

EXECUTIVE SUMMARY of

1. World Robotics 2011 Industrial Robots

2. World Robotics 2011 Service Robots

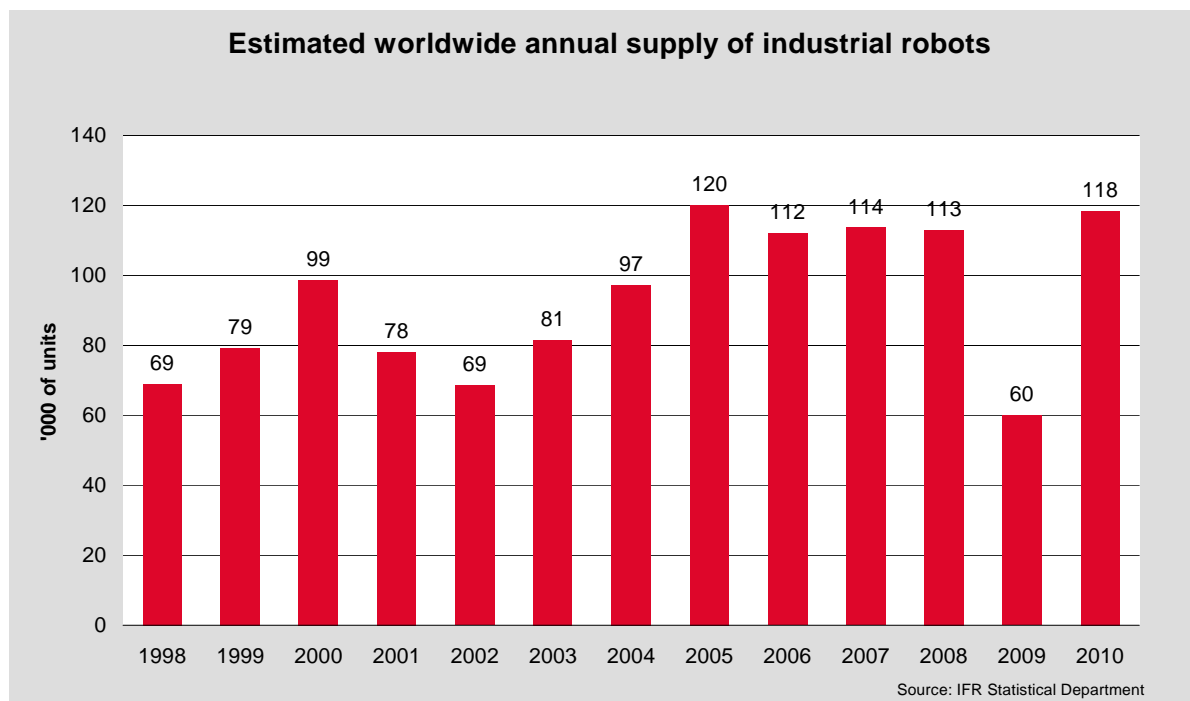
1. World Robotics 2011 Industrial Robots

2010: Strong comeback of the robotics industry

In 2010, robot sales almost doubled compared to 2009 to 118,337 units. The automotive industry and the electronics industry were the main drivers of the strong recovery.

In 2009, the worldwide economic and financial crisis caused a significant slump in the sales of industrial robots. Compared to 2008, considered one of the most successful years, 2009 had a decline of 47% (60,000 units). This is the lowest level reported since 1994. Robot installations had never decreased so heavily.

Various regions experienced different rates of recovery in robot sales in 2010. **Asia** (including Australia and New Zealand) was on top with an increase of 132% to about 70,000 units, the highest level ever recorded. The most dynamic markets were **China, the Republic of Korea and the ASEAN** countries. Sales to these markets almost tripled. In 2010, the **Republic of Korea** topped the list with some 23,500 robots sold, up from 7,800 units in 2009. Huge investments made by the electronics industry and the motor vehicle industry were mostly responsible for this large increase in robot sales. Robot sales to **Japan** recovered by 72% to about 21,900 units. For the first time, Japan was the second largest robot market in the world. The strong increase in 2010 could not compensate for the slump of sales in 2009. In 2010, the motor vehicle suppliers continued to reduce robot investments while the electrical/electronics industry considerably increased robot purchases. 15,000 new robots were supplied to **China**. It became the fourth largest robot market following North America. Robot investments in China took off like never before. Not only the increase of production capacities were the reason for this, but also an increasing trend towards automation in order to meet the demand for quality.



About 17,100 units were shipped to the **Americas**, 90% more than in 2009, reaching almost the level of 2008. In the **United States** robot shipments increased by 111% to 14,380 units in 2010 compared to 2009. The main drivers of the growth were the electronics industry and the metal industry, which increased their robot investments considerably in 2010. The automotive industry still remained the main customer, but the increase of robot orders was below average. In **Canada**, shipments surged by 110% to 1,076 units. Between 2007 and 2009 the annual supply decreased from 3,025 units to 513 units. There were almost no investments taking place in the automotive industry. This changed in 2010 when the automotive industry ordered considerably more robots. However, the volume of shipments was still only one third of that of 2007. About 16% fewer robots than in 2009 were delivered to **Mexico** (900 units). Most of these robots were shipped to the automotive industry. Despite the decline in robot supply in 2010, Mexico started to gain importance as a production site for the automotive industry due to lower costs. In 2010, 640 industrial robots were supplied to **Brazil**, 29% more than in 2009.

About 30,600 units were sold in **Europe**, 50% more than in 2009. This is still about 13% lower than the peak levels of 2007 and 2008. Between 2005 and 2008, a strong trend towards automation boosted robot sales. But, the economic downturn in 2008/2009 put a halt to this upward trend.

In 2010, 14,000 new industrial robots were supplied to **Germany**, 65% more than in 2009. After the strong decrease in 2009, this was the third highest number of units ever recorded. Particularly, the motor vehicle industry was the main driver of the strong recovery with 172% more industrial robots than in 2009. Also, other big customers, i.e. the automotive parts suppliers, the metal industry and the rubber and plastics industry ordered almost 50% more than in 2009. The food and beverage industry reached a new peak level as well.

In 2010, total robot sales to **Italy** were up by 57%, to about 4,500 units after decreasing two years in a row. This was the result of a strong increase of robot sales to the automotive industry. Sales to all other industries only grew below average. From 2007 to 2009, robot sales fell from about 5,800 units to 2,900 units. In 2010, about 2,000 industrial robots were sold in **France**, 41% higher than in 2009. However, sales in 2009 reflect the second lowest number of installations since 1995. Sales of industrial robots to **Spain** recovered by 41% compared to 2009 to 1,900 units, but did not reach the level of 2007 and 2008. Shipments to the **UK** also increased by 38% to some 900 units. All three countries are important automotive production sites with decreasing number of robot installations between 2006/2007 and 2009.

The economic downturn as well as the decreasing or stagnating car market in Western Europe in the past few years revealed the existing overcapacities in the region. While Germany was hardly affected by the restructuring of the automotive industry, all other production sites in Western Europe saw a continued decline of investments by the automotive industry as a whole between 2006/2007 and 2009.

Robot sales to the **Central/Eastern European** countries surged by 73% in 2010. Thereof, shipments to the **Russian Federation** decreased.

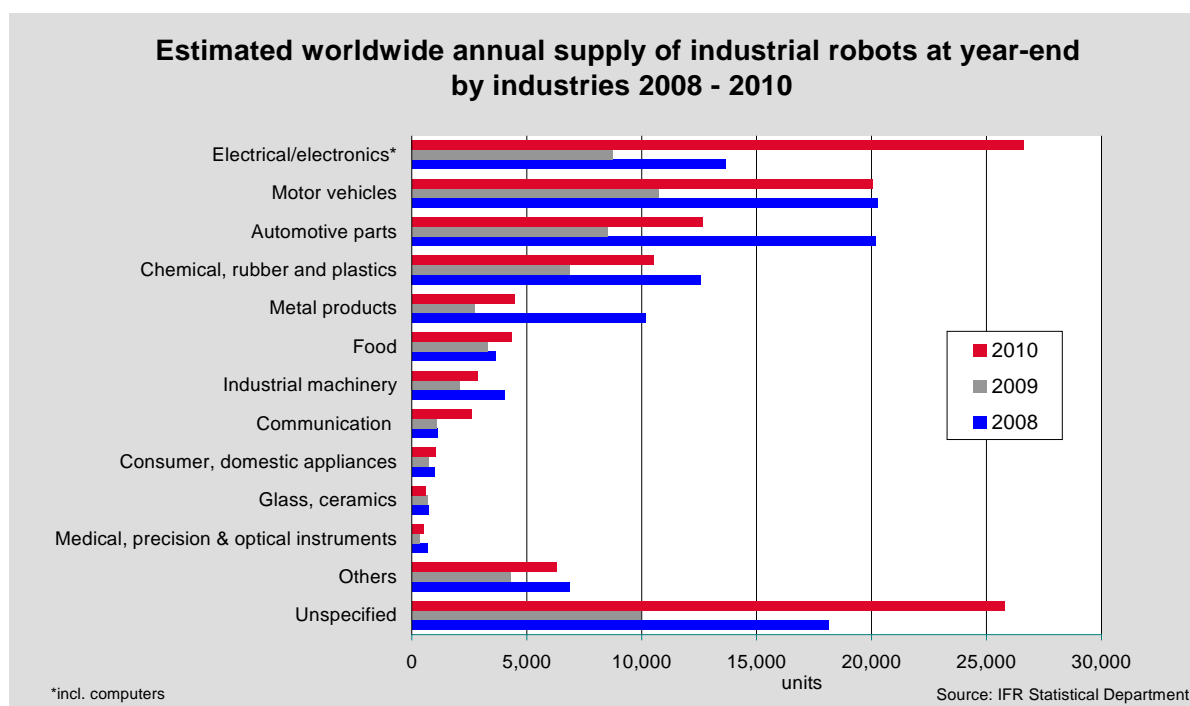
Automotive industry and electrical/electronics industry were the drivers of the strong recovery

In 2010, the **automotive industry** – the most important purchaser of industrial robots - restarted to invest in industrial robots after continuously reducing robot installations since 2006 and was one of the main drivers of the strong recovery of robot shipments. In 2009, robot installations hit rock bottom. In 2010, about 70% more robots were sold to the automotive industry, 32,700 units. With regard to Australia, China, India, Thailand, Taiwan and other Asian countries the distribution by various industries is not complete. Given the distribution by application, it can be concluded that the supply to the automotive industries in China, Thailand, Malaysia and India also increased considerably in 2010.

The **electrical/electronics industry** (including computers and equipment, radio, TV and communication devices and equipment and medical, precision and optical instruments) was the second main driver of the recovery of robot sales in 2010. The worldwide shipments of industrial robots almost tripled in 2010 to 30,745 units up from 10,855 units in 2009. The share of the total supply was about 26%. After strong investments in robots in 2004 and 2005, installations slowed down between 2006 and 2009.

After years of continuing growth, the **rubber and plastics industry** reduced robot investments in 2008 and 2009 from the peak level of about 14,800 units to 5,800 units. In 2010, sales increased by 54% to 8,940 units which is still far below the peak level. Share of the total supply was about 8%. The **food and beverage industry** increased robot orders by 32% to almost 4,350 units, accounting for a share of 4% of the total supply. About 58% of the worldwide robot sales to this industry were made in Europe.

In 2010, sales to the **metal products industry** recovered by 63% to about 4,500 units which was only half of the volume of 2008. In 2009, only about 2,700 robots were ordered by this industry. Regarding the **machinery industry**, there were no separate data available for North America. The data for North America for this sector are included in metal products. Sales to all other countries recovered just moderately by 37% to about 2,900 units which was only about 70% of the volume of 2007 and 2008. Until 2008, robot supplies to the metal and machinery industry as well as to the food and beverage industry were continuously growing.



Operational stock of industrial robots increased in 2010

Total accumulated sales, measured since the introduction of industrial robots at the end of the 1960s, amounted to more than **2,142,000 units** by the **end of 2010**. These units include the dedicated industrial robots installed in Japan up to and including 2000 (see the tables in annex A). Most of the early robots, however, have by now been taken out of service. Based on the assumptions made in chapter I, the IFR estimates:

the total worldwide stock of operational industrial robots at the end of 2010 was in the range of 1,035,000 and 1,300,000 units.

The minimum figure above is based, as was discussed in chapter I, 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 of an industrial robot might in fact be as long as **15 years**, which would then result in a **worldwide stock of 1,300,000 units**.

Due to the tremendous decrease of robot installations in 2009, for the first time the minimum stock of 1,021,000 units in 2009 was about 1% lower than the stock of the year before. In 2010, the stock increased by 1% to the level of 2008.

Value of the market was up to US\$ 5.7 billion

In 2010, sales recovered by 50% to US\$ 5.7 billion, which is still below the value of 2008, one of the most successful years. It should be noted that the figures cited above generally do not include the cost of software, peripherals and systems engineering. Including the mentioned costs might result in the actual robotic systems market value to be about three times as high. The worldwide market value for robot systems in 2010 is therefore estimated to be \$17.5 billion.

High potential for robot installations in many countries

When comparing the distribution of multipurpose 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 multipurpose industrial robots per 10,000 persons employed in manufacturing industry or in the automotive industry or in the “general industry” (which is all industries excluding the automotive industry).

The most automated countries in the world – include: **Japan**, the **Republic of Korea** and **Germany**. In 2010, these three countries had robot densities of 306, 287 and 253 respectively. While the density in Germany and the Republic of Korea increased continuously up to 2010, it was more or less stagnating in Japan between 2006 and 2009 and had a considerable decline in 2010. 9 countries of the 45 surveyed countries have a robot density between 103 (Austria) and 161 (Italy), 7 countries from 50 to 100, 5 countries from 20 to 49 and all others (21 countries) have less than 20 robots in operation per 10,000 employees in the manufacturing industry. **The estimated average robot density in the world is about 50 industrial robots in operation per 10,000 employees in manufacturing industry.**

The considerable high rate of automation of the automotive industry compared to all other sectors is demonstrated in the evaluation of the number of industrial robots in operation per 10,000 employees in automotive industry and in all other industries.

Japan has by far the highest robot density in the automotive industry. 1,436 industrial robots are installed per 10,000 persons employed in the automotive industry and 191 in all other industries. In **Germany** 1,130 robots per 10,000 employees were installed in the automotive industry. But in all other German industries the robot density is 134, which is significant compared to all the other countries. Only Japan and the Republic of Korea had a higher rate, 191 and 215 respectively. These higher rates are mainly due to robot installations in the electronics industry. The comparatively high rate in Germany is due to a more diversified distribution of industrial robots in all industries, especially in the metal industry, the chemical industry and the food industry as well as in the electronics industry. Regarding the robot density in the automotive industry, **Italy** ranked number 3 with a robot density of 1,229. In other sectors the robot density was increasing and reached 114 robots operating per 10,000 employees in 2010. In 2010, 1,112 industrial robots per 10,000 employees were installed in the automotive industry in the United States, but only 69 in all other sectors.

In **China**, the huge robot investments in the recent years resulted in a substantial increase in the robot density of the automotive industry. Between 2006 and 2010, it was up from 37 to 105 robots per 10,000 employees. Also all other sectors increased their robot density considerably from 30 to 86 during the same period. However, the potential for new installations in this market is still tremendous.

The overall conclusions indicate that in almost all the surveyed countries, not only the potential for robot installations in the non-automotive industries is still tremendous, but it is also considerably high in the automotive industry among the emerging markets and in some traditional markets as well. This is mostly due to the necessary modernization and retooling that is needed in these markets.

Another strong increase in 2011, continued growth between 2012 - 2014

Another strong increase of robot installations of about 18% to a new peak of about 139,300 units is estimated for 2011. The main impulses are coming from North America, China and other South-east Asian countries. Investments in Japan will gain momentum as reconstruction and new projects are carried out in the coming months. Japan is likely to return at the top of the robot market in 2011. As a consequence of the disaster in Japan, Japanese companies have been trying to diversify their production geographically. This will result in considerable investments in robot installations in Asian markets as well as in Europe and in North America. The robot supply to the Republic of Korea will only slightly increase after the huge investments in 2010. Robot supply to China will surge and finally at least in 2014 China will be on top of the robot markets. The robot sales in Europe will increase below average because of a rather moderate increase in investment by the western European countries. The robot installations in the eastern and central European countries will surge in 2011. However, it is still possible that due to a shortage of components and capacity problems a part of these expected robot installations will have to be shifted to 2012.

The automotive industry is continuing to be the main driver of the growth in worldwide robot installations with investments in new technologies, further capacities and renovation of production sites. Investments of the General Industry - all other industries, except automotive – are gaining momentum. The trend towards automation which was interrupted by the economic crisis in 2008/2009 will further boost robot installations.

The success story of industrial robots will continue also after 2011. Huge consumer markets are opening up in China, India, Brazil, Russia, and in Southeast Asia. All industries will increase capacities and modernize existing production sites in the years to come in these markets. The necessary increase of automation of the industrial production will continue in the United States. The companies are forced to make these investments in order to be competitive on the world market. Rising wages and the increasing standard of living will also push automation in still low-wage countries in Eastern and Central Europe as well as in Asia and in South America. The Middle Eastern countries are becoming new markets for automation.

Apart from any economical development, the robotics industry is confronted with the modification of production processes due to the individualization of consumer products. The handling of robots has to become much easier, ever greater flexibility is necessary, and rapidity and accuracy have to be increased. The robotics industry is on track to meet these challenges.

A further increase will resume in the period between 2012 and 2014 about 6% per year on average attaining a level of about 167,000 units. In the Americas sales will be up by 31% in 2011, in Asia/Australia by 16% and in Europe by 13%. Between 2012 and 2014, robot shipments will increase by about 6% per year on average: about 6% in the Americas, about 7% in Asia/Australia, and about 4% in Europe.

Certain risks are involved with regard to this rather optimistic forecast, i.e. weakening growth of the world economy or even a new recession caused by financial problems of major markets.

Table 1

Estimated annual shipments of multipurpose industrial robots in selected countries. Number of units

Country	2008	2009	2010	2011*	2014*
America	17,192	8,992	17,114	22,450	26,700
North America (Canada, Mexico, USA)	16,242	8,417	16,356	21,000	24,000
Central and South America	950	575	758	1,450	2,700
Asia/Australia	60,294	30,117	69,833	81,200	100,000
China	7,879	5,525	14,978	19,500	32,000
India	883	363	776	1,000	3,000
Japan	33,138	12,767	21,903	26,000	30,000
Republic of Korea	11,572	7,839	23,508	24,500	21,000
Taiwan	3,359	1,474	3,290	3,700	4,500
Thailand	1,585	774	2,450	3,100	5,000
Other Asia/Australia	1,878	1,375	2,928	3,400	4,500
Europe	34,695	20,483	30,630	34,700	38,900
France	2,605	1,450	2,049	2,400	2,800
Germany	15,088	8,507	14,000	15,500	16,500
Italy	4,793	2,883	4,517	4,600	4,900
Spain	2,296	1,348	1,897	2,100	2,400
United Kingdom	856	635	878	950	1,100
Central and Eastern Europe	2,603	1,448	2,507	3,700	5,100
other Europe	6,454	4,212	4,782	5,450	6,100
Africa	454	196	259	400	500
Total**	112,972	60,018	118,337	139,300	166,700

Sources: IFR, national robot associations.

*forecast

**including sales which are not specified by countries

Table 2

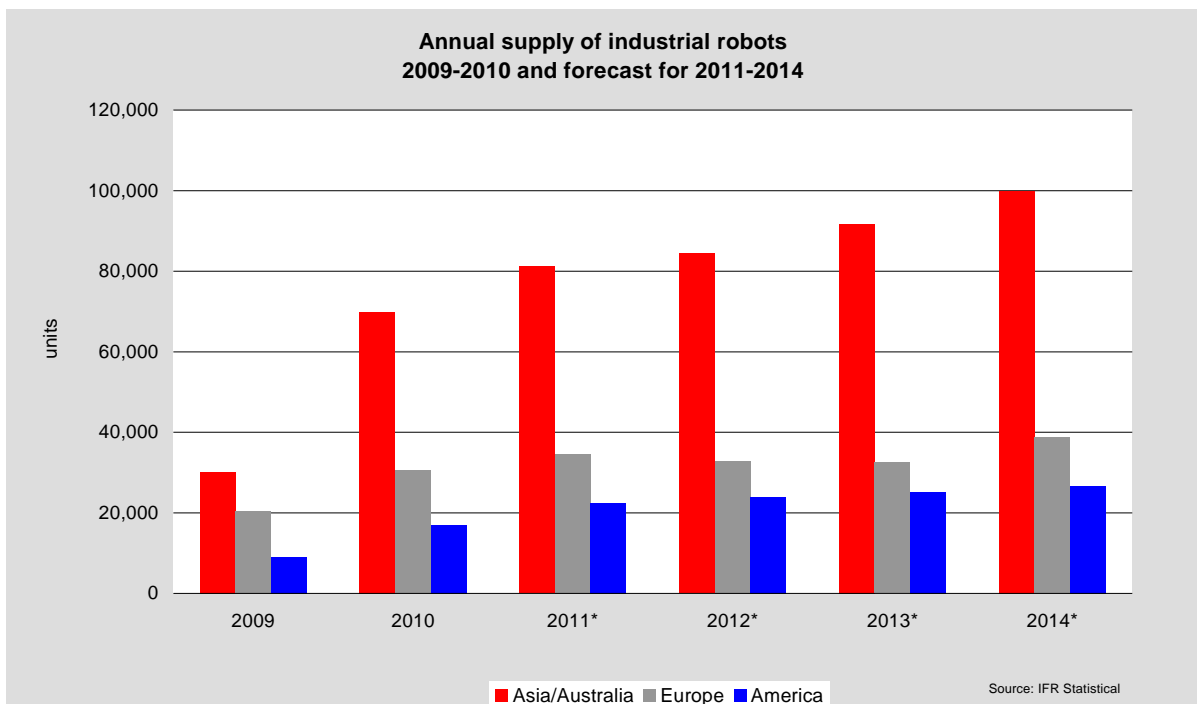
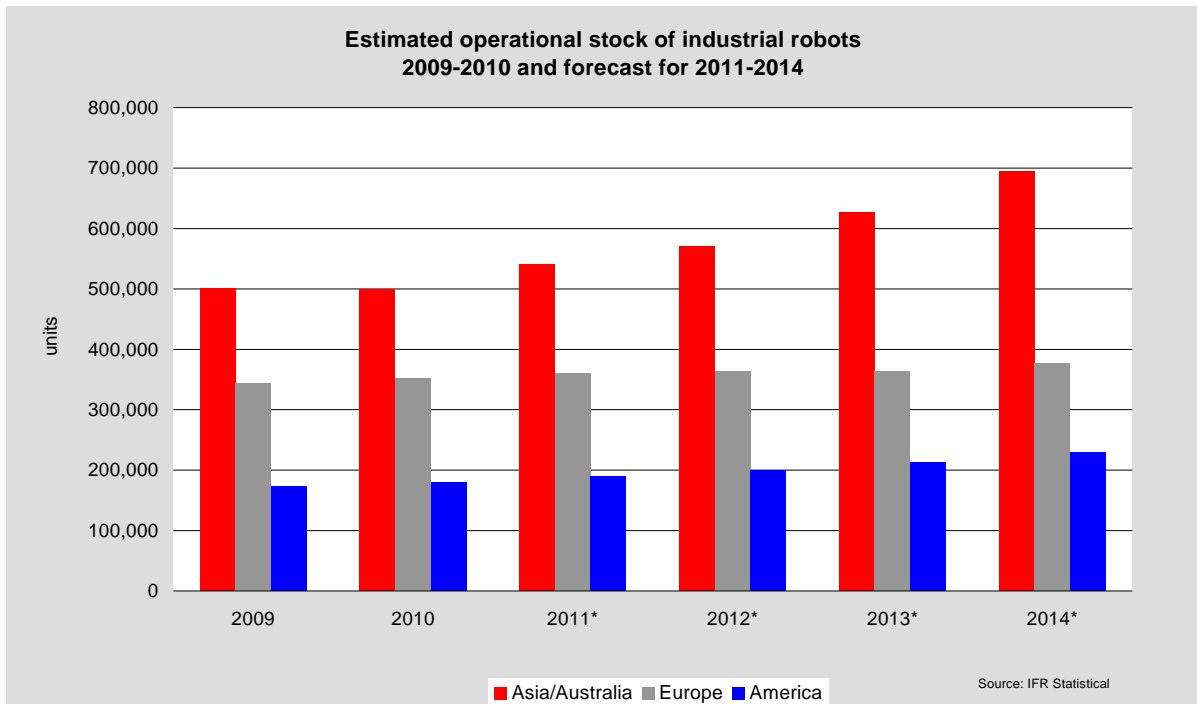
Estimated operational stock of multipurpose industrial robots at year-end in selected countries. Number of units

Country	2008	2009	2010	2011*	2014*
America	173,977	172,141	179,785	189,200	229,000
North America (Canada, Mexico, USA)	168,489	166,183	173,174	181,300	216,600
Central and South America	5,488	5,958	6,611	7,900	12,400
Asia/Australia	514,914	501,422	498,933	539,900	695,000
China	31,787	37,312	52,290	71,200	155,600
India	3,716	4,079	4,855	5,800	13,000
Japan	355,562	332,720	285,800	276,200	262,000
Republic of Korea	76,923	79,003	101,080	123,150	169,300
Taiwan	23,644	24,365	26,896	29,800	40,400
Thailand	6,411	7,185	9,635	12,700	25,100
Other Asia/Australia	16,871	16,758	18,377	21,050	29,600
Europe	343,329	343,661	352,031	360,700	376,000
France	34,370	34,099	34,495	33,800	31,400
Germany	144,643	144,133	148,195	153,100	158,300
Italy	63,051	62,242	62,378	61,800	58,400
Spain	28,636	28,781	28,868	28,900	26,800
United Kingdom	15,080	13,923	13,519	13,100	11,800
Central and Eastern Europe	10,216	11,470	13,761	17,100	28,300
other Europe	47,333	49,013	50,815	52,900	61,000
Africa	1,777	1,973	2,232	2,600	3,000
Total**	1,035,301	1,020,731	1,035,016	1,095,000	1,308,000

Sources: IFR, national robot associations.

*forecast

**including stock data which are not specified by countries



2. World Robotics 2011 Service Robots

The total number of professional service robots sold in 2010 rose by 4% compared to 2009 to 13,741 units. The value of sales increased by 15% to US\$3,2 billion.

With 6,125 units, service robots in **defense applications** accounted for 45% of the total number of service robots for professional use sold in 2010. Thereof, unmanned aerial vehicles are the most important application. The value of defense robots can only roughly be estimated. It was about US\$ 696 million, 4% lower than in 2009. This is about 22% of the total sales of professional service robots. The total number of **field robots** - mainly milking robots - sold in 2010 was almost 4,200 units, accounting for a share of 30% of the total unit supply of professional service robots. The value of sales of field robots increased by 5% to US\$744 million, accounting for about 24% of the total value of professional service robot sales. **75% of the total unit sales of professional service robots in 2010 were defense or field robots.**

Sales of **medical robots** increased by 14% compared to 2009 to 932 units in 2010, accounting for a share of 7% of the total sales of professional service robots. The most important applications are robot assisted surgery and therapy. The total value of sales of medical robots was up by 33% to US\$1361 million, accounting for 43% of the total value of sales of professional service robots. Medical robots are the most valuable service robots with an average units price of about US\$1.5 million, including accessories and services.

More than 900 **logistic systems** were installed in 2010, 10% more than in 2009, accounting for 7% of the total sales of professional service robots. About 900 logistic systems were supplied, which are courier and mail systems as well as automated guided vehicles for factories.

Other professional service robots with lower units sales are construction and demolition systems, robots for professional cleaning, inspection and maintenance systems, rescue and security robots, mobile robot platforms and underwater systems. Underwater systems are among the most valuable professional service robots with a unit price of about US\$850,000.

In 2010, about 2.2 million service robots for personal and domestic use were sold, 35% more than in 2009. The value of sales increased by 39% to US\$538 million.

Service robots for personal and domestic use are recorded separately, as their unit value is generally 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 pricing and marketing channels.

So far, service robots for personal and domestic use are mainly in the areas of **domestic (household) robots**, which include **vacuum cleaning, lawn-mowing robots, and entertainment and leisure robots**, including **toy robots, hobby systems, education and research**.

Up until now robots for **handicap assistance** robots have not yet taken off to the anticipated degree, given their potential with regard to both imaginable need and the existing technological level of the equipment. Some of the most apparent reasons for this are explained in the later chapter III. In a longer perspective, say in the next 5 to 10 years, and taking into account demographic shifts and advances in technology, assistive robots for disabled and handicapped persons as well as robotic prostheses are certain to be a key area for service robots. Some major research institutions are focusing on developing prototypes of this kind of robots and robotics-related devices.

Robots for **personal transportation** and **home security and surveillance** robots will also gain in importance in the future.

In 2010, it was estimated that **1.445 million domestic robots**, including all types, were sold.

The actual number might, however, be significantly higher, as the IFR survey is far from having full coverage in this domain. The value was about US\$369 million.

As for **entertainment robots**, it is estimated that about 753,000 units were sold in 2010, 31% more than in 2009. It is expected that the cross-fertilization of PC, smart phones, home entertainment and robot technologies will become a very substantial business area in the near future. The **total value of the 2010 sales of entertainment robots** amounted to US\$159million. In 2010, these low-priced robots (unit prices between \$100 and \$1,000) were slightly cheaper on average than in 2009.

**Projections for the period 2011-2014:
87,500 new service robots for professional use to be installed**

Turning to the projections for the period 2011-2014, sales of professional service robots are forecast to increase by about 87,500 units. Thereof, more than 25,500 **milking robots** will be sold in the period 2011-2014. They are followed by service robots for **defense applications** with more than 22,600 units. This is probably a rather conservative estimate. These two service robot group make up 55% of the total forecast of service robots.

**Projections for the period 2011-2014:
about 14.4 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) could reach over 9.8 million units in the period 2011-2014, with an estimated value of US\$4.3 billion.

Sales of all types of entertainment and leisure robots are projected at well about 4.6 million units, with a value of about \$1.1 billion

