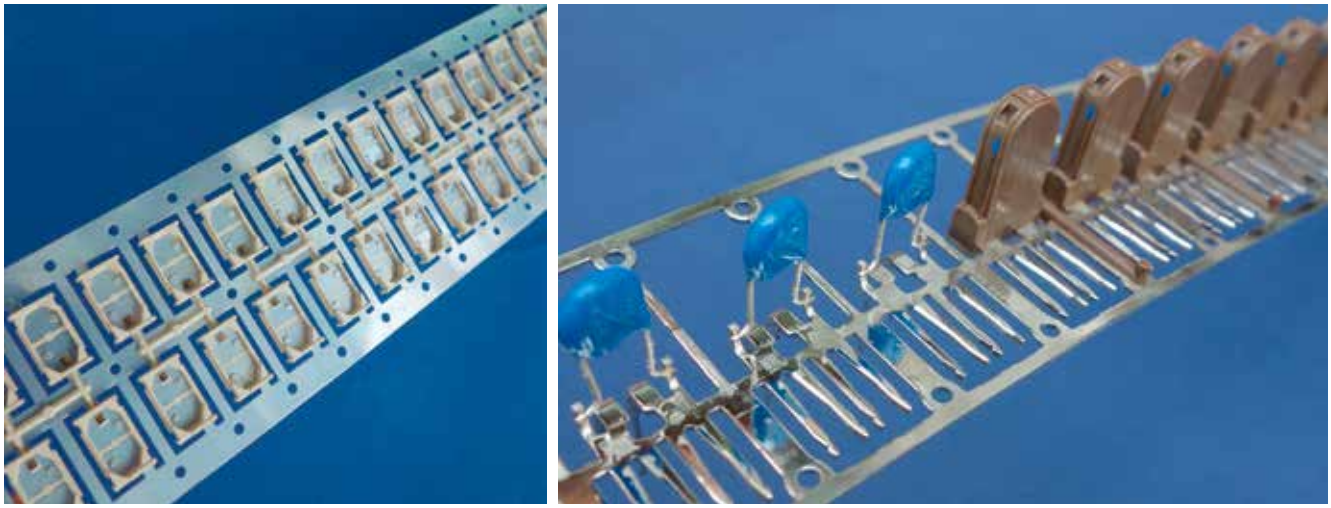

Modular system solutions enable the flexible production of precision hybrid components made of metal and plastic (© MMS)

Both Economical and Flexible

Engel and MMS Offer Modular System Solutions for Metal/Plastic Hybrid Components

Highly specialized production cells, tailored precisely to the respective product, are used to produce connectors, switches or contacts in an efficient way. The cells integrate the various work processes, from metalworking to plastics injection molding. With product variance rising while batch sizes fall, manufacturers are increasingly looking for more flexible production options.

Precision hybrid components made of metal and plastic are required in a wide variety of industries, from the automotive and domestic appliances industries to telecommunications and medical technology. As different as the applications may be, the industries have one thing in common: they need to adapt to increasing individualization of consumer goods and products. For production, this means more flexible processes and systems that can be retrofitted more quickly, with process integration and automation ensuring that unit costs do not increase.

Modular systems are key to this. In addition, it is above all the cooperation between the technology providers that determines the success of the projects. After all, the intent is to connect the world of metal with the world of plastics. At the American plastics trade fair NPE 2018 in Orlando, Florida, system partners Engel and Modular Molding Systems (MMS) presented how this can look in practice.

Linear Production Line on a Compact Footprint

Thermal switch housings were produced at the Engel booth. From the punching of the contacts to the inspection and labeling of ready-to-use electronic components, all work steps are fully automated in the highly integrated production cell (**Fig. 1**). The raw material for the brass carrier plates is fed directly from a reel and pre-punched including a thread in-line. The thread is servo-electrically tapped before the carrier plates – still on the strip – are overmolded with glass-filled nylon on an Engel insert 60V/35 single vertical injection molding machine.

Quality control happens also within the production process. In addition to the camera inspection, high voltage testing is integrated into the tool, thus already guaranteeing 100 % short-circuit inspection during production. In order to ensure seamless traceability, the good quality parts are labeled by laser before the sprue and carrier tabs are removed and the components are separated from the strip. Eight ready-to-install electronic components leave the production cell every 20 s.

Thermal switches, such as those used for monitoring electric motors in automobiles or in domestic appliances, are traditionally produced in a complex, multi-stage process. Typically the metal components are punched and overmolded even at different locations. This not only requires a considerable logistics overhead, but also uses large amounts of material because two independent processes need to be ramped up. This is a considerable cost factor, especially where non-ferrous metals are used, that can be avoided through the highly integrated process.

Safely Managing Complexity

Thanks to the modular design of the MMS systems, additional processing modules

Fig. 1. The raw material for manufacturing thermal switch housings is fed directly from the reel and pre-punched, including thread tapping, in-line (© Engel/MMS)

can be easily integrated, for example, for resistance or laser welding, riveting, assembly or cleaning of the parts. Regardless of the number of modules, the entire process can be visualized and controlled via the CC300 control unit on the insert machine (**Fig. 2**). This is an essential feature of the integrated solutions, as it considerably reduces complexity and ensures simple and safe operation of the entire process. A handheld operator panel is also available for setup and manual work.

The production cell presented at NPE is an example of a linear production line that is mainly used for reel-to-reel production when no further handling systems and robots are required. The carrier strip, known as a lead frame, handles transportation from one module to the next. At the end of the manufacturing process, the hybrid components are separated from the lead frame and the remaining metal strip is usually rewound.

The injection molding machine is located between the various metalworking modules. This linear arrangement makes the system particularly clear and simplifies operation. In addition, the linear arrangement enables particularly compact systems and thus supports the trend towards greater productivity per unit of area. In many companies, floorspace has already become an important gage of efficiency.

Radial Arrangement with Rotary Table Machine for Short Cycle Times

In contrast, radial or transfer systems are used where the hybrid components must not be attached to a carrier strip, or the metal parts are significantly smaller than the plastic components. The core of these production lines are injection molding machines equipped with a multi-station rotary table that allow the overmolded finished parts to be removed and new metal inserts to be placed in the mold at the same time.

Usually the preparatory machining modules are arranged to the left of the injection molding machine, and the modules for the downstream processes such as quality assurance and marking are arranged to the right. The handling system is located in between. Linear robots – also with multiple x- or z-axes – keep the layout particularly clear. Depending on the application and product, Scara and articulated robots are often used. The radial arrangement allows the modules upstream and downstream of the injection molding step to be quickly converted or supplemented.

Manufacturing of four-pin plug inserts, for example (**Fig. 3**), requires a radial system concept. The pre-punched and galvanized strip with gold-plated contact area is unwound from a coil by means of an automatic swivel winder. The swivel winder supports replacement of the strip during operation. The coil can be changed within a very short time without damaging the plastic material thermally.

In the cam-controlled punching and bending module, the connecting webs are cut and the contacts bent. Subsequent joining and sealing in the injection mold requires a particularly high degree of precision, which is ensured by feeding the parts on a carrier strip. In addition, bending the parts immediately before overmolding has the advantage that stress fluctuations in the strip can still be compensated for.

The total of 32 contacts (4 x 8) are separated in the punching tool and inserted into the injection mold by an robot in Scara design (Engel easix). The Engel insert 60V/35 XS injection molding machine has two bottom mold halves on the rotary table for inserting the next set of contacts while the parts are being overmolded. Parallel operation reduces the cycle time and avoids energy losses, as the clamping unit only needs to be opened briefly each time.

Eight plug inserts are produced per shot, and then removed by an Engel viper 6 linear robot. Visual quality control takes place immediately after part removal. The camera is installed on the robot gripper for this purpose. The robot transfers the parts to a rotary table, which serves as a buffer for the subsequent checking and assembly processes. With its eight stations, the rotary table integrates the assembly of sealing elements, various camera and laser testing stations and the required repositioning steps.

Eight parts are produced in 24 s. The finished component parts are transferred to a tray server by a servo handling system and the filled trays are stored and »

Fig. 2. Regardless of the number of modules, the entire process can be visualized and controlled via the CC300 control unit on the insert machine (© Engel)

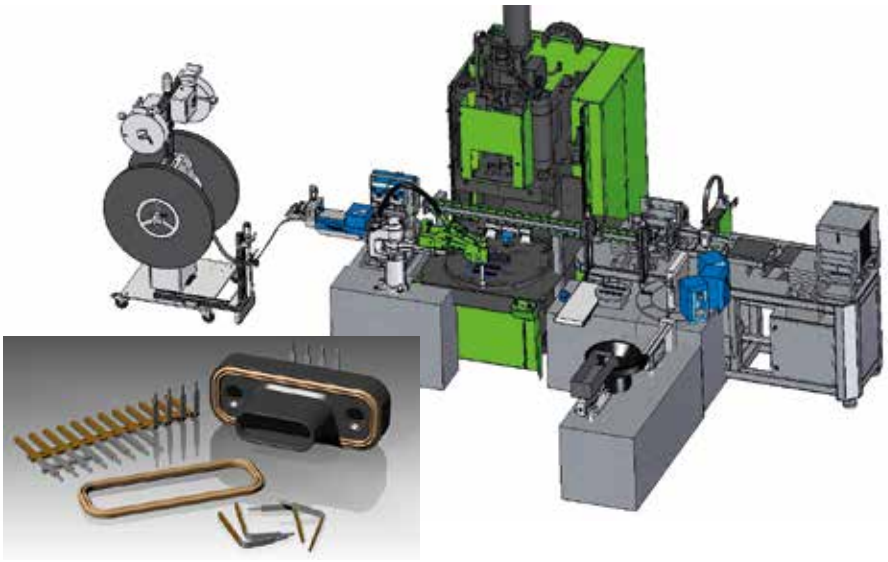

Fig. 3. Radial plant layouts are used where the hybrid components must not be attached to a carrier strip. This is the case, for example, in the production of four-pin plug inserts (© MMS)

stacked. Reject moldings are automatically separated.

Highest Machining Precision Enables Complete Automation

Manufacturing contact elements is another example of a production cell with a radial arrangement (**Fig. 4**). Due to the complexity of the conducting paths and restricted space in the component, the lead frame in this application must be divided into two strips. Here too, the prepunched and galvanized strips are fed to the injection molding machine from the left. The two feeding and bending stations have an identical layout. The strips are unwound by a swivel winder, while the strip is fed into the line via servo-electric gripper feeders.

In the cam-controlled punching and bending module with its six independent slide units, the contacts are exposed by cutting before bending and separating. With the aid of a moving cutting plate and two servo handling systems, the lead frames are transferred and placed in the correct positions in the injection mold. Before overmolding, the contacts are bent in a further bending module. The target of 90° must be precisely adhered to as the upper mold half must slot in over the contacts for overmolding. The position of the contacts is checked with the aid of a camera before the left-hand robot of the two easix articulated robots picks up the contacts and inserts them correctly into the 2-cavity injection mold.

In this application, too, the insert vertical machine is equipped with a rotary table to implement all of the handling steps for overmolding. The easix articulated robot mounted to the right of the clamping unit removes the finished contact elements and deposits them in a blister tray.

The handling concept with two articulated robots, each located to the side of the clamping unit, ensures excellent accessibility of the mold area. In addition, parallel operation of two robots in this application reduces the cycle time, considering that the injection molding step does not require a long cooling time due to the small component surfaces. ■

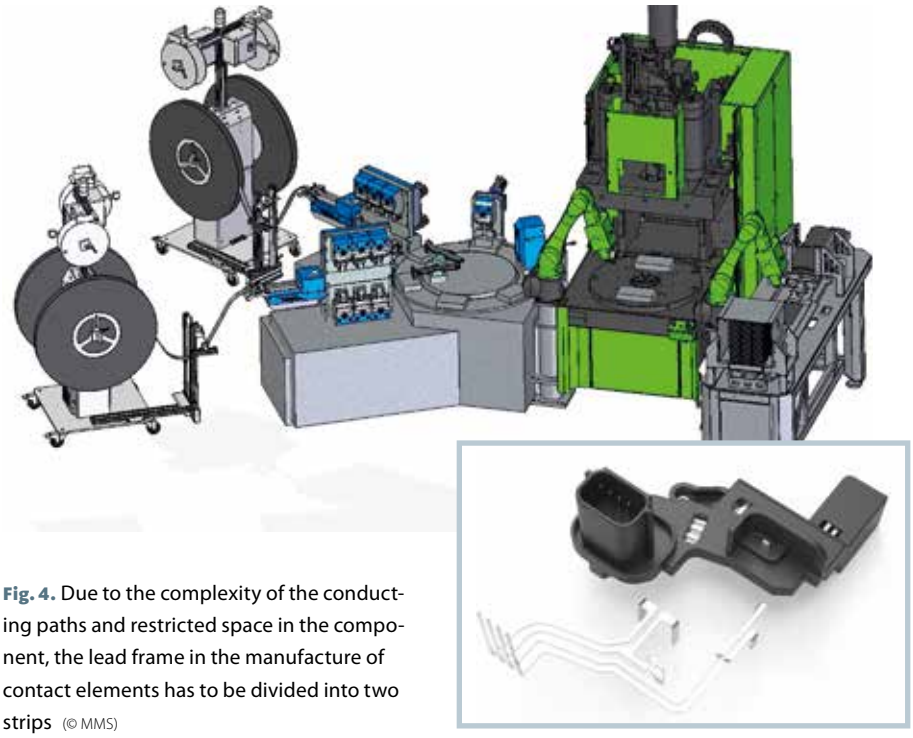

Fig. 4. Due to the complexity of the conducting paths and restricted space in the component, the lead frame in the manufacture of contact elements has to be divided into two strips (© MMS)

The Authors

Heinz Rasinger is Vice President of the Business Unit Teletronics at Engel Austria GmbH in Schwertberg, Austria; heinz.rasinger@engel.at
Rudolf Ehrenweber is Head of Sales at the Business Unit Teletronics at Engel; rudolf.ehrenweber@engel.at
Peter Buxbaum is the Owner and Managing Director of MMS – Modular Molding Systems GmbH in Berndorf, Austria; pb@mms-technology.com

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