INDUSTRIAL ROBOTS IN THE UK - A REVIEW

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1. INTRODUCTION

Following the development of the first industrial robots in the USA in 1961, licensing agreements were made with US companies following which robotics were used for the first time in the UK. Robots were used initially to manipulate process tools such as arc welding and paint guns, the first UK company to utilise robots in this way was Hawker Siddeley in 1972 for arc welding railway trucks.

The further development of robots was enhanced when the electric drive robot was introduced in the mid 70s giving accuracy and controllability in continuous process operations. This type of robot extended industry's horizons and applications were found in aerospace defence, nuclear as well as general engineering. Subsequently, the Science and Engineering Research Council introduced a specific robot initiative in the UK to encourage industrial academic co-operation and foster the development of robotics and robot applications in the UK.

Considerable advances are now taking place in manufacturing processes, particularly assembly, including product design for assembly and flexible manufacturing systems. Significantly, as robot capabilities are enhanced to meet the challenge of the more difficult industrial tasks, applications outside the factory will become more feasible lending credence to the present research on mobile robots capable of operation in unstructured environments, e.g. construction sites.

2. CURRENT ADVANCES IN THE GENERAL DEVELOPMENT OF ROBOTICS

2.1 The Advanced Robotics Initiative

The most significant advance in Robotics development in the UK and in international collaboration came as a result of the Advanced Robotics Initiative. The origins of the Advanced Robotics (AR) Initiative can be traced back to the meeting of Heads of State and of Governments and representatives of the European Communities at the Versaille Economic Summit of 1982. In order to promote longer term research and development and to devise co-operative undertakings between these nations the Technology, Growth and Employment Working Group was formed. Advanced Robotics was one of the technology areas identified for support and was promoted by initial discussions between representatives of Japan, France, Canada, Italy, West Germany, the UK and the USA.

Early in 1985 it was decided that the UK should develop a nationally co-ordinated and concerted course of action to develop an indigenous capability in AR by bringing together the resources of industry and academic and research institutions. Managed by the Mechanical and Manufacturing technology (MMT) division of the Department of Trade and Industry (DTI) the UK has since been establishing National Collaborative Groups to investigate the possibilities for AR in the following fields: tunnelling, civil engineering and construction, underwater, nuclear, fire fighting and emergency rescue, space, medical health care, agriculture, domestic and leisure.

The AR Initiative has the following aims: to develop a greater awareness of the future market potential for AR, to encourage co-operation between industry and academics to their mutual advantage, to avoid wasteful duplication of developments in particular industry sectors, and to assist the formulation of collaborative projects for the AR

application area and to nurture the growth of an indigenous UK AR industry. Technology areas included were wide ranging such as advanced manipulators and sensors, navigational systems and mobilities and artificial intelligence in as far as they apply to AR.

Direct support is offered for collaborative projects aiming to develop the enabling technologies required. These projects are not confined to national boundaries, there is growing willingness on the part of UK companies to consider international collaboration within the European framework of EUREKA. Collaboration within Europe will broaden UK markets and complement the technical capability and competitiveness in the international market. The AR initiative has galvanised and co-ordinated the UK future robotic interest across industrial sectors which in turn has encouraged companies to sharpen their perception and their measure of future market possibilities. The initiative also serves as a vehicle for the integration and directed development of related advanced technologies which will become major markets in their own right.

As a further means of focusing UK efforts the Department of Trade and Industry is presently appraising its support for a National Advanced Robotics Research Centre proposed to be established this year at Salford. This most important development would involve collaboration on a large scale between various companies, Higher Education Institutions and research establishments to address the research and development of AR generic technologies.

2.2 Industrial Robots in Use in the UK

The British Robotics Association(BRA)set up in 1977 undertakes an annual statistical survey[1] highlighting such factors as population growth, application analysis, country of origin of robots installed in the UK and a technical and cost analysis of robots installed in the UK. Extracts from this survey are as given in Appendix A, B and C.

2.3 Reactions to the use of Industrial Robots in the UK

A detailed study on 'Robotics in British Industry: Expectations and Experience'[2] was undertaken by the Policy Studies Institute (PSI) on behalf of the British Robotics Association (BRA). The study encompassed 248 British and foreign-owned plants and 363 non users. The major findings emerging from this report can be summarised as follows: 81% of users saw robots as worthwhile and 61% were of the opinion that robots increased profitability. 71% reported favourable attitudes in the workplace with only 2% experiencing any shop floor opposition. The great majority of plants undertook a feasibility study before the introduction of robots. Large factories with experience of other new forms of technology and automation predominate among robot users, with one third of robot users employing more than 1000 people and only 12% employing less than 100. Applications using the largest numbers of robots are spot welding and injection moulding.

Where difficulties have been encountered they include purchase and development costs, poor after sales support, installation problems and lack of appropriate skills.

3. ROBOTICS IN CONSTRUCTION

Since the late 70s there has been a limited amount of research and development work on the application of robotics to the Construction Industry. This work, in the main, has been carried out in isolation with unrelated objectives. For example, a lightweight mechanical beetle which can be programmed to clamber about and paint steelwork is under development at Portsmouth Polytechnic. Slingsby Engineering of Kirby Moreside, North Yorkshire claim to have built a robot arm that can inspect bridges; CLI of Dorset are undertaking development work for the automation of excavation work and related work is being undertaken at the University of Lancaster and British Rail; Bristol Polytechnic is undertaking studies on the Design of Buildings and Site Layouts for Robotic Assembly.

These examples are given primarily by way of illustration and although significant in their own way, do not represent a major input in terms of research and development in the field. By far the greatest impact particularly in terms of a co-ordinated programme of R & D is that emerging from the DTI Construction AR Feasibility Study[3].

3.2 Advanced Robotics in Construction - A feasibility study

A Feasibility Study (FS) on the potential application of Advanced Robotics (AR) to Construction has been undertaken for the UK Department of Trade and Industry by CIRIA - the Construction Industry Research and Information Association - between May 1986 and July 1987. The feasibility study report completes stage one of a three-stage process envisaged by the DTI for the development of an autonomous device (or devices) within each industry area.

Stage 1: A feasibility study fully funded by DTI to identify and assess potential applications and to recommend a preferred project on the basis of a number of technical and market factors.

Stage 2: A Project Definition Study (PDS) with funding shared by DTI and other interested government or non-government organisations, to produce a proposal for an Industrial Development Project including R & D requirements, design schematics, a detailed market analysis, work share proposals, cost estimates and a detailed project plan.

Stage 3: An Industrial Development Project, also with shared DTI/Industry funding, to develop, through one or more stages, an advanced robotic device (or devices)

The feasibility study identified the three areas considered most promising i.e. inspection of civil engineering and building structures, autonomous mobile robotic construction plant, and computer controlled construction and analysed them in detail. The area of inspection and maintenance of civil engineering and building structures was finally selected as the more appropriate area for AR development. The UK market for non-civil engineering repair and maintenance is approximately £10.6 billion, split £4 billion on services, £3.2 billion on re-decoration and £3.4 billion on the fabric of structures.

Proposals for Stage 2 a Project Definition Study are now at an advanced stage of development and a report is currently being finalised for submission to the DTI. The collaborative group preparing the PDS has eleven members which includes representatives from the Construction Industry, Consultants and three Academic Institutions and the lead organisation is Taylor Woodrow Construction.

The construction field has also proved sufficiently attractive for a EUREKA project to be considered. Project 'Hercules' envisages the development of a robot crane 'Atlas' for working on tall buildings or large structures. The French group CBC and Potain would provide the construction and crane expertise whilst Lamberton Robotics Ltd and Marchant Filer Dixon would provide the necessary expertise from the UK on robotics and materials technology.

4. THE WAY FORWARD

It is considered that the UK has particular strengths through the combination of our leading construction contractors, construction plant manufacturers, control, system and robot manufacturers and leading academics, consultants and researchers in construction, control, robot design and advanced AI related software. This augers well for the development and application of robotics in the UK Construction Market (and other market areas) and the potential to compete internationally in this field.

5. REFERENCES

(1) British Robotics Association. "Robotics Facts" - 1987

(2) J Northcutt et al. "Robots in British Industry: Expectations and Experience" Policy Studies Institute, London, 1986

(3) Construction Industry Research and Information Association. "Feasibility Study - The Application of Advanced Robotics to Civil Engineering and Construction" for the Department of Trade and Industry - July 1987

Appendix A

TECHNICAL AND COST ANALYSIS OF ROBOTS INSTALLED IN UK DURING 1987

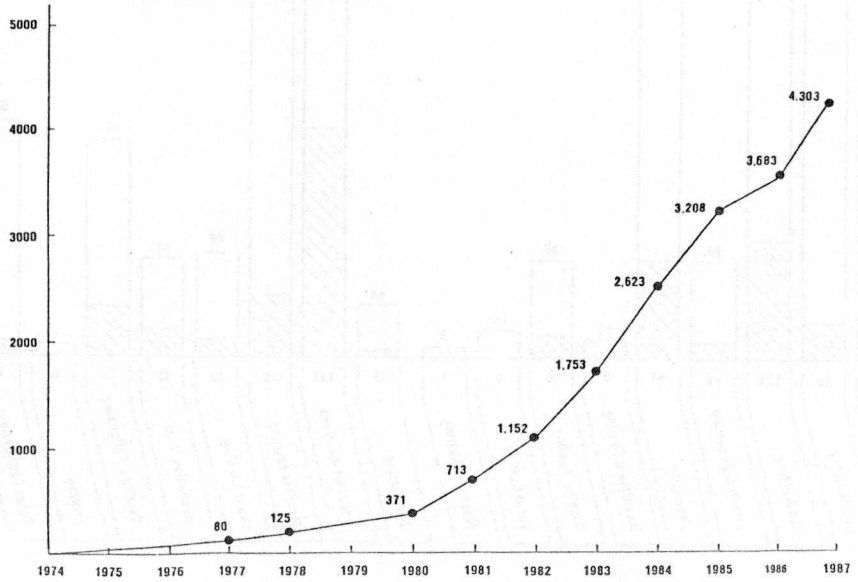
British Robot Association, December 1987

Application	*Robot cost (£1,000)*				*Technical*	
	<10	*10-20*	*20-35*	*>35*	*non-servo*	*servo*
Surface Coating	0	3	2	11	0	16
Spot Welding	0	0	5	25	0	30
Arc Welding	0	0	61	43	0	104
Grind/Deburr	0	2	5	4	2	9
Assembly	6	24	53	4	8	79
Investment Casting	0	0	0	2	0	2
Glueing/Sealing	0	2	6	10	0	18
Laser Cutting/Welding	0	0	0	0	0	0
Water Jet Cutting	0	1	0	0	0	1
Die Casting	0	0	0	5	0	5
Injection Moulding	53	123	15	0	173	18
Machine Loading	6	3	17	27	6	47
Press Loading	3	2	0	7	3	9
Inspection/Test	4	8	7	3	7	15
Handling/Palletising	1	1	16	18	2	34
Forging	0	0	0	0	0	0
Other Applications	0	2	2	5	0	9
Education/Research	1	4	17	1	1	22
Totals	74	175	206	165	202	418

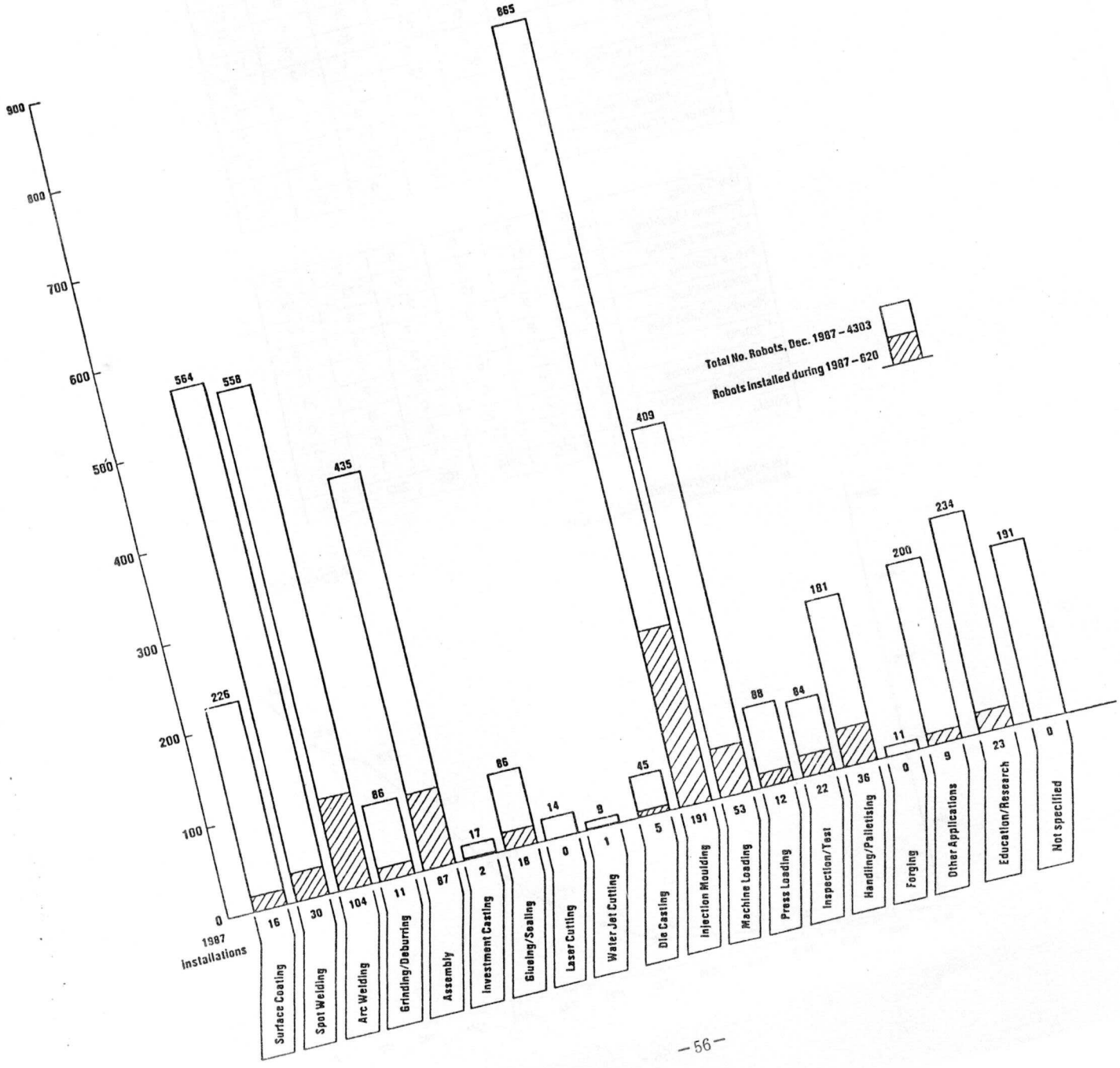
Appendix B

UK POPULATION GROWTH

British Robot Association, December 1987



Appendix C


900
800
700
600
500
400
300
200
100
0
1987 installations
Total No. Robots, Dec. 1987 – 4303
Robots installed during 1987 – 620
564
558
226
435
86
665
86
17
86
14
9
409
45
88
84
181
11
200
234
191
0
16
30
104
11
87
2
18
0
1
5
191
53
12
22
36
0
9
23
Surface Coating
Spot Welding
Arc Welding
Grinding/Deburring
Assembly
Investment Casting
Glueing/Sealing
Laser Cutting
Water Jet Cutting
Die Casting
Injection Moulding
Machine Loading
Press Loading
Inspection/Test
Handling/Palletising
Forging
Other Applications
Education/Research
Not specified