# The Automatic Crimper

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The client for this bachelor assignment was Allinq. Allinq is a Dutch network administrator in the telecom industry and is responsible for the entire lifecycle of the complete network infrastructure of their prime client, KPN.

The assignment was commissioned because of the big demand for copper migration in the KPN network. This migration is performed with a crimper tool, called Picabond. The job consists of opening up an underground cable, consisting of 1800 copper wires. For the migration, the cable is cut and all these wires need to be reconnected to a new cable by using the Picabond on each single wire pair. This job takes two operators and approximately six hours, during the night. The company will benefit from a quicker tool, that will also allow better ergonomics for the field engineers because of the unhealthy working conditions caused by cold, ground water, working posture, and repetitiveness. Hence, the goal of this assignment was to design a new tool to improve time efficiency and ergonomics, preferably by the use of automation. This is translated to the following research question:

*"How can the tool that is used to connect copper wires, be improved in such a way that the labor intensity is decreased and the efficiency is increased?"*

**Figure 2:** Picabond tool


**Figure 1:** Migration scene

During preliminary research, ergonomics evaluation methods were found to assess repetitiveness and posture of a specific job: the Occupational Repetitiveness Analysis (OCRA)[1] and the Rapid Entire Body

[1] Occhipinti, E., & Colombini, D. (2006). The OCRA Method: Assessment of Exposure to Occupational Repetitive Actions of the Upper Limbs. *International Encyclopedia of Ergonomics and Human Factors. Volume I*, *3*, 3289–3297. https://doi.org/0748408479

Analysis (REBA)[2]. The current situation was analyzed by doing field research and using video footage which was evaluated with the before mentioned methods. Also, the duration of the job and its sub tasks were measured. Analyzing the tool revealed the working principle of the Picabond. It involves pushing a metal connector piece into a grooved mold. This deforms (= crimps) the connector causing it to capture the wires and penetrating their insulation, establishing an electric connection. The market research revealed another interesting – but long deprecated – tool. It uses the same connectors as the Picabond, but mounted on a plastic strip that is automatically supplied. A copy was tracked down and purchased on eBay to further examine.

During the design phase, three concepts were developed. An animation was made of each concept to show the working principle and to give an indication of the prospected duration of the (partially automated) process. The concepts were scored on seven aspects with a multi-criteria analysis, resulting in a single best concept.

A new iteration of this concept was made which led to the building of a full-scale physical model. With the model, the basic principles could be tested which revealed some points of attention that qualified for immediate improvement. The model was also used to organize a first feedback session with the end user: two field engineers were invited and gave valuable (both critical and positive) input. Their main concern was the size of the tool, causing overlength in the wire which would be hard to eliminate due to technical risks. They liked the overall idea of the concept.

A final iteration was done and the concept was elaborated in more details. A final digital 3D model is made incorporating a possible design. The mechanics have been given more attention here, and a compact yet powerful solution is proposed. The size has been reduced to no more than the depth of the current Picabond tool, with dimensions of approximately 21x25x12 cm.

The Picabond Automator – the final concept – works by inserting four pairs of wire ends into eight wire grippers, fitted on two parallel disks. With the press on a button, these disks rotate, aligning a set of grippers in front of the crimp dies. Here the crimping starts, where the connector has already been supplied by a mechanical chain. After crimping, the established connection is automatically ejected. Then the disks rotate further to align the next set of grippers, repeating this process four times in total. The Picabond Automator is 49% faster than the current Picabond. On ergonomics, the OCRA index has improved, bringing the risk at musculoskeletal disorders down from 10% to 6%. This is primarily thanks to the lower frequency of manual actions to be performed, because it is partly automated. Unfortunately, improvements in the working posture were not made and will probably require a redesign of the entire work space, not just the tool.

Recommendations for further research include investigating the type of materials and the specifications for the construction and actuators to be used. For Allinq, it is recommended to start collaborating with parties that are specialized in precision mechanics and low volume manufacturing (the product will only be used in house). Attention should also be given to phased implementation of the product because the migration project has a limited duration. The concept does lend itself well for this because of its modular design.

[2] Hignett, S., & McAtamney, L. (2000, April 3). Rapid Entire Body Assessment (REBA). *Applied Ergonomics*. Elsevier Ltd. https://doi.org/10.1016/S0003-6870(99)00039-3

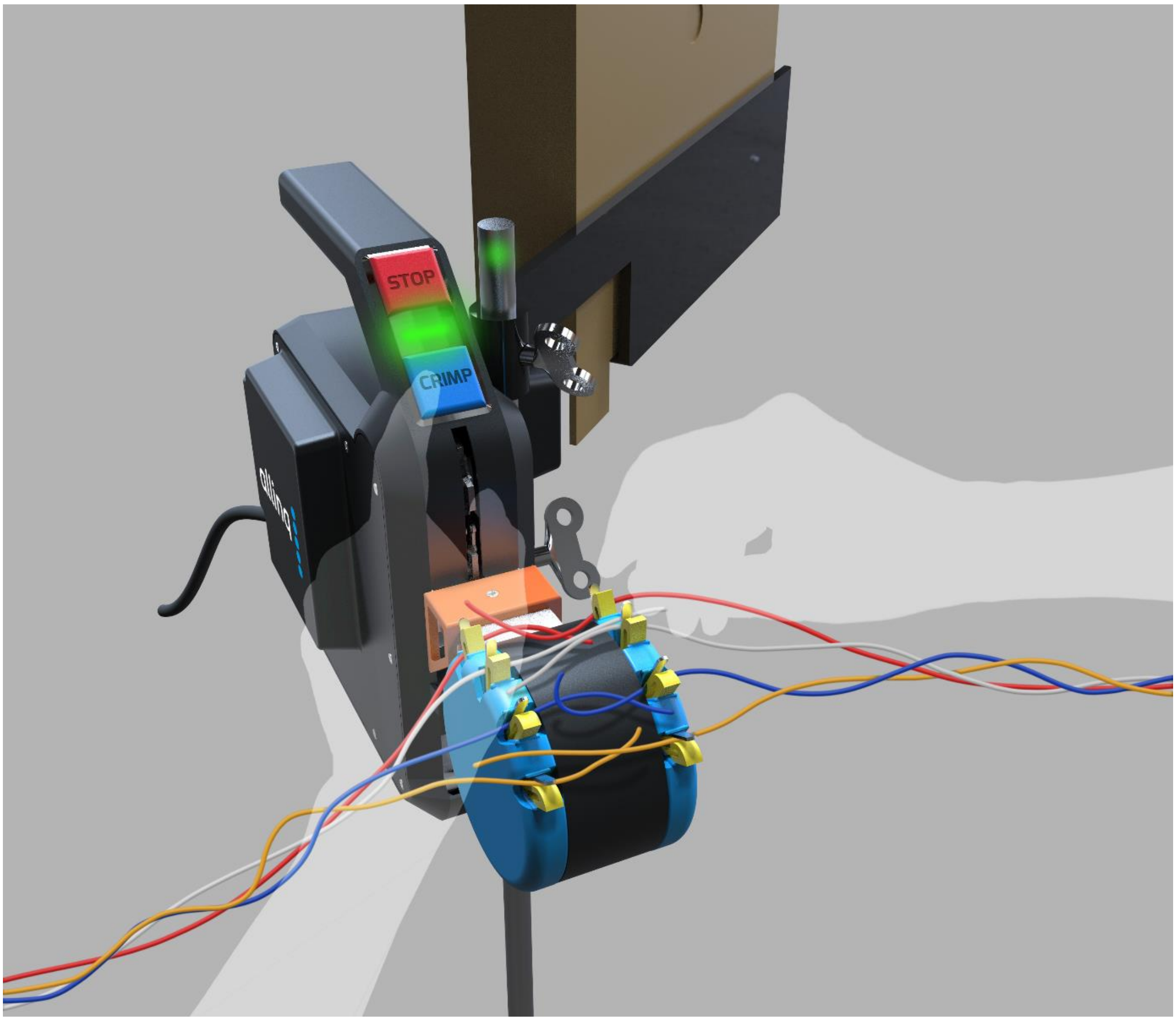


**Figure 3:** Final concept - Picabond Automator