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PRESS INFORMATION

Innovations for assembly processes and quality assurance

Fraunhofer IWU with three world firsts at AUTOMATICA 2014

At the 6th AUTOMATICA International Trade Fair for Automation and Mechatronics (Hall B4/Stand 228), the Fraunhofer Institute for Machine Tools and Forming Technology IWU is presenting three world firsts from June 3-6. A snake robot will be used to demonstrate how aircraft wing assembly can be automated. An "intelligent" adaptive alignment system will bring a completely new and much quicker quality control loop to car body construction. Hitherto, the fully automated inspection of screw threads has not been possible. Scientists have now succeeded in making a breakthrough using an innovative "sensitive" robot.

Air traffic has increased rapidly in recent decades. The aircraft manufacturer, Airbus, forecasts that this will triple by 2030.
In order to cater for the resulting high demand for transportation means, the modernization of production processes in aircraft construction is essential. So far, aircraft wing assembly has been a largely manual process, resulting in limited production quantities. This is due to the structure of the wing: in order to achieve the necessary load-bearing capacity and flexibility, the wing is generally constructed from separate "chambers" only a few square meters in size. Assembly personnel must gain access to these work spaces via small openings or man-holes in order to secure the wing components with shoulder screws and to seal joints. Thus, this procedure is time-consuming, physically demanding and tiring. In addition there are health implications of the fumes created by the sealant. Conventional industrial robots cannot get through the small openings. Moreover, their rigid limbs cannot reach into the furthest corners of these workspaces, which can be up to five meters long. What was needed was a slim robot with extreme twisting and turning capability.

Modeled according to nature: automated assembly for aircraft wings

Researchers at the Fraunhofer Institute for Machine Tools and Forming Technology IWU in Chemnitz are currently developing such an automated solution with flexible limbs as part of a project sponsored by the Sächsische Aufbaubank (SAB). "The robot is made up of eight swivel joints. Its linked series of short universal and pivot joints allow it to operate within a narrow turning radius, snaking its way into the farthest corners of the chamber. This is why we also like to call it a snake robot," says **Marco Breitfeld,**

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project manager in charge at the IWU. The robot, which is 2.5 meters long, is able to carry tools weighing up to 15 kg in addition to its own weight and is thereby capable of executing production relevance tasks. Both the load-bearing aspect and the flexibility of each individual joint of the robot presented a challenge. The structure and functionality of the individual joints are based on the muscle formation in the hand. A specially developed drive mechanism consisting of a spindle drive and pulley system makes it possible to insert very small drive motors, resulting in a compact construction entirely suited for its limited working space. Scientists drew on models taken from nature for both the construction and movement pattern of the robot, giving rise to its nickname "Snake Robot".

The plan is to mount the 60 kg robot on a mobile platform or on rails so that it can travel beneath the wings and snake its way into each of the chambers. Fraunhofer IWU researchers are currently testing the mechanical concept and the control system. They will present a demonstration model of the interior space robot at the AUTOMATICA trade fair in Munich from June 3 to 6.

Intelligent alignment system: more efficient quality control in car body construction

Clearance in a car body must be exact to the last millimeter. The prerequisite for this is that the measurements of every single component are exactly matched to those of the others. In the course of construction, the assemblies are therefore precisely fixed in place by specific clamping elements. A geometry check, carried out to a tenth of a millimeter, monitors precise alignment. Variations in materials or other constraints lead to deviations, meaning that the devices must be constantly realigned – sometimes more than once per shift. The devices involved in a typical door construction alone can be monitored at around 430 different points. "Correct adjustment is carried out manually based on empirical values and mostly according to the principle of trial and error," explains **Rayk Fritzsche, group manager in the Fraunhofer IWU assembly unit.** Extensive quality assurance is required to ensure that parameters match requirements, and so the quality loop is long and the resulting interruptions to production and finishing are expensive and significantly reduce productivity. In the future, monitoring personnel will be supported by an IT system developed by the Fraunhofer IWU as part of an SAB project and which will be presented for the first time at AUTOMATICA. On the basis of an "artificial neural network" with a mode of action imitating the human nervous system, the researchers are developing intelligent software that is also deserving of this description. The system is adaptive and transfers the empirical values of the geometry checkers to a database. "After about 30 sample data sets, the alignment suggestions of the system should be similar to those of an experienced geometry checker and will vastly improve with further use," says **Andreas Richter, who is in charge of the IWU project.** The scientists' ultimate goals: the software could reduce setup times for new production lines from months to weeks and alignment during operation from minutes to seconds. Researchers are not yet that far along the line, however; there is still a fair amount of development work to be done

before they will achieve a car body construction unit with automatic control. At AUTOMATICA, Richter and his colleagues will demonstrate the solution in its current stage of development: a software-based alignment assistant that will support employees and suggest alignment settings. The next step could be full automation when pushing a button. A direct link to quality inspection and a new type of clamping jig will identify errors in the first component and automatically make the necessary adjustments. The human element will not be replaced in this new quality control loop, but will be supported much more reasonably in its role of decision-maker.

A robot with sensitivity: automated solution for thread gauges

Another Fraunhofer IWU world first relates to a fundamental quality process in mechanical and plant engineering: the testing of threads, also referred to as thread checking. Screw connections are a reliable and therefore widespread process in the field of joining technology. A typical transmission housing for a mid-range car has approximately 50 threaded holes on average. In order to comply with DIN regulations and internal quality requirements, threaded holes have to be tested by random sampling with regard to ease of movement and soiling. Plug gauges are used for this. The check involves screwing in a go plug gauge that must screw fully into the thread over the entire length without too much resistance. This relies on the sensitivity of the tester, which is subjective. Electric plug gauges are also used in some instances; these allow an objective check result via induction coupling. A no-go plug gauge is used after this process to check the maximum permitted diameter of the thread. It should therefore not be possible to screw in this plug gauge. The testing procedure is not only very monotonous and therefore tiring but also costly in terms of time and personnel.

As part of a project sponsored by the Sächsische Aufbaubank (SAB), the Fraunhofer IWU is working on an automated solution that will not only relieve some of the burden from testing personnel but will also make the quality control loop more efficient in terms of time and cost. "Basically, we were faced with two problems: first we had to find a robot with the 'finger-tip sensitivity' necessary for screwing in the plug gauge," explains **Carsten Keller, project manager and member of the scientific staff at the Fraunhofer IWU.** "The second challenge was to capture the rotational movement during operation and present it for interpretation in such a way that generally valid conclusions could be drawn regarding the state of the thread." Fraunhofer IWU scientists are working with a new type of robot and also a special test head incorporating sensor technology, with which the spacing of the thread groove can be reliably measured without the need for any other measuring systems. As a result, the time necessary for threading and screwing in the plug gauge will be approximately one quarter of that required by the manual process. As a next step, a database will be established that will enable the automatic identification of any problem on the basis of the resistance to the screwing in process. "Our vision is to establish a new automated quality control loop for gauging threads that will make it possible to take measurements and identify problems and their solutions more efficiently and link them more closely together," explains **Carsten Keller.**

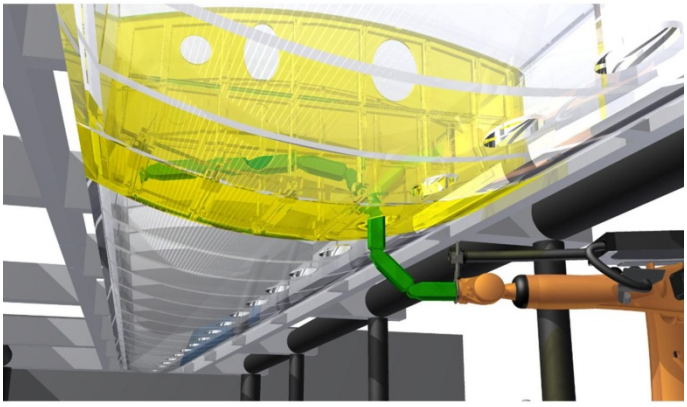

Image: The robot wriggles like a snake through the narrow opening in the interior of the wing. Its short universal and pivot joints enable it to reach the furthermost corner of the chamber. Source: © Fraunhofer IWU | Image source in color and print quality: http://www.iwu.fraunhofer.de/de/presse_und_medien/.

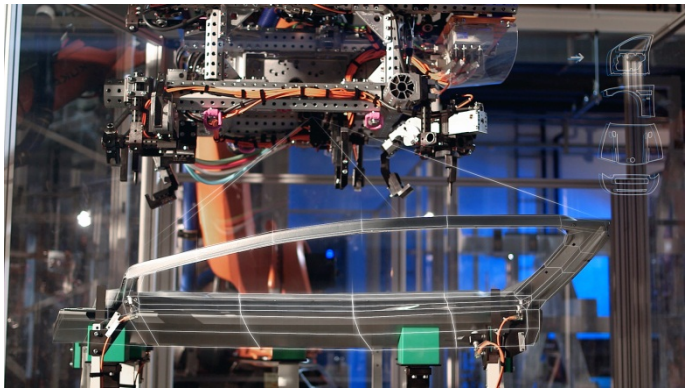

Image: The vision of the researchers at the Fraunhofer IWU: by applying in-line measurement technology, mechanized tensioners and an intelligent software-based assistance system it should be possible to provide adaptive car body production equipment. Source: © Art-Kon-Tor/Fraunhofer IWU | Image source in color and print quality: http://www.iwu.fraunhofer.de/de/presse_und_medien/.

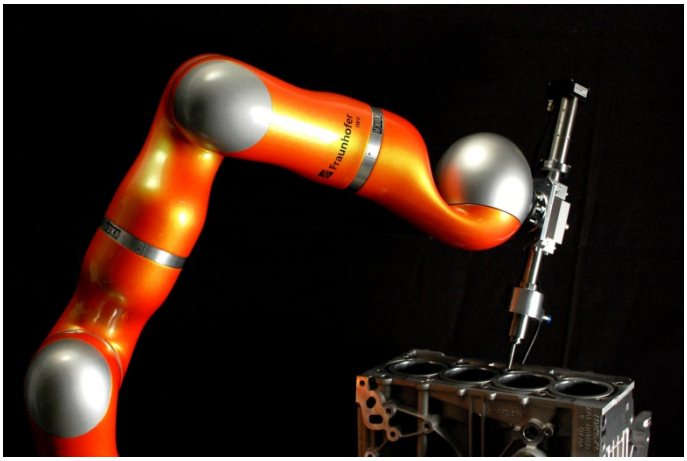

Image: The automated solution for thread checking is four times faster than manual checking.
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The sphere of competence "Body Construction" in the new
E³-Research Factory Resource-efficient Production

"Developing resource-efficient technology using realistic production conditions"

The E³-Research Factory for Resource-efficient Production opened in May 2014. Fit-for-the-future solutions for the production processes of tomorrow are being researched in the three spheres of competence: "Body Construction", "Powertrain" and "Energy Management 2.0". In the field of "Body Construction", the focus of research is on faster model changes in production through more flexibility and intelligent support systems, automation solutions for automotive construction, mechanical engineering and the aviation industry and initial and advanced training under real production conditions.
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"Research for the Future" is the motto of the Fraunhofer Institute for Machine Tools and Forming Technology IWU. This is exemplified by the Institute's strong emphasis on application-oriented research and development in the field of production technology for the automotive and mechanical engineering sectors.
With an annual budget of about 34 million euros and over 580 highly qualified engineers and scientists, combined with laboratories for machine tools, forming and joining technology, mechatronics, precision technology and Virtual Reality in Chemnitz, Dresden, Augsburg and Zittau, Fraunhofer IWU is recognized as one of the leading contractual research and development institutions across Germany in our specialized fields of work.

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