SUMMARY

This thesis discusses the development of a new electrical connection for the HSC safety edge manufactured by the Haake Technik GmbH. These safety edges are employed in several different safety applications, where movement of a machine part creates dangerous shearing or crushing edges. This includes, for example, sliding doors, theatre stages, revolving doors, and machine covers. Safety edges usually consist of a mounting profile, holding a rubber profile containing a sensor element. In the HSC a chain of conductive contact elements is used, called the contact chain. When the safety edge collides with an obstacle, for example, an arm, the profile is deformed locally, and the contact elements are separated, triggering the safety function. This signal can then be integrated into the machine controls, to act as an emergency stop, to turn off the dangerous movement.

The goal of this thesis is, to find a new solution for assembling the safety edge, mainly considering the electrical connections. Currently, certain assembly steps of the HSC take a lot of time. Handling of the parts and the partly assembled edges should be simplified and assembly time reduced. Also, all assembly steps should be made reliable, so that errors and variations in quality are less likely to happen. Furthermore, installation, repair, and replacement of the safety edges at the customer will also be looked at and improved in the new concept.

These areas were further investigated, to be able to come up with fitting concepts in the end. For this, the different stages the product goes through from assembly until replacement were run through to find any resulting requirements for the new design. Further, the product itself and its available variations were looked at. Other available products on the market were analyzed, to look for transferrable concepts, methods, and parts. Results and findings from a previous (discontinued) project of the company, that also focused on some of the goals of this thesis were also integrated.

Together with any normative requirements, the results of these further analyses were collected in a requirement list.

Based on these, several concepts were created, tested and compared. By modifying current parts from production and using quick 3D printed prototypes, early feedback on the handling of these concepts could be generated, and further iterated on. Several sub-concepts were further developed, and in the end, combined into a final concept.

In this concept, the sealing of the chain channel, and contacting the contact chain is combined into one plug, for which normally multiple assembly steps are necessary. It uses a banana plug to contact the contact chain, by sliding into a conductive rivet on the endpiece. Using this banana plug makes it possible for the endpiece to slide back and forth on it a bit. This is important, as safety edges can expand due to, for example, temperature differences. The plug accounts for these changes, without losing connection, or causing false actuations of the edge. On the other side, it has a sealing plug, to close off the chain channel. The plug outputs the signal out of the chain channel through a flat metal clamp lying flat against the channel. Before, rubber grommets were used, that are hard to pull in, and have a higher risk of breaking the cables on extreme actuations.

The clamp also saves room which is necessary to allow protection for overrun traverse in the edges. From there it is connected to a small foot duct piece, which plugs into a hole in the foot of the rubber profile. Before, wires were just directly led out of the foot, which sometimes risked breaking it on the edge of the aluminum profile while pulling in. Not having this risk anymore also allows customers to do this step themselves, which makes it possible for them to use a simpler attachment method.
After the edge is pulled into the aluminum profile, the outlet cable is screwed onto the foot duct from the outside. This allows for a separate replacement of the edge or the cable in case it is broken, and also acts as a slip stop. Currently, the profiles have a tight fit, so they do not slide out. As the rubber profile is fixed by this screw, the foot can be made a bit smaller, to make pulling in easier.
In tests, assembly time was reduced by using the new parts, and good switching behavior was achieved. The new parts are going to be a bit more expensive than the current standard parts, however, improvements in assembly time, handling, and replacement are likely going to outweigh this. Before the concept can fully be integrated, still a lot of tests are necessary, to make sure normative requirements are fulfilled. Therefore, further development is going to focus on one of the parts of this concept at first.