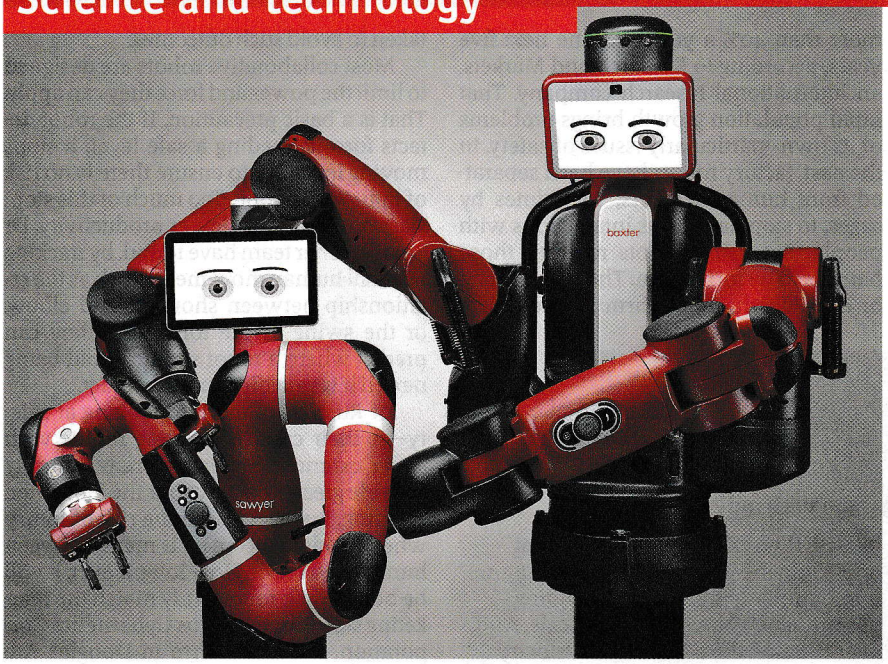

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Cobots

Your plastic pal who's fun to be with

If robots are to work with people, they must understand how people work

TUTHILL PLASTICS GROUP, an injection-moulding company in Clearwater, Florida, recently welcomed a new team member to its factory floor. From his first day on the job he performed the repetitive tasks required of him with dexterity, working comfortably alongside longtime employees. Sawyer, the operative concerned, is one of the fleet of robots now labouring in the world's factories. Instead of replacing people, however, as some earlier industrial robots have, Sawyer is built to work alongside them. For Sawyer is a collaborative robot, also known as a "cobot".

Direct interaction between robots and humans at work is changing the face—or rather the arms—of manufacturing. Such interaction also means that roboticists need to design effective team mates as well as efficient workers. Cobots operate in a realm where human thoughts, human modes of communication and human safety are paramount. Rethink Robotics, a firm in Boston, had this in mind when it developed Sawyer, a one-armed cobot, and his two-armed colleague, Baxter (both pictured above). These robots are not the isolated moving arms of an assembly-line 'bot. They incorporate cameras and touch sensors. And their most noticeable feature is a screen that displays almost cartoonlike human facial elements.

Such faces are not meant to endear robots to workers (though they do). They are, rather, intended to promote communication between person and machine. For example, when a human reaches for a coffee cup, he or she usually glances towards the cup before doing so. This is a cue indicating the action about to be performed. Sawyer emulates this by "glancing" in the direction he is about to reach, in advance of the motion. That permits people to anticipate the cobot's movements.

Smile and wave

Researchers at the Massachusetts Institute of Technology (MIT) are now pushing this non-verbal conveyance of intention between Baxter and his human colleagues a step further. They are giving cobots the ability to read minds—or, more specifically, to read brain signals. Daniela Rus and her team at MIT have equipped an experimental version of Baxter with an electroencephalography (EEG) decoding system. This takes signals from a set of electrodes attached to a human colleague's scalp and recognises within them characteristic patterns known as error-related potentials. These are generated by a brain when it is making a mistake, and also when it is observing a mistake being made by another. For example, when Baxter recognises an error-related potential from a human team mate who has sorted an item into an incorrect bin, he is able to log the error and fix the mistake, sparing the human the trouble. In the future, Dr Rus hopes, the robot will also be able to recognise such a signal when it, itself, has been seen by a human to make a mistake.

Asking the flesh-and-blood members of a human-cobot team to wear EEG caps at work is probably a stretch (though Dr Rus hopes that, by proving the idea behind them works, she will stimulate the invention of something less intrusive). But there are other ways to bridge the gap between human and 'bot. Both speech and the recognition of facial expressions—in either direction—are options. And several groups are working on these.

Once a channel of communication has been established, regardless of what it is, it needs to be used appropriately. It is important—as anyone who has had to deal with the socially inept will know—that robots understand the right moments to convey messages, and also how much information to convey. Julie Shah, another researcher at MIT, has been analysing the costs and benefits of robot over- and under-communication, and is using that information to design algorithms which can decide when and what communication is appropriate. When attempting to convey a message, a robot must estimate its interlocutor's intentions and what his response is likely to be. If an algorithm calculates that communication will be beneficial, it must then convert the concept to be conveyed into something understandable, whether that be a raised eyebrow or a stream of synthesised speech. Too much information may result in people ignoring messages completely. One feature of Dr Shah's algorithms, therefore, is that they try to take into account what information a human team mate already possesses.

Cobots are not entirely new. BMW, a German car company, brought its first into ▸▸

use in its plant in Spartanburg, South Carolina in 2013. Cobot numbers are, however, growing rapidly. That original BMW cobot, nicknamed Miss Charlotte by her human colleagues, is still mounting sound insulation into car doors. Now, however, she has more than 40 non-human colleagues—and that number is expected to exceed 60 by the end of the year.

Sales of cobots and their software to the vehicle industry are expected to rise by more than 40% a year over the next five years, according to Research and Markets, an international research company. That rapid population growth brings problems of its own—particularly issues of safety. In the past, factory robots have been separated from human workers, sometimes by cages, to stop dangerous interactions with people. But using cobots requires those barriers to be torn down. That risks injury, or even death, unless firm measures are taken to avoid such outcomes.

Most collaborative robots are designed to limit the power and force they can apply. That is a basic precaution. If the robot detects force exceeding a safe level, it stops moving instantly, to ensure there is no risk of injury to anyone. Too much of this stop-start can, however, lower productivity. Dr Shah and her team have found, by tracking in detail human movements such as the relationship between shoulder and elbow, or the swing of the torso, that they can predict where a robot should avoid being next, if it is to avoid human contact.

Dr Rus's team are also looking at safety—in their case by creating robots with softer exteriors. Softer materials not only provide greater dexterity for the 'bot when gripping, but also lessen the risk of injury when incidental contact is made between human and robot. How long, if ever, it will be before such robots truly match the marketing slogan of the Sirius Cybernetics Corporation, a fictional firm in Douglas Adams's creation, "The Hitchhiker's Guide to the Galaxy", remains to be seen. But even if not actually fun to be with, your plastic pal will become increasingly effective. ■