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**1996 MARKED THE SECOND CONSECUTIVE YEAR OF DOUBLE DIGIT  
GROWTH IN WORLD ROBOT INVESTMENT**

**WORLD ROBOT MARKET FORECAST TO INCREASE BY 13%  
PER YEAR IN 1996-2000**

**BY THE END OF 2000 ALMOST ONE MILLION ROBOTS  
IN OPERATION WORLDWIDE**

**Shipments (sales)**

Worldwide sales of industrial robots peaked in 1990 when they reached almost 81,000 units. Following the recession in 1991-1993, sales of robots plummeted to about 55,000 units in 1993. With the economic recovery a surge in robot investment followed. In 1995, the world market surged by almost 29% over 1994 and in 1996 global sales increased by 11%, reaching about 80,500 units, or more or less the same level as the record year of 1990 (see table 1 and figure 1).

The large drop in sales between 1990 and 1993 is mainly explained by the sharp fall in the supply of robots in **Japan**, from 60,000 units to under 30,000 units in 1994. After this trough the market started to recover although hesitant and by 1996 the **Japanese market reached almost 39,000 units, up almost 7% over 1995.**

After the three year of yearly growth rates of the order of 30% the market in the **United States** fell by 5% in 1996 (in terms of value, however, it increased by 4%). Modest increase over 1995 was recorded in **Italy** (+3%). For the third year in a row **France** showed double digit growth, almost 23% in 1996 over 1995. The market in the **United Kingdom** experienced a roller coaster, from an increase of 84% in 1994 to -27% in 1995 and back to +41% in 1996. The **German** market showed incredible strength, increasing by over 40% per year in both 1995 and 1996, more than compensating for the depressed years of 1991-1993.

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Table 1

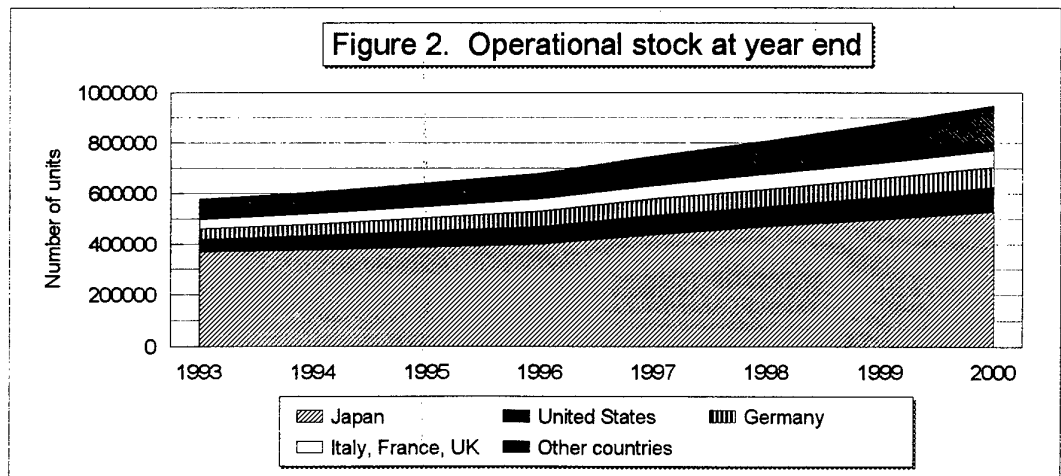
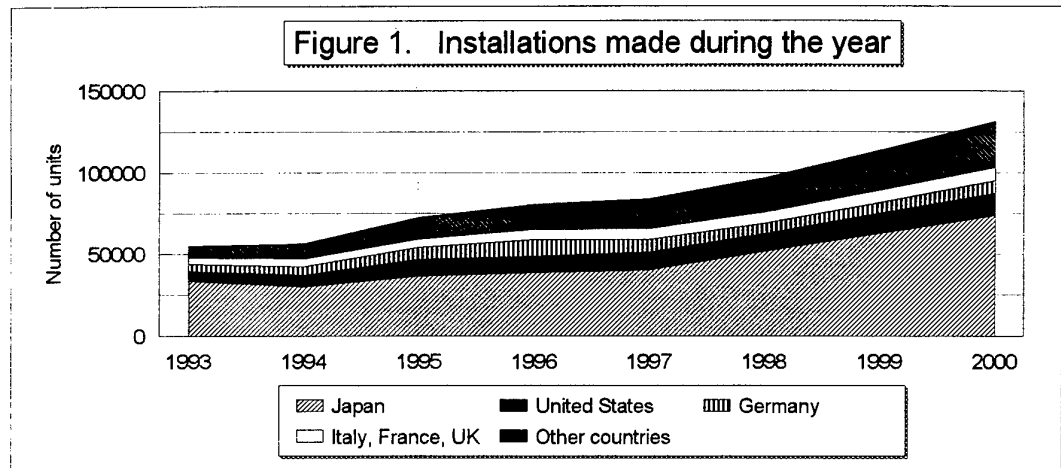
Number of robots installed in 1996 and estimate of the operational stock at end 1996. Forecast for year 2000

Country	Installations made during the year		Operational stock at year end	
	1996	Forecast 2000	1996	Forecast 2000
Japan	38,914	73,800	399,629	527,500
United States	9,709	13,800	70,858	99,200
Germany	10,425	7,500	60,000	76,900
Italy	3,200	4,000	25,363	34,600
France	1,697	2,400	14,784	19,000
United Kingdom	1,116	1,800	8,751	12,300
<b>Total above</b>	<b>65,061</b>	<b>103,300</b>	<b>579,385</b>	<b>769,500</b>
<b>Other western Europe a/</b>	<b>3,716</b>	<b>5,700</b>	<b>24,328</b>	<b>39,600</b>
<b>Asia-4 b/</b>	<b>9,349</b>	<b>17,000</b>	<b>37,175</b>	<b>91,000</b>
Other countries	2,403	5,100	36,686	47,800
<b>Grand total</b>	<b>80,529</b>	<b>131,100</b>	<b>677,574</b>	<b>947,900</b>

Sources: ECE, IFR and national robot associations.

a/ Austria, Benelux, the Nordic countries, Spain and Switzerland.

b/ Australia, Republic of Korea, Singapore and Taiwan Province of China.



The **Republic of Korea** had an impressive average yearly growth rate of 47% between 1991 and 1996. In the latter year, however, it "only" increased by 16%. The group **Other western Europe** (Austria, Benelux, the Nordic countries, Spain and Switzerland) had a market growth of 24% over 1995.

### **Estimates of worldwide operational stock of industrial robots**

**Total accumulated yearly sales**, since industrial robots started to be introduced in industry at the end of the 1960s, amounted at the **end of 1996** to some **860,000 units** (see table 1 and figure 2). Many of the early robots have, however, by now been taken out of service. The stock of industrial robots in actual operation is therefore lower. The United Nations Economic Commission for Europe (UN/ECE) and the International Federation of Robotics (IFR) estimate the total worldwide **stock of operational industrial robots** at the end of 1996 at just under **680,000 units compared with about 640,000 units at the end of 1995**, representing an increase of 6% over 1995, or the same increase as in 1995 over 1994.

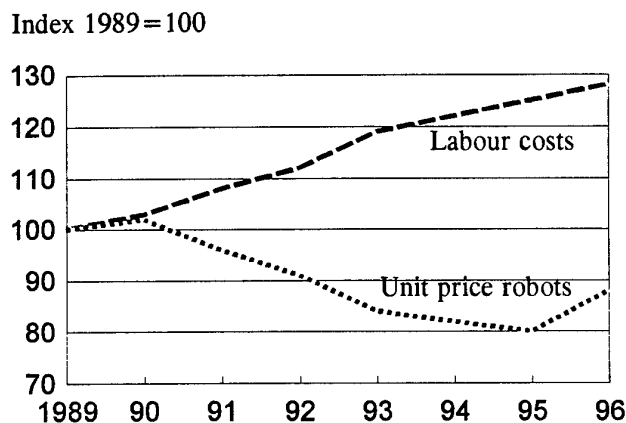
**Japan accounts for more than half of the world robot stock.** However, the **net increase** in the Japanese robot stock, as well as in the gross domestic shipments (sales) of robots, fell sharply in the period 1992-1994. The net increase in the robot stock in 1994 was less than a fifth of the record year of 1990, underscoring the depth of the Japanese recession. In 1996, the operational stock grew by about 12,000 units, from a supply of new installations of almost 39,000 units, to just under 400,000 units.

### **Unit value and relative prices of robots**

Unit value of robots for United States, Germany, Italy, France and United Kingdom peaked at just under **\$110,000** in 1991 (it should be noted, however, that the unit price only accounts for 30% on average of the total system cost). By 1994 they had fallen to \$82,000 but rose slightly to \$85,000 in 1996.

The **relative price** of robots, i.e. the price of robots for a given set of performance indicators in relation to labour costs and to other types of machinery, manually operated, has been falling rapidly. **Since 1989, prices of robots relative to employee compensation in the business sector have fallen by between 30% and 50% in the United States, Germany and France, although there was a slight reversal of this trend in 1996 in the first two countries.** It should be noted, however, that these calculations of relative prices does not take into account the improvements made in the **quality and efficiency of robots, factors which would, if included, have made relative prices fall even more.** Data on different types of robots being installed strongly indicate for many countries that there has a gradual shift towards a higher share of more sophisticated robots. **The calculations of relative prices above thus underestimate the true relative prices.** Figure 3 compares index of labour compensation in the business sector in the United States with index of the average unit price of robots being installed, illustrating the so-called "crocodile gap".

Figure 3. Index of labour compensation in the business sector and index of average robot unit price in the United States (1989-1996).



#### The value of the world robot market in 1991-1996

In 1990, the world market can be estimated at \$7.3 billion. In the trough year of 1993, the world market had fallen to \$3.4 billion. It increased slightly to \$3.8 billion in 1994. In 1995, the world market surged to some \$5.2 billion. In 1996, the world market for robots amounted to about \$5.3 billion.

The sharp fall in the world market between 1990 and 1993 was mainly caused by the plummeting Japanese market, from \$5.2 billion in 1990 to \$1.8 billion in both 1993 and 1994. In 1996, the Japanese market had reached \$2.3 billion. Its share of the world market fell from an estimated 71% in 1990 to about 42% in 1996. The market in the **United States**, on the other hand, increased both in nominal and relative terms, from \$485 million in 1990 to almost \$950 million in 1996 and from almost 7% of the world market to 18%. It should be noted, however, that the estimates for 1996 are, for several reasons, regarded to have higher accuracy than those of previous years. In reality, the fall in the market between 1990 and 1995 might therefore have been less significant than shown here.

#### Robot density in selected countries

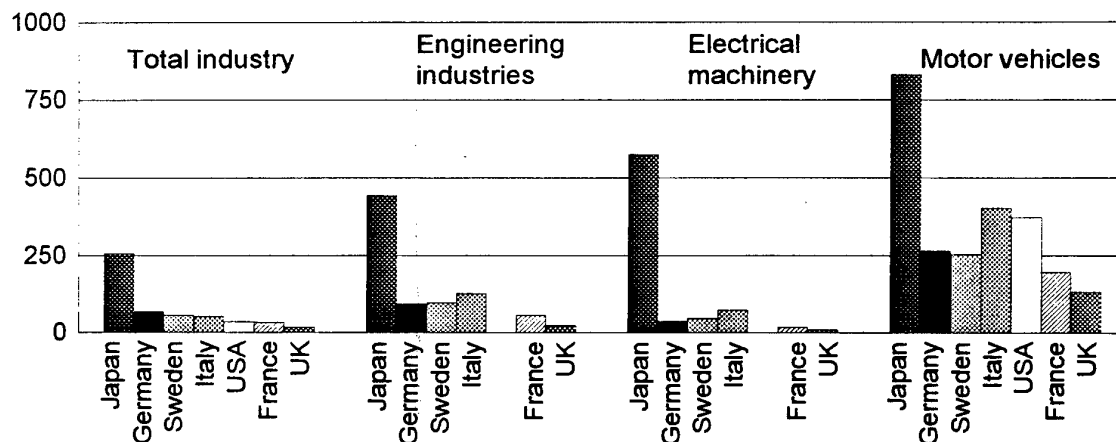
When comparing the rate of diffusion of industrial robots in various countries, the robot stock, expressed in the total number of units, can sometimes be a misleading measure. In order to take into account the differences in the size of the manufacturing industry in various countries, it is preferable to use a measure of **robot density**. One such measure of robot density is the **number of robots per 10,000 persons employed in the manufacturing industry**.

Two types of robot densities are calculated. The first relates all types of robots to the number of persons engaged in manufacturing industries while the second measures only the more advanced types of robots, that is, trajectory-operated robots and adaptive robots and/or robots with four axes or more.

Japan has by far the highest density of advanced robots. In 1996, it amounted to 225 units (265 when counting all types of robots) per 10,000 persons engaged in manufacturing industries. The Republic of Korea had the second highest with 75 units, followed by Germany with 71, Sweden with 54 and Italy with 47 units. In the other countries in western Europe, Australia and the United States the density ranged between about 15 and just under 40. The countries in central and eastern Europe had densities in the range of 2-5.

Figure 4 below shows the 1995 robot densities (number of robots per 10,000 people employees) broken down by industries for some of the major robot using countries. In the motor vehicle industry there were over 830 robots for every 10,000 persons employed in Japan. In Italy the corresponding density was estimated at 400 (which might be an overestimate), while it reached 370 in the United States, 260 in Germany, 250 in Sweden, 200 in France and 130 in the United Kingdom. As one robot generally performs the tasks of at least two persons it could be said that robots in the Japanese motor vehicle industry correspond to some 20% of the labour force.

Figure 4. Number of robots per 10,000 employees, broken down by industries.



## Forecasts 1997-2000

### Yearly sales

After two years of booming robot demand, the market in 1997 is projected to increase by just 4%, largely a result of sharp falls in the market in Germany and a slow down in the growth in Japan, France and the United Kingdom (see table 1 and figure 1). In the United States, on the other hand, growth will pick up again after the temporary halt in 1996. It is projected that growth in 1997 will reach at least 10% over 1996. Europe, other than the foresaid countries, and Asia will also be buoyant markets.

For the period **1998-2000**, worldwide growth is expected to reach a **yearly average of just over 15%**. In absolute numbers this implies that sales will increase from just over **80,500 units in 1996** to about **131,000 units in year 2000**.

In the period 1996-2000, the gross yearly supply in **Japan** is forecast to almost double, from 39,000 to 74,000 units. In this context it should be noted that a very large share of the new robots supplied will replace older robots taken out of operation. In 1996, for instance, more than **two thirds of the Japanese supply were replacement investment**. In the **United States** supply in the period 1996-2000 is projected to increase from 9,700 to 13,800 units, down from the record and exceptional level of 10,400 in 1996 to 7,500 units in **Germany**, from 3,200 to 4,000 units in **Italy**, from 1,700 to 2,400 units in **France** and from 1,100 to 1,800 units in the **United Kingdom**.

The combined supply of **Australia, Republic of Korea, Singapore and Taiwan province of China** is forecast to grow from 9,300 units in 1996 to 17,000 in 2000. As was previously shown, the Republic of Korea is now the world's fourth largest robot market both in terms of units and values.

In the **eight smaller western European countries** the market is forecast to increase from 3,700 units in 1996 to 5,700 units in 2000.

#### **Results in the first half of 1997**

Looking at the first half of 1997, **shipments** in the **United States** surged by 35% in terms of units, over the same period in 1996, and by 31% in terms of value. The actual shipments of the first half of 1997 corresponded to 62% of the projected total 1997 shipments. In the period 1992-1996, the first half years' shipments as a percentage of the full year shipments varied between 43% and 49%, indicating that the projected value for 1997 will be more than realized.

#### **Operational stock**

In terms of units, it is estimated that the **worldwide stock of operational industrial robots will increase from just under 680,000 units at the end of 1996 to just under 950,000 at the end of 2000**, of which more than half in Japan, just under 100,000 in the United States, 77,000 in Germany, 35,000 in Italy, 19,000 in France and 12,000 in the United Kingdom (see table 1 and figure 2). As, in the same time, the number of personnel in industry in the best case will be stable or only grow modestly, the density of robots measured as the number of robots per 1,000 workers will continue to surge.

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The publication *World Industrial Robots 1997 - Statistics, Analysis and Forecasts to 2000* is available, quoting Sales No. GV.E.97.0.20, through the usual United Nations sales agents in various countries or from the United Nations Office at Geneva (see address below), priced at US\$ 120:

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