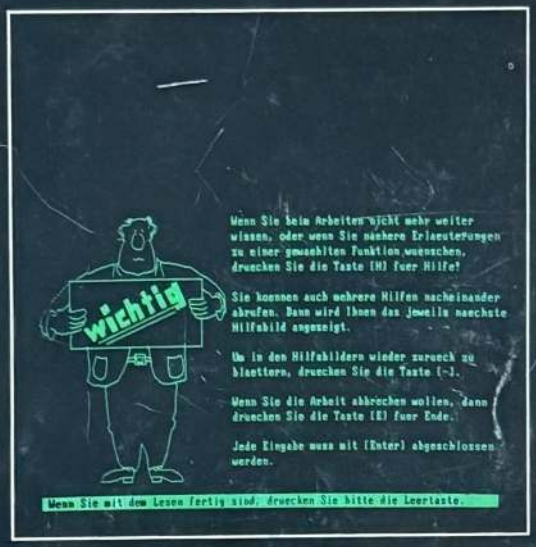
NC Fertigung

Fachmagazin für Metallbearbeitung und Automation



Mit dem Boom der NC-Fertigung mußten die Hersteller numerisch gesteuerter Werkzeugmaschinen notgedrungen die Rolle von NC-Ausbildern übernehmen — insbesondere den am Markt überdurchschnittlich erfolgreichen Firmen droht diese Aufgabe mittlerweile schier über den Kopf zu wachsen, zumal qualifizierte Lehrkräfte rar sind. Die Münchner Deckel AG hat nun kürzlich das Problem zeitgemäß gelöst: anstelle des traditionellen personalen Frontalunterrichts nutzt sie als alternativ-effizientes didaktisches Hilfsmittel Personal Computer, mit denen sich die NC-Eleven via Menütechnik selbst mit der NC-Technologie vertraut machen.

Heft 3–Juni '86
Printed in W.-Germany
20DM 17sFr 140 öS

NC VERLAG

Robot Technology

Smart and flexible in the 53-second cycle

Ford Cologne: large robots from Comau SpA enable a highly productive yet equally flexible welding line

It has long since moved beyond classic tasks like spot-welding car bodies: by now the large robot "Smart" from Turin-based Comau SpA has almost earned a reputation as a jack-of-all-trades in every production hall. Whether door hinges need mounting or wheels fitting, presses and conveyors feeding or finished parts steam-cleaned — the agile Piedmontese handles everything with its six axes. And because it has considerable control capability and learns remarkably fast, it proves communicative and reliable even in more demanding flexible manufacturing contexts.

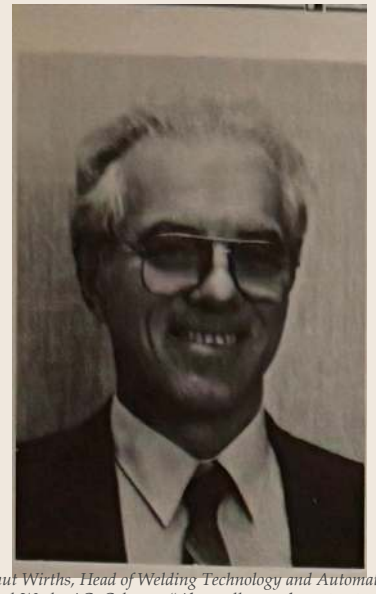
No fewer than eleven of these versatile Smarts from the South have now been deployed by Ford-Werke AG in Cologne along a 70-metre Bock line, spot-welding the complete body-in-white for their flagship model "Scorpio". Cycle time: just 53 seconds.

A rather flattering fact for the supplier: "In maintenance our people are already starting to forget everything they were taught about the hardware and fault-finding, simply because there have been no problems so far. In terms of control and electrical engineering, it is almost optimal." Helmut Wirths is the responsible head of welding technology and automation at Ford-Werke AG; he knows the "Smart" robot type 6.50 from Turin-based Comau SpA.

Can we still do without "Map"?

It stands in the Cologne-Niehl plant in eleven units on the Bock line for the "Scorpio" model, placing a total of 257 spot welds every 53 seconds with considerable precision between front and rear, floor and roof. And one must also credit the Smart with high reliability, remarks Helmut Wirths with some satisfaction, thereby also indicating that the six-axis robot has not disappointed other expectations either. Even before the Comau robots were ordered, the Cologne planning team for Ford Europe (to which Helmut Wirths belongs) had outlined in a series of points what requirements future industrial robots for flexible manufacturing would have to meet — requirements that went beyond mere resistance welding and also included demanding automation tasks.

Even before the Comau robots were ordered, the Cologne planning team for Ford Europe had outlined in a series of points what technical and economic criteria the robots would have to meet. After all, it was not just about spot welding alone — the system needed to be flexible enough to be retooled at reasonable cost when models changed.



Helmut Wirths, Head of Welding Technology and Automation at Ford-Werke AG, Cologne: "Above all, no sub-contractors."



Karl-Heinz Kleifgen, Head of Fixture and Gauge Design at Ford-Werke AG: "...after the trial phase."



Vincenzo Marino, Comau Deutschland: "We can remedy any malfunction within eight hours."

The requirements that also had to meet the demands of hard automation in resistance welding. Among other things, the robots had to be able to carry at least 60 kilograms payload while still having sufficiently high acceleration and braking values to quickly bridge widely spaced weld points. It also had to be possible to archive and transfer control programs, as well as buffer the program memory for at least four weeks. And to connect seamlessly to peripherals, naturally enough freely programmable inputs and outputs had to be available — 20 as a minimum. A commitment to specific interfaces such as Map does not yet exist (though Ford participates in the relevant Map committees).

Then repeatability: values better than 1 mm are nothing sensational for industrial robots, but after replacing exchange parts they are often no longer easily achieved. In short: the axes needed to have an exactly reproducible zero position. Finally, availability: assuming conscientious maintenance, the failure rate for electromechanically driven robots should be well below one percent.

Evidently the Italian Comau was able to respond with a technically and commercially adequate offer, for in December '82 the eleven Smarts along with the complete Bock line were ordered in Turin; between September '83 and January '84 they were installed in the Niehl X-Hall. Since then they have been working in two-shift operation; satisfactorily, as mentioned. However, the order was anything but a purchase based solely on theoretical comparison. About a year earlier, Comau had agreed to supply the Cologne team with a single "Smart" for testing; which Ford then thoroughly trialled, first in an experimental facility and later under near-production conditions, for a quarter of a year. Karl-Heinz Kleifgen, Head of Fixture and Gauge Design at Ford:

To the manufacturer's attention: Suggestions for improvements Test robot for trials under real-world conditions

"At the end of such trial phases, you already work much more closely with the robot manufacturer and can offer suggestions on where the device could be improved." For example with the sixth axis: Vincenzo Marino from Comau Deutschland: "There was a small problem with the mechanics, the elasticity in the joint head was increased. After the test run at Ford we corrected it immediately."



Welding guns are quite heavy — yet the robot must quickly traverse widely spaced points.

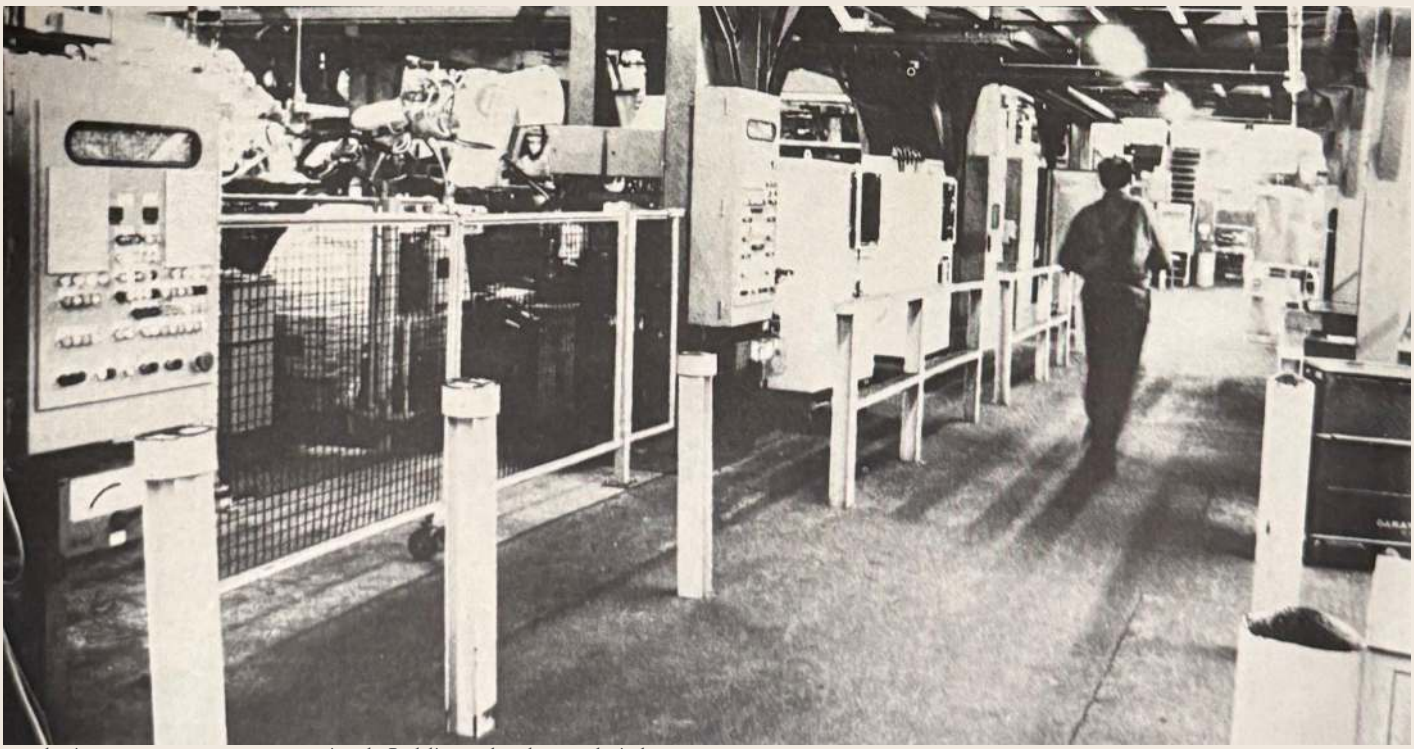


The car bodies are tack-welded in fully automatic two-shift operation...

Automation of the conventional transfer-line type (with specifically assigned tasks) represents a huge advance — yet still requires considerable effort for each changeover. After all, the eleven Italian articulated-arm robots must be precisely coordinated with four Niko gantry robots and an extensive feeder periphery.

Karl-Heinz Kleifgen explains: "Of course, when different robots work at one station, everything must fit together precisely — cycle times, gripper positions and handover points must be exactly synchronised so that the line runs smoothly in the 53-second cycle."

Despite this complexity, the eleven Comau Smarts together with the four Niko gantry robots have proved a well-coordinated team. The entire Bock line operates largely autonomously, so that operators can focus primarily on monitoring and quality control.



...so that just one or two operators can monitor the Bock line — though not exclusively.



'Smart' — like the 'Ford' sanitary robots are controlled from a central control panel.

Comau countered latent concerns about possible complications with foreign suppliers with equal determination and speed. Vincenzo Marino: "We have set up a complete Ford-specific spare parts warehouse for the 'Smart' in Germany, are reachable for Cologne at any time and can remedy any malfunction within eight hours."

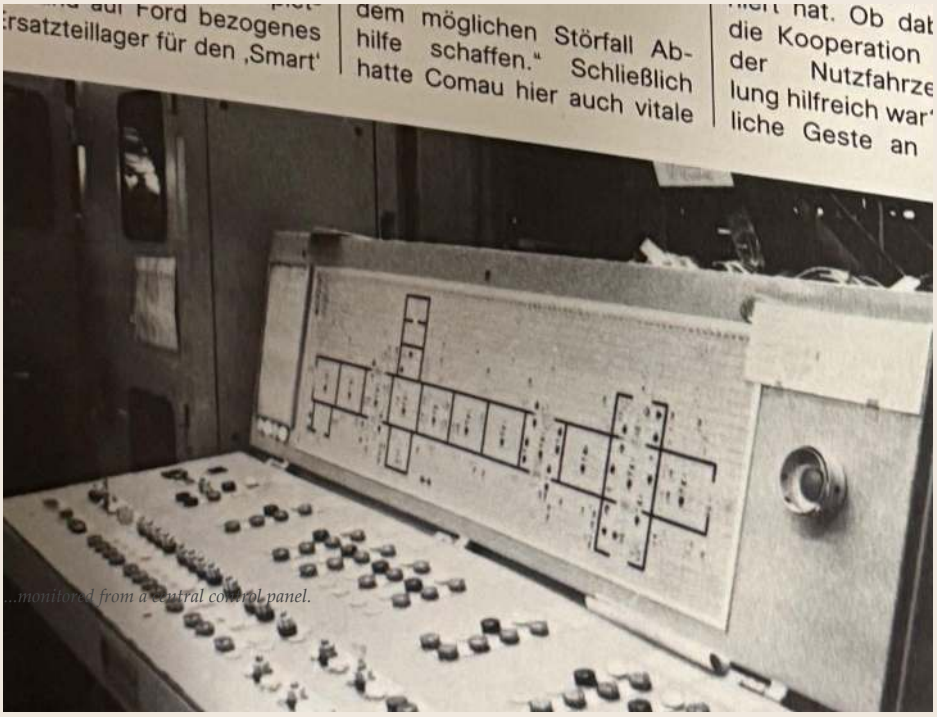
Know-how and overall responsibility in one hand

After all, Comau also had vital interests here: the tacking stations already delivered to Ford for the Genk and Dagenham plants (both, incidentally, without "Smart") were to be adequately and rapidly upgraded — which then also worked out. Whether the Ford/Fiat cooperation in commercial vehicle development helped? As a friendly gesture to the Comau parent company in Mirafiori?

Helmut Wirths waves it off: "On the contrary — when we want to do business with other companies in the automotive sector, we need specific approval from the board. Behind this is simply the desire not to enter into any kind of dependency; hence the approval requirement. And apart from that: the cooperation with Fiat only started later..." The board evidently did approve; not least because from Comau one could obtain the robots as a proprietary product plus the Bock line itself under overall responsibility.

Between flexible and hard automation

With the "Smart" as with the "framing line", the Cologne team is now thoroughly satisfied: beyond the agreed 80%, it is available at around 86%, and evidently the expected flexibility for minor model changes has also been achieved. Which represents a considerable advantage over hard automation — conventional transfer lines with fixed assigned tasks —: during a model change, the entire plant does not need rebuilding; only the robots need reprogramming and the fixtures adapting.



...monitored from a central control panel.

Robot type:	Electric with anthropomorphic joint structure
Axes:	6
6 DOF:	6 axes (1, 2, 3, 4, 5, 6)
5 DOF:	5 axes (1, 2, 3, 5, 6)
Axis 1:	Base rotation 270° (78°/s)
Axis 2:	Arm movement 140° (80°/s)
Axis 3:	Forearm movement 280° (102°/s)
Axis 4 (6.DOF):	Forearm rotation 360° (138°/s)
Axis 5:	Wrist rotation 230° (136°/s)
Axis 6:	Hand rotation 360° (144°/s)
Max. reach:	1917 mm (horiz.), 3000 mm (vert.)
Repeatability:	±0.4 mm
Static load:	50 kg / 400 mm or 60 kg / 330 mm
Control:	Multi-microcomputer structure
Program memory:	RAM C-MOS with battery (50 days without power)
	16, 32, 48, 64K words (8 bit) program via memory capacity only
Interface (I):	14 inputs, 9 outputs digital, programmable in standard config
Programming:	From teach pendant and/or keyboard/CRT in PDL language
Motion (1):	Point to point, robot axes
Motion (2):	PtP with tool centre point control (linear and circular)
Motion (3):	PtP with TCP path control in Cartesian coordinates
Execution (1):	By program, from teach pendant and from workpiece
Program exec.:	Jog forward and reverse, automatic, step-by-step and continuous
Power:	380 V three-phase (+10%, -15%) 48-62 Hz, 14 kVA (other voltages on request
Robot weight:	1600 kg (with pneumatic counterbalancing)

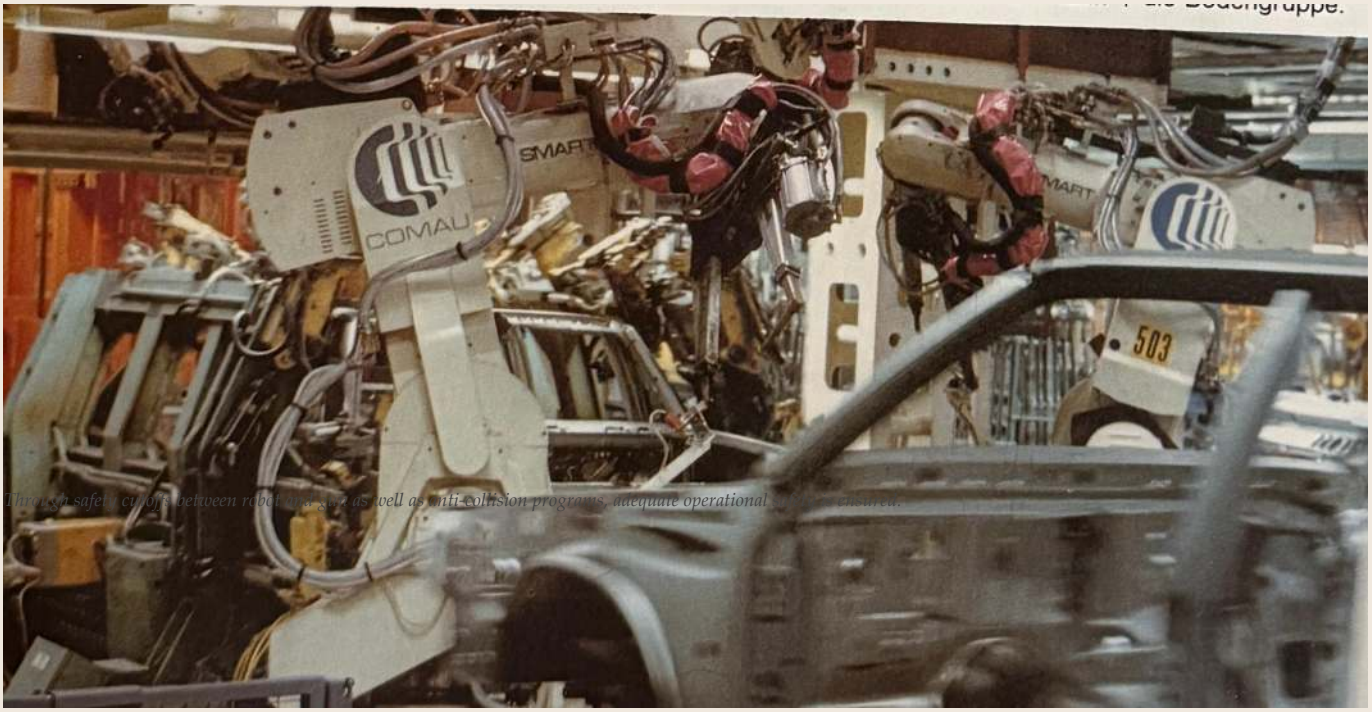
Articulated robot "Smart": key technical specifications

"Smart" flies even at maximum values without losing control

All inputs can be entered, outputs and timers set — with "Smart" this is possible off-line; most manufacturers still struggle with this. In the "Smart" program only the open slots for positions to be traversed later remain; these must then be quickly taught to the robot; the program is then ready. Operation is truly very simple.

As an option for assembling models with significantly different dimensions along the line, so-called "idle stations" are provided. Helmut Wirths: "This way you can later produce a similar model without problems — for example an estate car —; if necessary even a small car like the 'Fiesta' — some fixture modifications would be needed, but it is possible."

Two more "Smart" units are already working on the "Fiesta": they spot-weld the floor assembly at another location. Always with safety in mind: through safety cutoffs between gun and robot, or with anti-collision programs, adequate operational safety is ensured.



Through safety cutoffs between robot and gun as well as anti-collision programs, adequate operational safety is ensured.