

# White Paper: Automatic Plug Assembly Development Project.

## Executive Summary

We want to revolute the wiring harness production. In order to achieve this goal, the following development steps are necessary:

- Automatic preparation of the single wires.
- Automatic wire routing.
- Automatic insertion of the crimped contacts into the connector housing.

This will enable ams reichert to:

- Reduce the manufacturing costs.
- Better product quality.
- Resource savings for personnel, space and material.
- Possibility to locate the production close to our customers.

## Introduction

The wiring harness production consist of mainly manual work steps. The automation of this production failed in the past due to the large variety of the wiring harnesses, the difficult handling of thin and flexible wires and the complex motion sequences.

The ongoing pressure to reduce the costs was countered by shifting the production away from the OEMs production sites to low-wage countries.

With a fully automated production we can achieve a more cost-effective production with a higher quality standard and the possibility to locate the wiring harness production close to our customers.

## Innovation

The automatic plug assembly is one of the key technologies for the automated wiring harness production. In order to realise the automatic plug assembly an artificial hand-eye coordination has to be developed.

This technology is not yet available at the market and is one of the major innovations in this project.

## Detailed view on the plug assembly

After the routing of the single wire, it is necessary to insert the contacts into the connector housing.

The narrow tolerances between the housing cavity and the contact part led to a certain degree of frictional locking. However, the dominating connection is the form fit, which is ensured by the locking lugs as part of the crimped contact. In the case of rectangular plugs, precise angular alignment is required in addition to position orientation (see Figure 1). While humans can efficiently master this task through the interaction of their sense of touch and spatial perception, this is a major challenge for automatic plug systems.

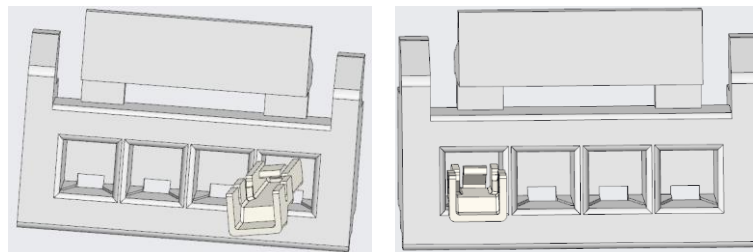


Figure 1: Wrong alignment (left) and correct alignment (right).

## Technical Considerations

During primarily testing, it was shown that the correct plugging is possible with repeat accuracy, if the connector is positioned exactly in the gripper and the connector housing is in a clearly defined position.

This result is proofing, that the positioning accuracy of the portal system (automatic wiring harness routing machine) is sufficient. However, if interferences occur, like shifting or twisting of the cable or the connector housing, it will result in a faulty connection. Deviations in the range of millimetre or a few degrees in angle will lead already to a negative result. Additionally, an incorrect process cannot be detected without some kind of monitoring system.

During the routing process, shifts and twists of the connector are possible. To counter this, a sensor system has to be developed for a reliable automatic plugging process.

## Artificial hand-eye coordination

Even the insertion of the smallest connector does not pose a great challenge for an experienced worker. The human hand is perfect for gripping different shapes. Thanks to the sense of touch in the fingertips, the employee is always aware of whether a component has been grabbed and how it is oriented.

During the manual plugging process, a folding of the cable or a wrong positioning of the connector in front of the connector housing can be recognized immediately. In combination with the three-dimensional vision a fast and accurate pre-positioning of the connector is possible. Even during the plugging, small unintended movements of the housing or the connector will be immediate recognized and compensated.

We try to imitated the human senses through force sensors, machine vision and depth perception through a three-dimensional camera system. All the data will be completely evaluated by a superordinate logic and set in relation to each other. On the one hand, this creates a certain redundancy and on the other hand incomplete or faulty data can be supplemented by the superimposed evaluation. This is essential for the complex work steps and enables additional process stability.

The real innovation in this development project is the holistic view of several sensors for one process step. High tech solutions are commercially available for individual sensor groups (e.g. machine vision). However, a combination of several sensor and measuring systems with different working principles is not available for our specific challenge.

The development of the hard- and software for an automatic plug assembly, based on an artificial hand-eye coordination is a key technological innovation for the automatic wiring harness production.

## Outlook

The solution, developed in this project will support the main process. The process-reliable automatic plug assembly enables a higher degree of automation of the wiring harness production. This enables an even more efficient and higher quality process.

By the knowledge gained in this project, especially in the field of handling limp components, further related assembly processes can be automated.

The main focus of this development project is for ams reichert, to further reduce the manufacturing costs and increase the product quality. Furthermore, personal, space and material can be saved. In combination, this allows ams reichert to produce close to our customers with competitive prices even in high-wage countries.