## **Editorials**\*

The first stage of the robotics history is now drawing to a close, that of the industrial robot promoted by Engelberger; the device thus introduced is a rigid and unwieldy monstrosity which faithfully, though in an unintelligent way, follows a 'learned' or programmed set of instructions to execute a variety of movements in an industrial environment. Considerable courage and belief were necessary to arrive at a conclusion that this industrial automaton contributed to a revolution in industrial production methods. In fact, in pursuing this notion one profited from a confusion between the concept of tasks that man can only perform with great difficulty (e.g. move a very heavy or hot object) and that of man's qualities that involve his articulated structure, his brain and magnificent adaptive potential. So far, only the multi-joint structure of man has been imitated in practice. It follows that the introduction of robots into an industrial plant requires an environment that is geometrically fixed (or varying in accordance with *a priori* known laws) and adapted to the devices thus used, though the reverse is desirable.

At present the second stage in the robotics history is making its appearance, possibly the advent of the true industrial revolution. The robot is not an object of worship in itself but, thanks to the work of research workers, it is seen as a *tool* with new properties which contributes to the automatization of wide fields of human activities, particularly in the realm of manufacturing systems where investment is more readily accepted for numerous and well known economic reasons.

This tool has still to be improved in many ways, as it is clearly shown when considering new products in the market place (which take partially into account the desired progress) and also predictive studies.

One of the ways thus envisaged is concerned with the robot itself, since the mechanical versatility of the obsolescent device at present used in industry is unsatisfactory; the robot has to be improved in order to be adaptable to the environment. To achieve this aim, it is necessary to endow the device with sensory organs (particularly vision and force sensors) and a capability for decision-making. This trend is now evident in the development of vision systems. For instance, in 1979–80 two or three such systems came on the market, while at present that number has grown to more than thirty. A RIA report in 1982 predicts that 25% of robots will be endowed with vision in 1990.

Another development is concerned with the relations between the robot and the other tools of manufacturing systems – the closed-control system – which used to trouble the user trying to synchronise his robot with numerous sensors and a computer. This approach is disappearing in favour of an integrated system incorporating other industrial tools. It is predicted that in 1990 over half the robots will not work alone but in conjunction with flexible manufacturing systems.

The last aspect of possible improvements is related to time; it is necessary to proceed more rapidly not only in the performance of tasks (Dynamic control is not well mastered at present; computers are too slow for pattern recognition when the environment is somewhat complex), but also in preparing the task (For preparation at a distance, the robot design has to be suitable; for preparation at close distances, it is the robot programming that has to be done off-line). It

\* These editorials represent the personal views of scientists and industrialists of various countries.

follows that CAD/CAM systems are entering the scene, and it is reckoned that by 1990 about 25% of robots will be linked with such systems.

We have to realise that we are now witnessing a transition between the industrial concepts of the 1970–80s in the field of automation and modern developments; indeed, we are passing from a rigid and partial automatic control situation to a flexible and quasi-complete automatic control that is based on two main pillars: the advanced robot and the CAD/CAM systems. Truly, we are in the midst of a second industrial revolution. Unfortunately, the politicians will realise this development too late, as usual. Hence research workers have not only to make progress in their fields of expertise and knowledge, but also information media (such as *Robotica*) to acquaint all with the implications of their work as regards industry and other sectors that are affected by the recent developments.

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The conjunction of Artificial Intelligence and Robotics is a natural one; the former is making fast and exciting progress in unravelling and computerising the various complicated features of human 'mental activity', while the field of Robotics enabled us to infuse Artificial Intelligence with its autonomous and active implementation. One, as it were, supplies the brain, and the other adds the movement and the muscles. The theoretical side of the problems is immense and its interest in pursuing the path of finding a blueprint for the human brain is clear. The more immediate and more obvious 'spin-off' is supplying much needed systems that would, in Norbert Wiener's words, increasingly allow "the human use of human beings".

This new journal, *Robotica*, ought to provide a wide range of information in the fields of Artificial Intelligence and Robotics, with special emphasis on the overlap and general relationship between these two branches of science and technology. It should deal both in the accumulating research involved and also with the implications for education in the widest sense. There can be no field of journals that is developing more quickly than that of cybernetics, general systems and allied subjects, and this reflects the enormity of the information explosion which is still in its first stages in this vast and complex field.

It is perhaps not always obvious when one lives so close to (and amongst) change – a rapid and accumulating change – to realise how necessary it is to keep close contact with change, in general, and that in one own's field, especially. The field of robotics, like so many others, is spreading fast, overlapping and interlocking with other equally fast developing disciplines; thus this journal helps to provide an excellent focal point for a diversity of disciplines with a keen 'cutting edge'.

> Professor F.H. George Director, Institute of Cybernetics Brunel University, Uxbridge, Middlesex (U.K.)

The publication of *Robotica* continues the tradition of leadership for Cambridge University Press by giving recognition to the forceful emergence of robotics and artificial intelligence as viable forms of scientific inquiry.

Robotic versus cybernetic systems became a subject of intense debate when the U.S. and the U.S.S.R. developed their first space mission plans. The triumphs achieved since by these two great nations attest to the attained sophistication of complex engineering systems. Now, embedded systems of similar complexity are coming off the engineering drawing boards headed for mass markets in industry, government, academe, and even the home. Their electronic components are inching toward levels of artificial intelligence hardly conceivable at the time of the earliest electronic computers.

The spectacular progress in the fields of robotics and artificial intelligence is a signal to the coming explosive growth of an entirely new industry. Therefore, this move by Cambridge University Press will be acclaimed by researchers worldwide. The free and open interchange of their findings through this medium will be a powerful stimulant; it will help speed up development of new tools needed to raise human productivity another order of magnitude. Thus we can but marvel at the genius of Norbert Wiener who foretold half a century ago that mankind would gradually cast off its inhuman shackles, ending forever the drudgery of manual toil and of the rote of mental labors.

Carl Hammer,

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Robot technology has been developing rapidly in recent years. The robot is the most recent in a series of developments such as the steam engine, the conveyor belt and the computer. Together they have set the industrialisation process in motion, a permanent development in which our activities are absorbed in comprehensive conversion processes tended by people and machine together.

Although the human "hand-eye-brain" co-ordination will not be surpassed by machines this century, the field of robotics, as a component of industrial cybernetics, is creating a great deal of interest among electronic, mechanical and production specialists.

Today our physical activities are decreasing; we are doing less and we are moving less, due to robots.

'The most important factor in the increased demand for robots is the resulting gain in productivity, as translated into cost and quality improvements. In addition, robots yield many other immediate gains — improved workplace safety, reduced scrap losses, enhanced flexibility, predictable production rates and increased control over the entire manufacturing process.

The future robots, which will be modular, multi-armed, capable of shorter cycle times, and available in a wide range of sizes, will strongly affect the rapid development of industry and economic cybernetics. More and more robots will be sold as a part of an entire manufacturing cell or system, improving overall performance. A rapid expansion of links is foreseen between robotics and computer-aided design and manufacturing systems, also based on artificial intelligence. Aided by artificial intelligence systems man can control many problems with less mental effort and much reliability. Human and artificial intelligence acting together become parts of social intelligence. The ultimate aim is to programme the world so that it entirely matches our needs. Technology and its integration in our society is the central point of evolution.

A new publication on this subject is very welcome.

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For centuries man has endeavoured to create gadgets and toys in his own image. The word "Robot" was first used by Karel Capek, a famous Czech writer in his novel "R.U.R. 1932", to describe a humanoid system capable of performing intellectual as well as physical work. From this point of view the robot acts like a slave: he obeys his master, fulfills his commands and never turns against him. The present trend in the area of manipulators and robots is to achieve a higher functional performance of the movement, control and supply systems. From that point of view the robot is a certain cybernetic machine, the versatile and adaptive properties of which enable it to simulate some of the functions of a human being. Thus robots may help man in daily routines and release him from heavy tasks in industry. We observe at present two general directions in development, viz. in the area of research in the field of applications.

The efforts of many researches concentrated on some main topics such as mechanics, control of motion, sensing and machine intelligence, man-machines systems, biomechanics of motion and applications and performance evaluation. The seven mentioned above subjects dominated during the permanent CISM-IFToMM Symposia "Ro.man.sy", organized every two or three years. A more applicable orientation is presented at the so-called ISIR Symposia. These two types of Symposia describe the present state of robotics.

At present more than 200,000 units, representing robots and manipulators of different generations, are used in industry, rehabilitation engineering and research. The prognostics for 1990–2010 show that the World of human beings will slowly turn to a mixture of human beings and humanoid systems. In the USA 125,000 new units are expected to be in use about 1990, in Japan twice as many, while the Western and Eastern European countries will add to this number no less than 60–70,000 units. According to forecasts of futurologists in Japan for the year 2010, the population of robots will constitute a meaningful part of that of human beings.

But let us be more optimistic. The family of intelligent machines, like robots, computers and others, has been very helpful and, hopefully, will be so in the future, assisting us in fulfilling our everyday tasks. They will be the most obedient servants who will never turn against man.

I do hope that the new International Journal "*Robotica*" will help the relevant specialists to keep up with the advances in Robotics, and will play an important role in the exchange of opinions and views.

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In today's technological society, any development that appears to qualify as a breakthrough receives ample attention in the media, from public to professional. It is often presented prematurely as revolutionizing the society. It takes a good while before the nature and impact of new technological approaches are understood.

Robotics is still in the unclear stage, one where status and expectancy are often exaggerated, the difficult tasks of design and application underestimated, and the societal impact oversimplified. True, robots are already economically and socially effective, performing functions too repetitive, monotonous, dangerous, and environmentally negative for humans. But today's robots are highly limited, practical largely in extremely structured situations such as industrial applications in which hard objects are in predictable orientations and positions and move on precisely known paths.

The design of a programmable robot possessing complex electronics for senses and flexible, versatile electro-mechanical arms is an engineering task of enormous difficulty. Even more challenging is the systems problem inherent in the broad application of robotry. To be widely used, robots will require high built-in capability for information handling and storage and will have to harmonize with other elements of the complete system. The architecture of that system must recognize that total automation is rarely optimum and, instead, a careful .

matching up of machines and humans is required. Today, programmable robotry is less advantageous in most real life industrial applications than fixed automation, and humans are more practical than robots for performing familiar household tasks.

The mass take-over by robots of jobs now held by humans is far into the future. Making it happen will not be simple.

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