

**UNECE**United Nations Economic Commission for Europe



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Worldwide investment in industrial robots up 17% in 2004

In first half of 2005, orders for robots were up another 13%

***Worldwide growth in the period 2005-2008 forecast
at an average annual rate of about 6%***

***Over 1,000,000 household robots in use – several millions
in the next few years***

UNECE/IFR issues its 2005 World Robotics survey

The International Federation of Robotics (IFR) in cooperation with the United Nations Economic Commission for Europe (UNECE) publishes the study ***World Robotics 2005***. The following executive summary of this 404 page in-depth analysis summarises the main results:

After two years of falling demand of industrial robots a strong recovery already started in 2003 with a growth of 19% all over the world. **In 2004, again 17% more robots were sold than in 2003. This was the result of strong demand in all Asian markets and robust growth in Europe and America.**

In 2004, more than 52,000 robots were supplied to **Asian countries** (including Australia and New Zealand), almost 29% more than 2003, as a result of strong investments within the automotive industry and the electrical/electronics industry.

After two years of falling sales in Japan, a sharp recovery already started in 2003 when the market grew by 25%. In 2004, the increase of installations continued: about 37,100 units, 17% more than in 2003, were sold in **Japan**. Robot installations in the automotive industry as well as in the electrical/electronics industry surged by 42% and 64%, respectively. An increase of about 16% was recorded in the motor vehicle industry, whilst in the automotive parts industry, installations surged by 64%.

Installations in **the Republic of Korea** also increased by 17%, mainly due to investments by the combined branches of the automotive industry (motor vehicle producers and parts suppliers). The installations in the other Asian markets, including **China, India, Indonesia, Malaysia, the Philippines, Singapore, Thailand and Taiwan (Province of China)**, surged by an average of about 125%. Most of these markets are still relatively small, but are gaining in importance as a result of expanding investments by the automotive industry.

In **North America** (United States, Canada, Mexico), the number of installations increased by 6% in 2004, to more than 13,400 units, the highest sales of multipurpose industrial robots (strictly defined) ever recorded. After reaching a peak level of 13,000 units in 2000, sales dropped in 2001 and 2002 to just under 10,000 units. In 2003, however, there was a sharp recovery; the market expanded by 28% to about 12,700 units. **In 2004, North America was the second largest market for robot installations** behind Japan but just ahead of Germany. Automotive parts producers and other industries were responsible for the growth, whilst car producers did not increase their robot investments.

In **Europe**, sales of multipurpose industrial robots rose by 18% in 2000 to 30,600 units. In 2001, sales continued to grow, but only by a modest 3%, reaching 31,600 units. In 2002, the market fell by 15% to 26,700 units. In 2003, there was a slight recovery of 4% to 27,800 units. In 2004, again, modest growth of 5% was achieved, to about 29,300 units. Installations in the automotive industry as a whole – the most important customer for industrial robots in Europe – increased by 5%. **However, whereas investments by automotive parts suppliers surged by 23%, end manufacturers of motor vehicles decreased theirs by 6%.** Other industries recorded remarkable increases in robot investments. Sales to the chemical industry surged by 72%, to the machinery industry by 22%, and to the food industry by 24%. **In Europe, more robots were installed in the food industry than in both America and Asia.** The share of total supply here was more than 3% in Europe, and under 1% in America and Asia.

Europe and North America are rapidly catching up with Japan ...

In the early 1990s, installations of multipurpose industrial robots in Europe and North America only totalled about 25% and 7%, respectively, of Japan's installations of (all types of) industrial robots. Following more restrictive reporting by Japan, recent data shows that in 2001-2002, more multipurpose industrial robots were installed in Europe than in Japan. However, since 2003, the market in Japan has again been larger than that of Europe.

Looking at the operational stock of industrial robots, and again comparing Japan's stock (to which all types of robots were added up to and including 2000) of multipurpose robots to those in Europe and North America, the same pattern prevails: the European stock rose from 34% of that of Japan in 1994 to 78% in 2004. The corresponding figures for North America were 13% and 34%, respectively.

Estimate of the worldwide operational stock of industrial robots

Total accumulated yearly sales, measured since industrial robots started to be introduced in industry at the end of the 1960s, amounted at the end of 2004 to some 1,500,000 units, including, as mentioned before, the dedicated industrial robots installed in Japan up to and including 2000. Many of the early robots, however, have by now been taken out of service. The stock of industrial robots in actual operation is therefore lower. UNECE and IFR estimate the

**total worldwide stock of operational industrial robots
at the end of 2004 between a minimum of 848,000 units
and a possible maximum of 1,120,000 units**

The minimum figure above is based on the assumption that the average length of service life is 12 years. A UNECE/IFR pilot study has indicated that the average service life might in fact be as long as 15 years, which would result in a worldwide stock of 1,120,000 units.

When the minimum 2004 stock of almost 848,000 units is compared with the 800,000 units at the end of 2003, it represents an increase of 6%. Japan accounts for just under half the world robot stock - largely because the Japanese figures include all types of robots. Its share is, however, rapidly diminishing (Table 1 and Figure 1 and 2).

Table 1

Installations and operational stock of multipurpose industrial robots in 2003 and 2004 and forecasts for 2008. Number of units

Country	Yearly installations			Operational stock at year-end		
	2003	2004	2008	2003	2004	2008
America	12,957	13,674	16,800	115,384	125,235	159,900
Argentina	33	17		172	189	
Brazil	231	208		2,144	2,352	
Chile		5			5	
North America (Canada, Mexico, USA)	12,693	13,444	16,500	112,390	121,937	155,700
- Canada	1,235	440		4,077	4,517	
- Mexico	172	877		1,260	2,137	
Other America a/				678	752	
Asia/Australia	40,579	52,311	70,400	422,721	443,193	532,900
China	1,451	3,493		3,603	7,096	
India	57	369		250	619	
Indonesia	44	74		47	121	
Iran	336	106		404	510	
Japan	31,588	37,086	45,900	348,734	356,483	390,500
Malaysia	191	250		1,202	1,452	
Philippines	20	65		28	93	
Republic of Korea (all types of industrial robots)	4,660	5,457		47,845	51,302	
Singapore a/	48	244		5,273	5,443	
Taiwan, Province of China a/	1,454	3,680		8,730	11,881	
Thailand	156	757		257	1,014	
Other Asia a/	5	78		2,712	3,009	
Australia/New Zealand a/	569	652		3,636	4,170	
Europe	27,832	29,296	33,700	262,025	278,906	348,100
Austria a/	365	545		3,602	3,907	
Benelux a/	715	536		9,053	8,749	
Czech Rep. a/	498	163		1,445	1,533	
Denmark	288	296		2,078	2,342	
Estonia	1	1		1	2	
Finland	387	288		3,407	3,599	
France	3,117	3,009	3,400	26,137	28,133	35,900
Germany	13,081	13,401	14,900	112,393	120,544	151,100
Greece	19	3		60	63	
Hungary	35	77		216	285	
Ireland, Iceland	10	23		14	37	
Israel	5	47		94	141	
Italy	5,198	5,679	6,200	50,043	53,244	65,900
Lithuania		1			1	
Norway	48	61		684	724	
Poland	60	75		584	643	
Portugal	135	211		1,367	1,488	
Romania	9	18		9	27	
Russian Federation a/	9	24		5,000	5,000	
Slovakia a/	1	39		494	483	
Slovenia a/	31	15		494	391	
Spain	2,031	2,826		19,847	21,893	
Sweden	386	833		6,959	7,341	
Switzerland a/	240	310		3,479	3,539	
Turkey	51	24		172	196	
Ukraine	1	6		1	7	
United Kingdom	1,111	785	1,000	14,015	14,176	14,000
other Europe a/				377	418	
Africa	108	87	100	343	430	800
South Africa	108	87		343	430	
Subtotal, excl. Japan and Rep. of Korea	45,228	52,825	68,400	403,894	439,979	651,200
Total, including Japan and Rep. of Korea	81,476	95,368	121,000	800,473	847,764	1,041,700

Source: UNECE, IFR and national robot associations.

a/ estimated by UNECE and IFR for some or for all the years.

Figure 1. Yearly installations of industrial robots, 2003-2004 and forecast for 2005-2008

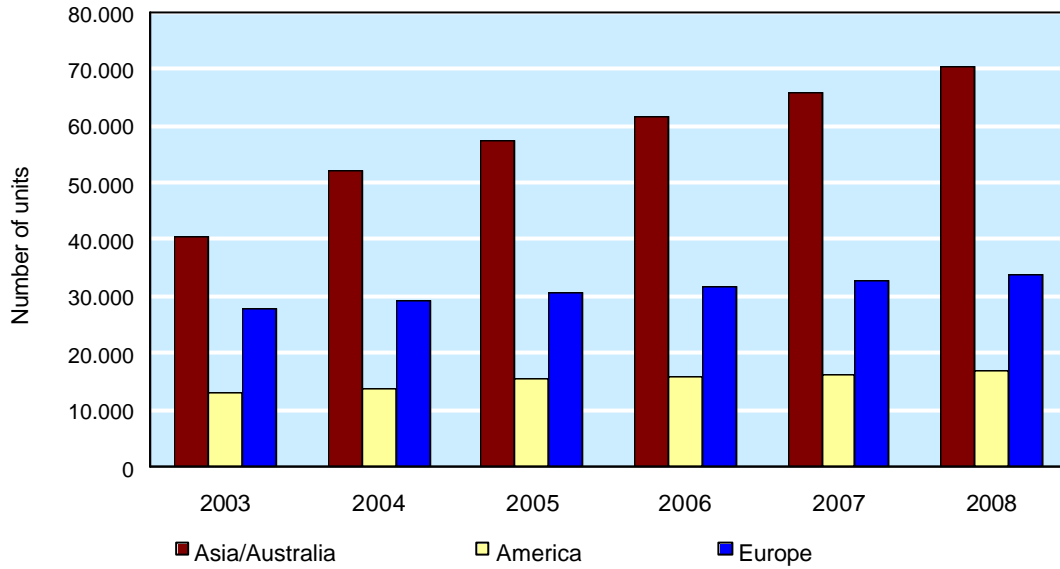
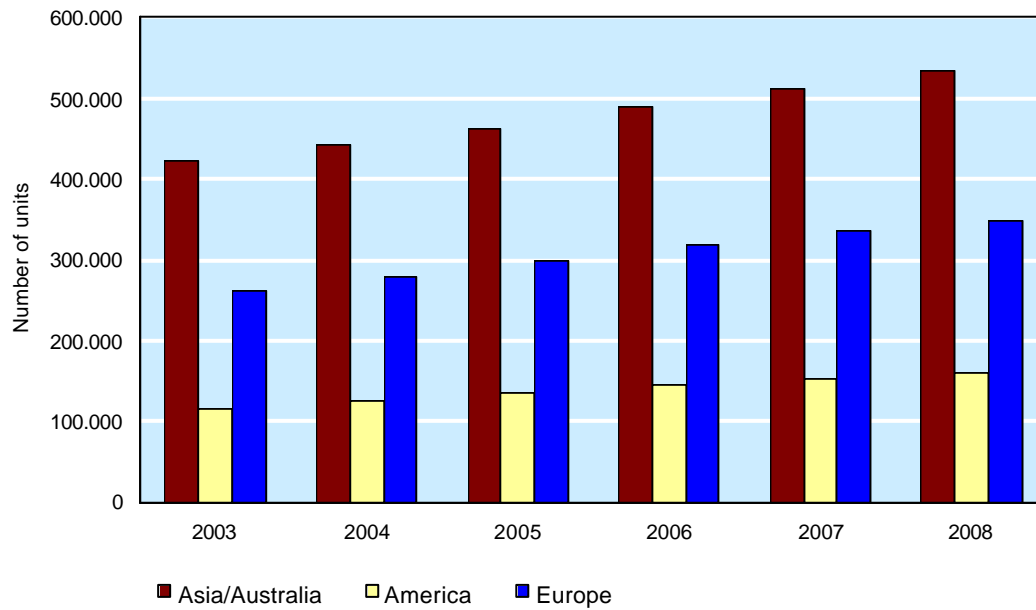


Figure 2. Estimated operational stock of industrial robots 2003-2004 and forecast for 2005-2008



Forecasts for 2005-2008

In the near future the **reasons for investments in robots** are:

- **to save costs**
- **to increase productivity**
- **to raise quality**
- **to remain competitive in a global market**
- **to transfer dangerous and laborious work from man to machine**

In 2004, demand for robots amongst end producers in the motor vehicle industry decreased, whilst the automotive parts industry boosted its investments in robots. During the last few years, motor vehicle suppliers have found it difficult to increase sales in the big, traditional markets, especially Western Europe, United States/Canada and Japan. Neither new model offensives nor special sales discounts have succeeded in fundamentally changing demand. In the last two years, the new model strategy has caused an increase in investments in new production sites and in reorganisations of existing plants. This brought about high levels of investment by automotive parts suppliers in 2004, which has apparently been continuing into 2005. From 2006, the saturation of the automotive market in the countries concerned may affect the demand for robots. Although there is still a large market for replacement investment, the number of new robot installations in the automotive industry could be flat in these regions.

A robust growth in robot installations worldwide between 2005 and 2008 can be expected

Although demand for robots within the automotive industry in Europe, North America and Japan may decrease, there is still growing demand in all developing markets in the world. Installations in general industry - especially the packaging industry, the food industry, the rubber and plastics industry and the machinery industry, will grow all over the world as a result of technical developments. Improvements in robot technology, such as new control systems and safety systems to permit interactive operations of man and machine, as well as improved sensor technology and robot-vision applications, will promote further robot installations.

The world market for industrial robots is projected to increase from 95,400 units in 2004 to 121,000 in 2008, or by a yearly average of 6.1%.

Sales in Japan continue to recover ...

Between 2004 and 2008, yearly sales are projected to increase from 37,100 units to some 45,900 units. In 2005, a continued expansion of sales in Japan will be driven by strong demand from the automotive industry taken as a whole (i.e. including parts suppliers), and in spite of a small reduction in the supply to the electrical/electronics industry. In the period 2006 to 2008, demand for replacement investment and an increase of installations in new applications will ensure that robust growth is sustained.

Robust growth in North America ...

The market in North America will surge in 2005 thanks to investments by the automotive industry. Japanese motor vehicle suppliers, in particular, will enlarge their capacities in the United States as a result of increasing sales, which have seen them gain market share from their American competitors. In Mexico, huge investments by motor vehicle suppliers as well as by automotive parts suppliers are continuing. Between 2004 and 2008, sales are projected to increase from 13,400 units to 16,500, a yearly average of 5.3%.

Slow increase in sales in Europe ...

The robot market in Europe is expected to grow from 29,300 units in 2004 to over 33,700 units in 2008, representing average annual growth of 3.6%. In Western Europe, the investments of the motor vehicle industry will decrease, whilst in Eastern European countries, sales will increase at an above average rate. There will still be growing demand from automotive parts suppliers in 2005 and 2006. Increased installations in the non-automotive sector will not compensate for falling demand from within

the automotive industry as a whole. In 2004, 60% of all new installed robots were still supplied to the motor vehicle industry including automotive parts suppliers.

The operational stock of industrial robots continues to grow

In terms of units, it is estimated that the worldwide stock of operational industrial robots will increase from about 848,000 units at the end of 2004 to 1,000,000 at the end of 2008, representing an average annual growth rate of 5.3%. It is interesting to note that the operational stock of robots in **Japan** decreased for the first time in 1998. In 1999-2001, the decrease accelerated. In 2002-2003, however, the rate of decrease slowed down significantly. In 2004, for the first time since 1998, the Japanese robot stock again increased.

In **North America**, the operational stock of multipurpose industrial robots is forecast to reach 156,000 units in 2008. The projection for **Europe** is 348,000 units, of which 151,000 in Germany, 66,000 in Italy, 36,000 in France and 14,000 in the United Kingdom.

These estimates of stock data are minimum figures. Assuming a longer average service life of robots (15 years instead of 12 years) would significantly increase the estimated stock.

Results in the first half of 2005 – robot sales continue to rise

Looking at the first half of 2005, the UNECE/IFR quarterly survey on order intake for industrial robots, which includes most of the world's largest companies, showed that worldwide order intake increased by 13%, compared with the same period in 2004. Orders from North America surged by 36%, those from Europe grew by 7% whilst orders from Asia remained approximately stable.

Order intake of industrial robots, first half of 2005 compared with the same period in 2004

North America	+36%	Asia	-1%
Europe	+7%	Other regions	-49%

Growth in robot investment has been spurred on by plummeting robot prices but price decreases are starting to level off ...

Both the price of industrial robots and even more so their relative price, i.e. the price of industrial robots for a given set of performance indicators in relation to labour costs, have fallen sharply in the last decade. After 2000, nominal prices stopped falling. Although quality adjusted prices and relative prices will continue to fall, they are falling at a lower rate than before. This is the result of the expansion in applications for industrial robots in sectors other than the automotive industry. Bespoke solutions for particular operations will stabilise robot prices, and may even result in higher returns. (Figure 3)

Measurements of robot density based on the total number of persons employed

In 2004, Japan has the highest robot density with 329 robot installations per 10,000 employed in the manufacturing industry. The Japanese operational stock of industrial robots still includes all types. Therefore the rate is overestimated compared to other countries. But, however, Japan has the most automated industry in the world. It is followed by Germany with a robot density of 162. The Republic of Korea also counts all kinds of industrial robots, therefore the rate of 144 seemed to be overestimated. Italy has a robot density of 123, followed by Sweden with 107 robots per 10,000 employed in the manufacturing industry, Finland with 86, Spain with 81, and France with 78 robots. The United States have a robot density of 69 (Figure 4)

Despite this large range in the robot densities of the European countries mentioned, it is interesting to note that robot density in Europe is about 25% higher than in the United States.

Robot densities - 1 robot per 10 workers in the motor vehicle industry

Regarding the data on the number of multipurpose industrial robots per 10,000 production workers in the motor vehicle industry, Japan and Italy are in the lead with almost 1,600 robots per 10,000 workers, but, bearing in mind that Japan includes all types of robots (up to and including 2000), it is not comparable with the densities of other countries. Thereafter follows Germany with a density of 1,140, France 1,030, Spain 870, United States 800, United Kingdom 680 and Sweden 610. The technological level with respect to robotics is thus rather homogeneous in the motor vehicle industry in most of the above-mentioned countries (Figure 5).

Installations of advanced multipurpose industrial robots by types

In 2004, 62.5% of the installed robots were articulated robots, 14.5% linear/cartesian/gantry robots, 9.7% cylindrical robots, 11.6% Scara robots. About 59,600 articulated robots were installed in 2004. In America about 90% of the installed robots were articulated, in Europe 74% and in Asia only 49%. However, in terms of units most of the articulated robots were supplied to Asia, about 25,500 or 43% of the total supply of articulated robots. In Europe, 21,800 articulated robots were installed, about 37% of the total supply. Articulated robots are all-purpose robots. They are used in nearly all industries. The main operations of articulated robots are welding and handling, but they also operate in dispensing, assembling and processing.

Figure 3
Price index of industrial robots for international comparison (based on 1990 \$ conversion rate), with and without quality adjustment.

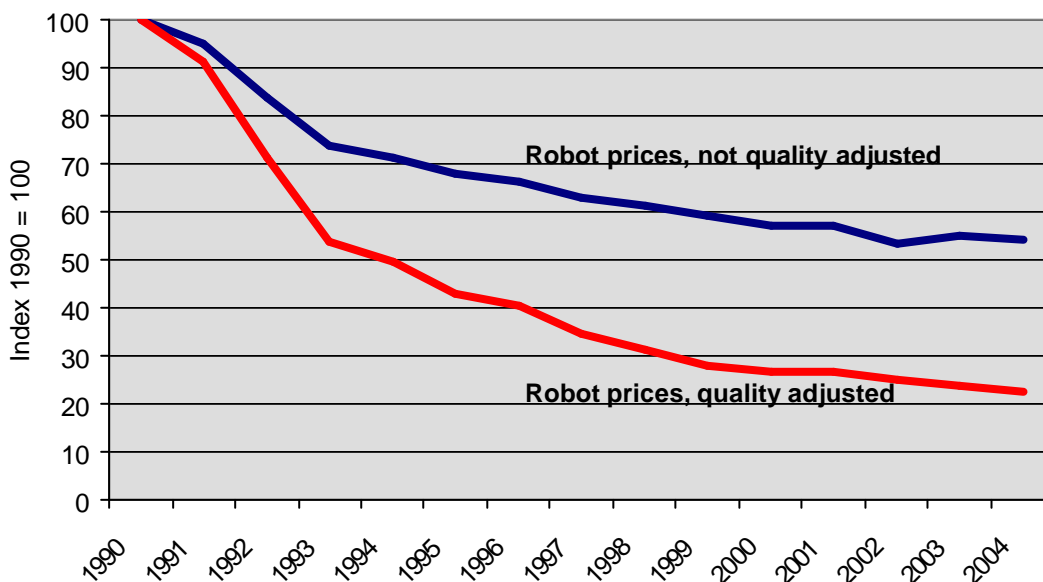


Figure 4 Number of robots per 10,000 persons employed in the manufacturing industry in 2004

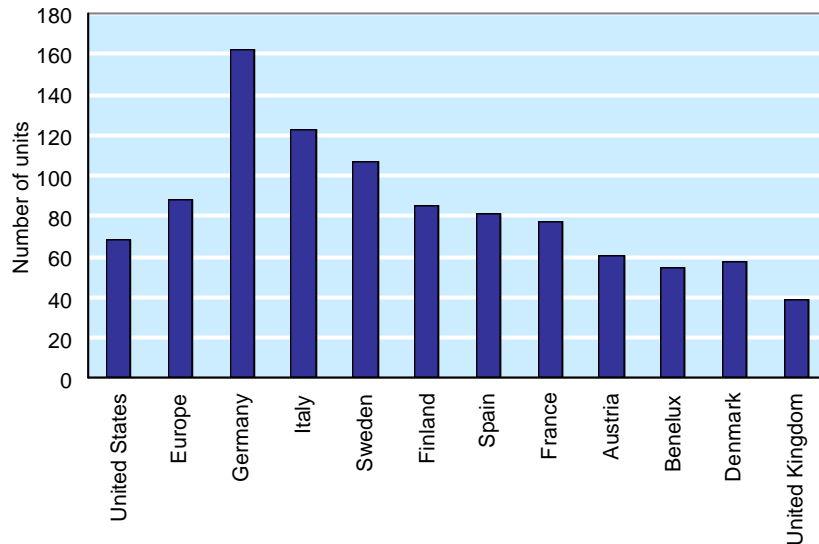
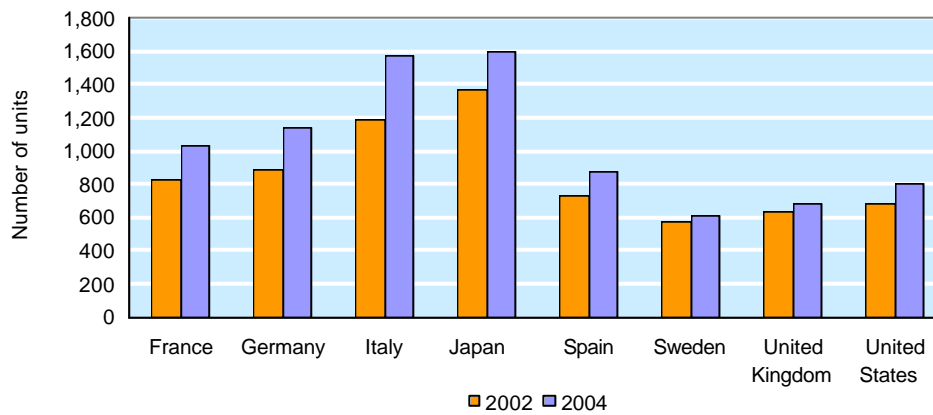


Figure 5 Number of robots per 10,000 production workers in the motor vehicle industry, 2002 and 2004



Distribution of service robots

The following pages provide details about the results of the UNECE/IFR survey of sales of service robots, broken down by application areas. As many companies did not provide market data, the figures reported here probably underestimate significantly the true sales amounts as well as the installed base of robots.

Service robots for professional use: 25,000 units installed up to the end of 2004

With 5,320 units, underwater systems accounted for 21% of the total number of service robots for professional use installed up to the end of 2004. Thereafter followed cleaning robots and laboratory robots with 14%, each, and construction and demolition robots with 13%. Medical robots and mobile robot platforms for general use accounted for 11%, each. Field robots, e.g. milking robots and forestry robots, had a share of nearly 9% and defense, rescue and security applications 5%. Minor installation numbers were counted for logistic systems (270 units), inspection systems (235 units) and public relation robots (20). The value of the stock of professional service robots is estimated at \$3.6 billion.

The unit prices for professional service robots differ significantly – from less than \$10,000 to more than \$300,000, depending on type of application. The most expensive robots are underwater systems (from \$300,000 to more than \$1,000,000), medical robots with a wide range from \$100,000 to some \$1,000,000, and milking robots (\$200,000).

Service robots for personal and private use: about 1.2 million units for domestic use and more than 900,000 units for entertainment and leisure sold up to end 2004

Service robots for personal and domestic use are recorded separately, as their unit value is only a fraction of that of many types of service robots for professional use. They are also produced for a mass market with completely different marketing channels.

So far, service robots for personal and private use are mainly in the areas of domestic (household) robots, which include vacuum cleaning and lawn-mowing robots, and entertainment robots, including toy and hobby robots (see figure 7). Sales of lawn-mowing robots have started to take off very strongly, with sales in excess of 46,000 units, and should continue to boom. The market potential is very large. Vacuum cleaning robots were introduced on the market at the end of 2001. The market expanded rapidly in 2002-2004 and at least one million units have been sold.

Of the 1.2 million robots for domestic household robots that were in use at end 2004, about 550,000 were installed in 2004.

Projections for the period 2005-2008: 50,000 new service robots for professional use to be installed

Turning to the projections for the period 2005-2008, the stock of service robots for professional use is forecast to increase by some 50,000 units. Application areas with strong growth are humanoid robots, underwater systems, defence, rescue and security applications, laboratory robots, professional cleaning robots, medical robots and mobile robot platforms for multiple use.

Projections for the period 2005-2008: about 7 million units of service robots for personal use to be sold

It is projected that sales of all types of domestic robots (vacuum cleaning, lawn-mowing, window cleaning and other types) in the period 2005-2008 could reach some 4,5 million units with an estimated value of \$3 billion.

The market for entertainment and leisure robots, which includes toy robots, is forecast at about 2.5 million units, most of which, of course, are very low cost. The sales value is estimated at over \$4.4 billion.

Figure 6a. Service robots for professional use. Stock at the end of 2004 and projected installations in 2005-2008

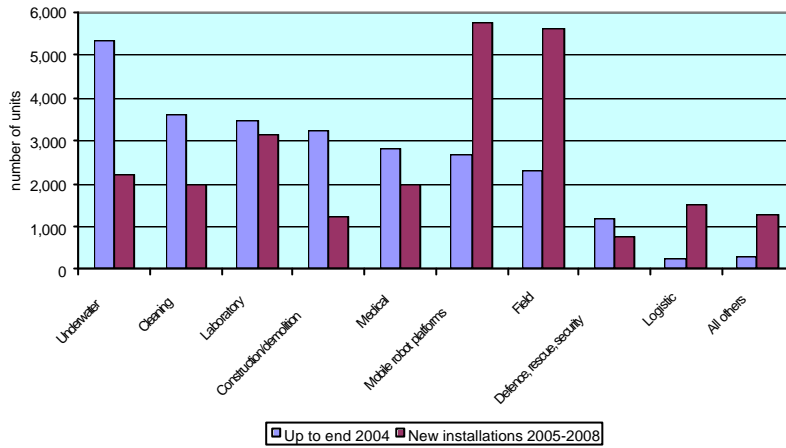


Figure 6b. Service robots for professional use. Value of stock at the end of 2004 and value of projected installations in 2005-2008

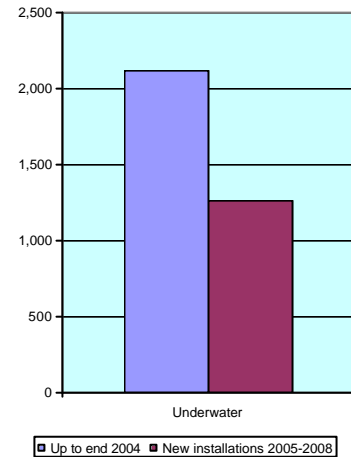
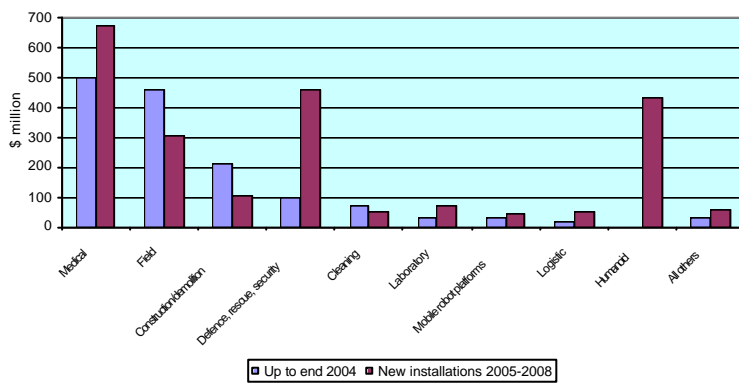


Figure 7a. Service robots for personal/domestic use. Stock at the end of 2004 and projected installations in 2005-2008

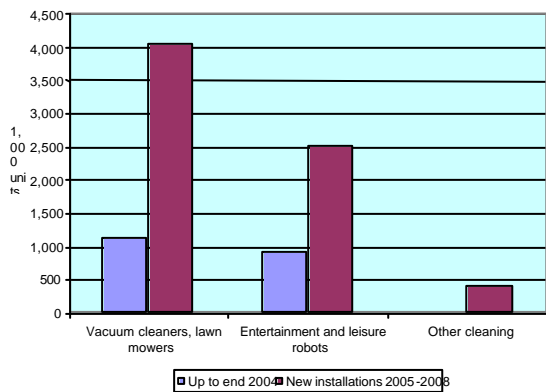
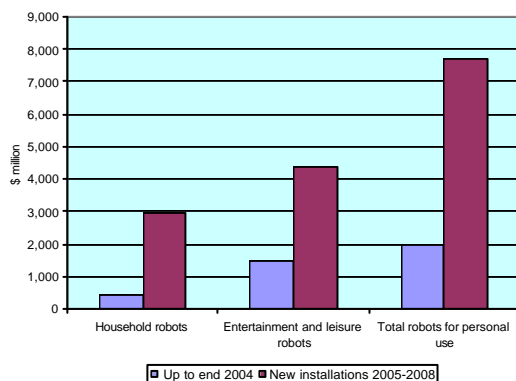


Figure 7b. Service robots for personal/domestic use. Value of the stock at the end of 2004 and of the projected installations in 2005-2008



The publication **World Robotics 2005 – Statistics, Market Analysis, Forecasts, Case Studies and Profitability of Robot Investment** as **book** is available, quoting Sales No. GV.E.05.0.17 or ISBN No. 92-1-1011000-05, through the usual United Nations sales agents in various countries or from the **United Nations Office at Geneva** or **IFR Statistical Department** (see addresses below). The **interactive CD-Rom** is available from **IFR Statistical Department** only (see also www.ifrstat.org).

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Statistics, Market Analysis, Forecasts, Case Studies and Profitability of Robot Investment

Published by United Nations Economic Commission for Europe (UNECE) and International Federation of Robotics (IFR)

This unique publication presents comprehensive global statistics on industrial robots as well as on service robots in uniform tables allowing consistent country comparisons. It contains detailed statistical data for some 40 countries, broken down by application areas, industrial branches, types of robots and by other technical and economic variables. Data on production, exports and imports are presented for a selection of countries. Trends in robot densities, i.e., number of robots per 10,000 employed, are also featured. The study is available as **book** or on an **interactive CD-Rom**.

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