how important fitting a finger prosthesis is, so that affected persons do not have to retrain and could thus avert a financial loss. In addition, the study participant mentioned pain when gripping the strings. Pressing on guitar strings causes pain at the distal end of the affected finger. The study participant has neither stump pain (i.e. the residual finger part) nor phantom pain in conditions without pressing against something. Schley and colleagues (2008) reported in their study that phantom sensations and phantom pain are often negative long-term effects of a missing finger (Schley et al., 2008).

Amputations alter the peripheral and central nervous system. This includes phantom limb sensations that cause the amputee to feel as if the missing phalanx is still present. This can be expressed by stabbing, throbbing or electric shock-like sensations up to a cramped or painful immobile sensation of the finger limb (Collins et al., 2018).

There are a number of study limitations for the current study. Due to the case study design (N = 2) and the individual requirements in life, the findings cannot be generalized beyond the context of the examined cases. Recall bias might have occurred because the participant reported experiences and feelings that dated back years. The researchers are not members of the study population and have little experience with it, which may have influenced their understanding of the research topic. In addition, it was not possible to pilot the interview questions in advance on a person comparable to the participant. The data generated by the interview is subject to

many biases and effects. Participants are therefore subject to the Hawthorne effect, as they are constantly reminded that they are missing a finger and/or have a prosthetic throughout the interview. The participants are overly conscious, thus affecting the quality of the data. It would have been helpful to study the reactions of people who came into contact with those who have lost a finger.

Summary and Future Goals

In conclusion, missing finger length and pressure pain were identified as challenges in the everyday life of affected people, which should be scientifically investigated in the future with sufficiently large study groups to determine whether these challenges exist for more affected people. Because the study participants were able to acquire some coping strategies over the course of their lives, many things were still possible, although sometimes in a limited way, but wearing a suitable finger prosthesis can provide relief in many (everyday) situations and thus contribute significantly to improving the quality of life. These aspects should be used as starting points for further research, as a significant reduction of the identified challenges might help several affected individuals in the long term. ■

References

Atroshi, I. & Rosberg, H. (2001). Epidemiology of amputations and severe injuries of the hand. Hand Clinics, 17(3), 343–350. https://doi.org/10.1016/s0749-0712(21)00515-1

Burger, H., Maver, T. & Marincek, C. (2007). Partial hand amputation and work. Disability and Rehabilitation, 29(17), 1317–1321. https://doi.org/10.1080/09638280701320763

Collins, K. L., Russell, H., Schumacher, P. J., Robinson-Freeman, K. E., O'Conor, E., Gibney, K. D., Yambem, O., Dykes, R. W., Waters, R. L. & Tsao, J. W. (2018). A review of current theories and treatments for phantom limb pain. Journal of Clinical Investigation, 128(6), 2168–2176. https://doi.org/10.1172/jci94003

Cone, J. W. & Hueston, J. T. (1974). Psychological aspects of hand injury. The Medical Journal of Australia, 1(4), 104-108. https://doi.org/10.5694/j.1326-5377.1974.tb47661.x

Crowe, S., Cresswell, K., Robertson, A., Huby, G., Avery, A. J. & Sheikh, A. (2011). The case study approach. BMC Medical Research Methodology, 11(1), 100. https://doi.org/10.1186/1471-2288-11-100

Davidson, J. (2004). A comparison of upper limb amputees and patients with upper limb injuries using the Disability of the Arm, Shoulder and Hand (DASH). Disability and Rehabilitation, 26(14–15), 917–923. https://doi.org/10.1080/09638280410001708940

Dillingham, T. R., Pezzin, L. E. & MacKenzie, E. J. (1998). Incidence, acute care length of stay, and discharge to rehabilitation of traumatic amputee patients: An epidemiologic study. Archives of Physical Medicine and Rehabilitation, 79(3), 279–287. https://doi.org/10.1016/s0003-9993(98)90007-7

Gallagher, P. & MacLachlan, M. (1999). Psychological Adjustment and Coping in Adults With Prosthetic Limbs. Behavioral Medicine, 25(3), 117–124. https://doi.org/10.1080/08964289909596741

Gavrilova, N. D., Harijan, A., Schiro, S., Hultman, C. S. & Lee, C. N. (2010). Patterns of Finger Amputation and Replantation in the Setting of a Rapidly Growing Immigrant Population. Annals of Plastic Surgery, 64(5), 534–536. https://doi.org/10.1097/sap.0b013e3181bffcaf

Gill, P., Stewart, K., Treasure, E. & Chadwick, B. L. (2008). Methods of data collection in qualitative research: interviews and focus groups. British Dental Journal, 204(6), 291–295. https://doi.org/10.1038/bdj.2008.192

Harris, A.P., Goodman, A.D., Gil, J.A., Sobel, A.D., Li, N.Y., Raducha, J.E., Baird, G.L., & Katarincic, J.A. (2018). Incidence, Timing, and Risk Factors for Secondary Revision After Primary Revision of Traumatic Digit Amputations. Journal of Hand Surgery. 43(11), 1040.e1-1040.e11. doi: 10.1016/j.jhsa.2018.03.028. Epub 2018 May 5. PMID: 29735290.

Imbinto, I., Peccia, C., Controzzi, M., Cutti, A. G., Davalli, A., Sacchetti, R. & Cipriani, C. (2016). Treatment of the Partial Hand Amputation: An Engineering Perspective. IEEE Reviews in Biomedical Engineering, 9, 32–48. https://doi.org/10.1109/rbme.2016.2523799

Kim, G., Powell, J., Lacey, S., Butkus, J. & Smith, D. H. (2022). Current and emerging prostheses for partial hand amputation: A narrative review. Physical Medicine & Rehabilitation, 15(3), 392-401. https://doi.org/10.1002/pmrj.12764

Kükrek, H., Moog, P., Nedeoglo, E., Wieschollek, S. & Megerle, K. (2022). The Declining Number of Finger Replantations in Germany. Annals of Plastic Surgery, 88(1), 44-48. https://doi.org/10.1097/sap.0000000000003025

Kuret, Z., Burger, H., Vidmar, G. & Maver, T. (2019). Adjustment to finger amputation and silicone finger prosthesis use. Disability and Rehabilitation, 41(11), 1307–1312. https://doi.org/10.1080/09638288.2018.1424954

Schley, M., Wilms, P., Toepfner, S., Schaller, H. P., Schmelz, M., Konrad, C. & Birbaumer, N. (2008). Painful and Nonpainful Phantom and Stump Sensations in Acute Traumatic Amputees. Journal of Trauma-injury Infection and Critical Care, 65(4), 858–864. https://doi.org/10.1097/ta.0b013e31812eed9e

Sparkes, A. C. & Smith, B. (2013). Qualitative Research Methods in Sport, Exercise and Health: From process to product. QMiP Bulletin, 1(19), 27–29. https://doi.org/10.53841/bpsqmip.2015.1.19.27

Ziegler-Graham, K., MacKenzie, E. J., Ephraim, P. L., Travison, T. G. & Brookmeyer, R. (2008). Estimating the Prevalence of Limb Loss in the United States: 2005 to 2050. Archives of Physical Medicine and Rehabilitation, 89(3), 422–429. https://doi.org/10.1016/j.apmr.2007.11.005

Self-reflection

The most challenging part of our experience came at the beginning of the project when we tried to identify a suitable research question. Doing research with different kinds of databases and with people coming from different backgrounds, one might shift the focus only to that subject that is most relevant in their respective fields of study. After weeks of initial research, followed by weeks of refining the search, we came to the conclusion that we should not get lost in our purpose but should stick to the theme of our current TUMJA class of 2022. Hence, we followed the slogan “learning from nature” and named our project accordingly, “aesthetics.” We did so because there are quite a lot of characteristics from the way insects (e.g. ants) move that we could adapt to a prosthesis whose goal – among others – was not to look like a real finger but which actually impresses with a futuristic, nature-based design.

One of our biggest strengths is the interdisciplinarity that makes up our team. We had to learn each other's academic “language” in order to fully function together. This resulted in a distribution of the tasks among all team members. Some of us were firmer on the development process of a prosthesis, others were well-versed in scientific reading and writing, while others were the best ones to turn to when it came to questions of design and of how presentable our ideas might actually look to the public.

Future steps will involve transitioning from prototyping to developing a high-end product. Since our interviewees have already asked to try out the present prototype version, we will be happy to provide them with these. Based on their experiences, further research needs to be conducted on their feedback and adaptation must be made accordingly. Besides following up the active development process, extensive marketing strategies must be undertaken. Lastly, in addition to achieving excellent quality and employing appropriate marketing skills, it will also be essential to be proactive with developing companies.

Acknowledgments

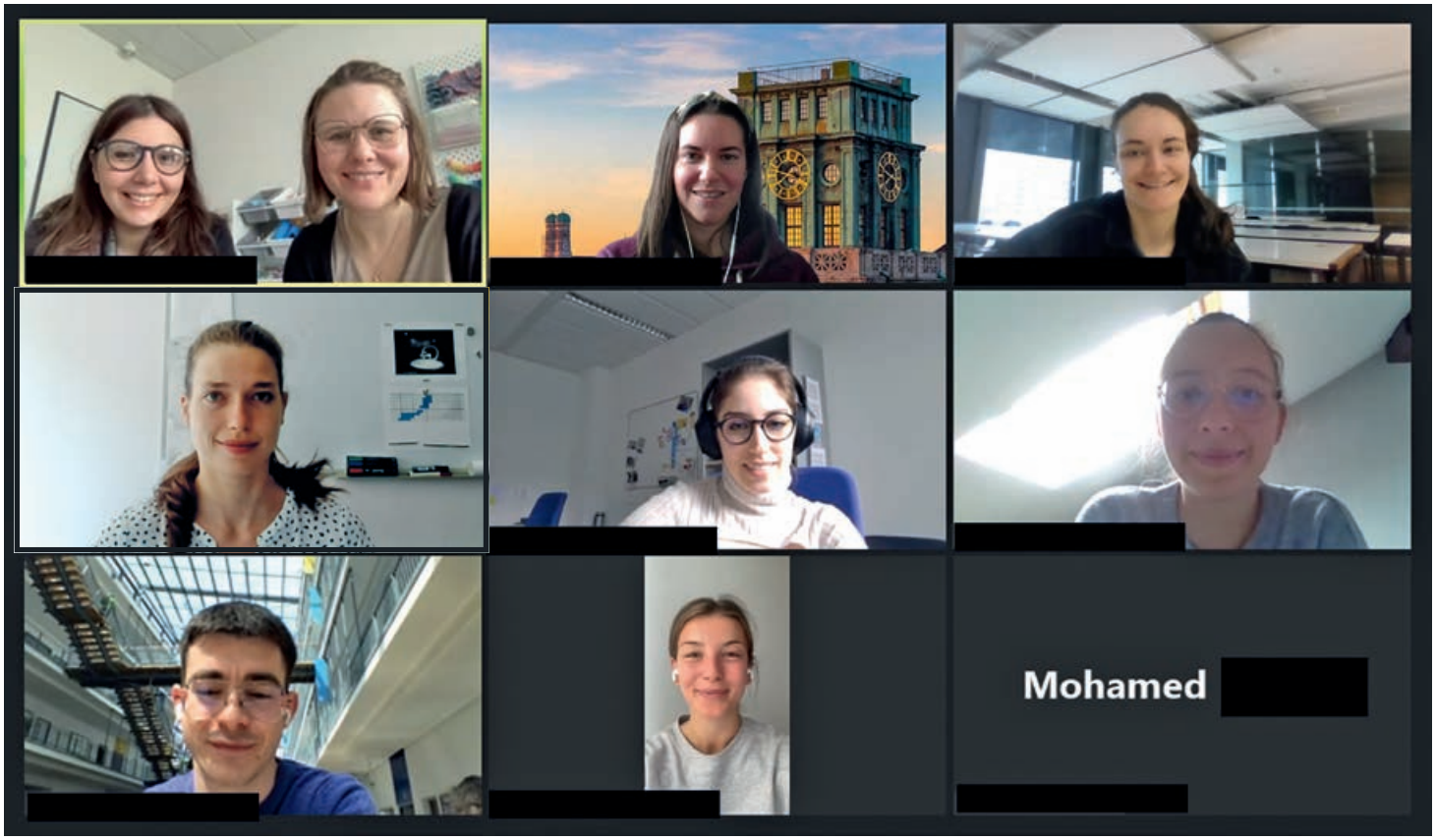
We would like to express a special thanks to our tutors, Moni and Dorina, who did not only give us input when asked but also reached out to us when they stumbled across something outside of our TUMJA bubble. They have demonstrated their greatest support through both virtual and in-person meetings by providing us with information and soft skills but also a fair amount of freedom for creativity and self-initiatives.

In addition, we are deeply thankful for the professional support that we received through our supervisors, Prof Dr. Anna Keune and Prof. Dr. Christina Piazza, for sharing their academic knowledge in the field of prostheses and the current research of respective designs and materials. Moreover, they made us realize that we should not only focus on the development of a prosthesis to fill the research gaps and the market, but also to acknowledge and meet the needs of the specific target group. Thus, they equipped us with much more than their academic knowledge: how to develop a product based on the process of evidence-based research!

Furthermore, we had the honor of speaking to Prof. Gordon Cheng, who is a big player in the field of robotics. He helped us enormously in explaining the current situation on the market and advised us on our best options for our primary goal and on where best to lay our emphasis. Therefore, we offer out great appreciation to him.

Another big thank you goes to UnternehmerTUM-MakerSpace. Thanks to their team we were able to print our very first prototypes and even got the chance to get photographed in the making. Those photos were followed by an interview with Verena Meinecke from the Corporate Communication Center on behalf of TUMJA. Doing those photos and the interview made us even more aware of our purpose and gained us attention for this project outside of TUMJA.

We say a big thank you to the participants of our interviews, which were qualitatively designed and individualized. Without you, the quality of our report would only have been half as good as it is now. You did not only have an impact and a main role in our study, but you also raised our awareness in terms of amputa-



tions and the emotional experience that might be bound to that. Since recruiting our target group was not the easiest part of this program, we are forever grateful for Peter Finger, who – despite his various tasks as the managing head of TUMJA – provided us with information and resources that might be useful for our special purpose.

Lastly, we would like to say thank you so much to the whole team of TUMJA! It has been one amazing experience in the last 20 months – along with the individual studies at TUM. They guided us in the process of finding like-minded people, identifying common interests, developing the research question, and helped in understanding the importance of good scientific practice. This includes the fact that we are not only alumni of TUM but of TUMJA, which offers so many exciting possibilities, including staying on as active members in the scholarship program even after its official ending – whether that be as a mentor for the teams of the new TUMJA classes, or continuing work in the taskforces, or even as a one-on-one mentor later on in life when leaving university and passing on one's own experiences to another student.

All these people contributed to the decision that we want to continue with our work after the official ending of the TUMJA program. Stay tuned!

POSTER 1:

The idea of creating a new prosthesis was in our minds from the beginning. The initial idea came from our mechanical engineer and inspired all of us.

We soon developed the aim of creating a prosthesis, which will be customizable and will also have an aesthetic appearance. This prosthesis should be able to adapt to the individual needs of the user. Hence, the prosthesis should ease the daily life of anyone who has lost a finger.

First, we focused on the manufacturing methods and immediately decided that we wanted to create the prosthesis with additive manufacturing - since this would allow us easily to make adaptions for different users.

Before we could start with the production of the first prototype, we had to define the requirements, which our prosthesis should fulfill. After a thorough literature search, we defined three categories of the technologies we wanted to use: joints, support and sensorial.

After we finished discussing our first thoughts and had a rough overview of what we wanted to do, we started to compile the initial timeline and structure plan.

POSTER 2:

Our primary goal was to find out to what extent amputations impact the everyday life of the patient and to what degree a prosthesis might help to counterbalance that impact. Therefore, we developed a survey. Furthermore, we wanted to figure out to what extent the prosthesis might impact on the environment of users. We did another round of literature search on this topic and developed another survey for the environment.

Unfortunately, we had to admit that the target group of our survey is very specialized and, therefore, hard to reach. After a few weeks, we had to change our plans since we had a very low response to the survey. Thus, we changed the strategy and started to find personal contacts who had lost a finger and planned to do some interviews with them.

Nevertheless, we started to develop the first prototypes. First, we designed them on computer software. After we had finalized our first prototype, we used the Makerspace of TUM to print the first three prototypes named Sputnik, Elektrischka and Anna.

An adaptation of our time schedule was necessary since the low response to our survey slowed the workflow. However, we were able to develop a new time schedule, which should guarantee our final success.

POSTER 3:

The focus was put on interviewing individuals who have experienced a loss of a finger and are willing to talk about their needs. A consent form, demographic and general questions format, and a semi-structured interview were prepared.

Finally, we were able to find four people who have lost a finger and who work in different professions. This variety of backgrounds enables us to have a wider insight into how the loss of a finger impacts on different individuals and different circumstances. With the data from the interviews, we were able to summarize the impact of a prosthesis.

Nevertheless, we had to adapt our time schedule again since the scheduling with the interview partners was quite difficult.

Simultaneously, we started to prepare our final research paper and started to summarize our literature research.

With the data from the interviews, we were able to adapt the functionality and design of our prosthesis. We were working on the final prosthesis and made a started on its production.

POSTER 4:

The emphasis was on evaluating the interviews with affected persons who have experienced the loss of a finger phalanx and are willing to talk about their needs.

First, the questionnaire on demographic and general questions was evaluated. Then, the semi-structured interviews were transcribed and qualitatively analyzed. Based on these results, we were able to summarize the impact of wearing or not wearing a prosthesis on daily life and well-being. Finally, the analyzed interview data were discussed in the context of the existing research literature on this research area.

With the data thus obtained, we were able to rethink the functionality and design of our prosthesis and incorporate it into the development of the final prosthesis.

It was very challenging because the study participants had very different backgrounds and had never worn a prosthesis before, but it also shows that we are going in the right direction with our research and there is still a lot of potential here.