

## Executive Summary

- 1. World Robotics 2012 Industrial Robots**
- 2. World Robotics 2012 Service Robots**

### 1. World Robotics 2012 Industrial Robots

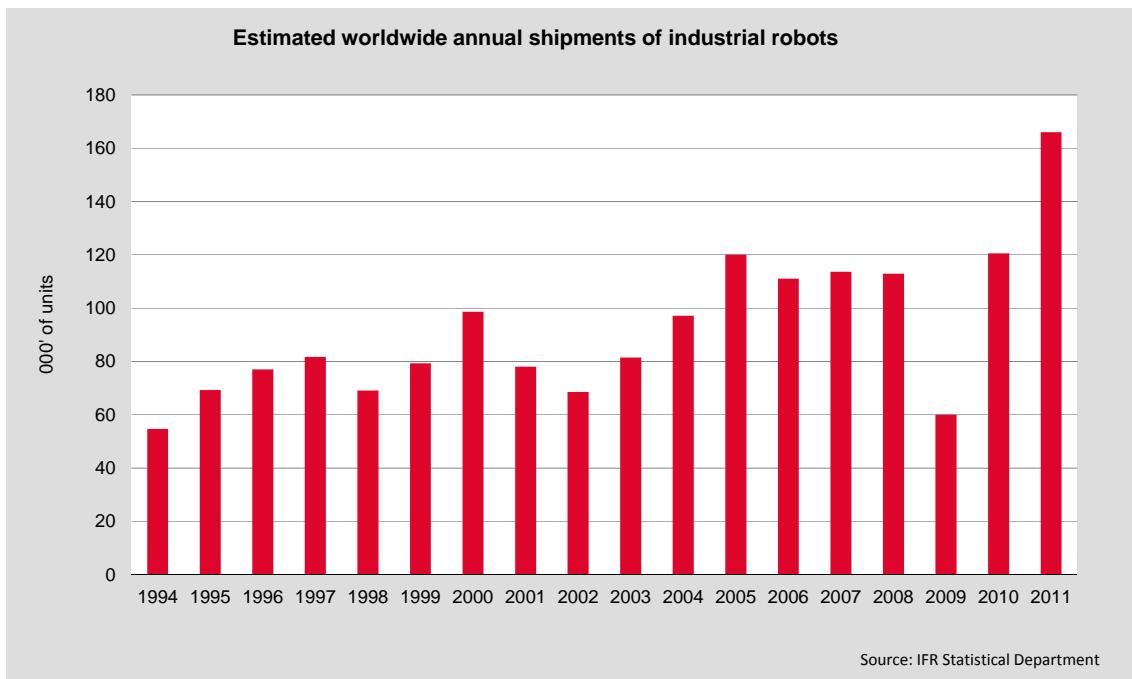
#### 2011: The most successful year for industrial robots since 1961

In 2011, robot sales again increased by 38% to 166,028 units, by far the highest level ever recorded for one year. The trend towards automation – interrupted by the crisis in 2009 – restarted already in 2010 and continued in 2011. The automotive industry and the metal industry were the main drivers of the strong recovery. The most important countries of the growth were China, United States and Germany with growth rates between 39% and 51%. However, they still could not reach the levels of the two biggest markets which only increased below average. Japan is back on top followed by the Republic of Korea.

Various regions experienced different rates in robot sales in 2011. The **Americas** was on top with a growth rate of 53% to about 26,200 units, the highest level ever recorded. In the **United States** robot shipments increased by 43% to a new peak level of 20,555 units in 2011 compared to 2010. The necessary modernization of the production facilities in the United States is gaining momentum. In **Canada**, shipments again surged by 72% to 1,848 units, but could not reach the peak level of 2007 (3,026 units). Robot shipments to **Mexico** more than doubled to a new peak level of 1,938 units. Robot sales to **Brazil** skyrocketed to 1,440 units in 2011, 125% more than in 2010. This is a new peak level. Also, robot sales in **Argentina** increased considerably to 407 units, up from 96 in 2010.

About 43,800 industrial robots were sold in **Europe**, 43% more than in 2010, a new peak level. This was again the result of considerable investments of the automotive industry with an increase of 66% compared to 2010. All other industries only grew by 16%. 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. Since 2010 however, robot sales have been on their way up and the situation is back on track.

In 2011, 19,533 new industrial robots were supplied to **Germany** – the biggest robot market in Europe - 39% more than in 2010. After the strong recovery in 2010, this is by far the highest number ever recorded for one year and it is about 45% of the total supply to Europe. Particularly, the motor vehicle industry was again – like in 2010 - the main driver of the strong growth. Also the automotive parts suppliers, ordered considerably more robots than in 2010. However, sales to all other industries did not meet expectations. In 2011, total sales of industrial robots were up by 13% to 5,091 units in **Italy** after a substantial recovery in 2010. The automotive industry, food and beverage industry and the metal and machinery industry increased robot orders above average. In 2011, 3,058 industrial robots were sold to **France**, 49% higher than in 2010. The 2011 sales numbers finally reached the average annual sales levels of the years before the crisis of 2008/2009. Robot sales had already considerably recovered in 2010. In 2011, sales of industrial robots to **Spain** continued to recover by 61% compared to 2010 to 3,091 units. All three countries are important automotive production sites with decreasing number of robot installations between 2006 and 2009. Robot sales to the Central/Eastern European countries surged again by 89%. Robot sales to the **United Kingdom** surged by 72% compared to 2010 to 1,514 units. Also those to **Turkey** were considerably up by 156% to 864 units in 2011, a new peak level.



**Asia** (including Australia and New Zealand) was by far the biggest market with about 88,700 units, again a new peak level. After the strong increase of 132% in 2010, sales of industrial robots rose by a more moderate rate of 27%. In 2011, Japan was again the biggest robot market in the world. Robot supplies to **Japan** continued to recover and increased by 27% to almost 28,000 units. The automotive industry and most of all other sectors were increasing robot investments above average. The electrical/ electronics industry also ordered considerably more robots than in 2010, but the increase rate was below average. In 2011, robot sales increased by 9% to 25,536 units in the **Republic of Korea**. After the huge investments of the electrical/electronics industry in 2010 - when Korea had topped the list - the increase was only moderately in 2011. The motor vehicle industry reduced their robot investments significantly compared to 2010, when a peak level had been reached. The electrical/electronics industry only slightly increased robot orders. The automotive parts suppliers and all other industries considerably rose robot purchases. In 2011, 22,577 industrial robots were sold to the **People's Republic of China**, 51% more than in 2010. With the exception of 2009, the Chinese robots market surged in the recent years. Between 2006 and 2011, the annual supply quadrupled. In the 50 years of the history of industrial robots there is no other country with such a dynamic growth of robot installations in such a short period of time. It is a question of time when China will become the largest robot market in the world.

Robot sales to South/Eastern Asia were up by 41%. Thereof, Thailand is the biggest market with about 3,500 units. Robot sales to India doubled to 1,547 units. The rate of robot installations in India seems to gain momentum.

### **Automotive industry was again the driver of the growth**

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. Automotive industry was one of the main drivers of the strong recovery of robot shipments. This continued in 2011. About 59,700 new robots, 55% more than in 2010, were installed (a new peak level). In 2009, robot installations hit rock bottom and in 2010, about 70% more robots were sold to the automotive industry (32,700 units). In 2011, the automotive industry accounted for 36% of the **total annual supply**. With regard to Australia, China, India, Thailand, Taiwan and other Asian countries, the distribution by various industries is not complete. But, considering that most of these

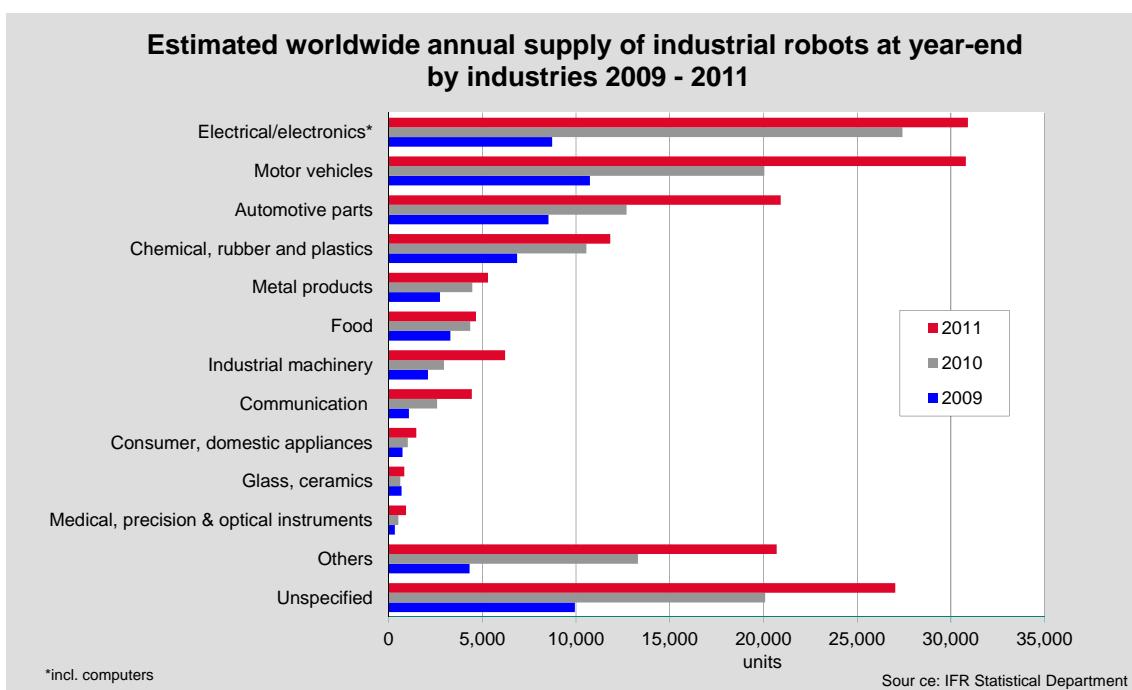
countries are emerging markets in the automotive industry, the real share of robot supplies to the automotive industry is higher. Given the distribution by application, it can be concluded that the robot supply to the automotive industries in China, Thailand, Malaysia and India also increased considerably in 2011.

The **electrical/electronics industry** (including computers and equipment, radio, TV and communication devices and equipment and medical, precision and optical instruments) further increased robot orders by 20% to a new peak level of 37,500 units. Already in 2010, the worldwide shipments of industrial robots almost tripled to about 31,500 units, up from 10,900 units in 2009. The share of the total supply in 2011 was about 23%.

After years of continuing growth, the **rubber and plastics industry** reduced robot investments in 2008 and 2009, from the peak level of about 15,000 units to 5,800 units. In 2010, sales recovered to about 8,900 units and in 2011 another 10,500 units were sold. The **food and beverage industry** increased robot orders by 7% to 4,650 units, accounting for a share of 3% of the total supply. Sales were continuously increasing but lost momentum in 2011.

In 2011, sales to the **metal and machinery industry** surged by 54% to about 14,100 units, accounting for a share of almost 9% of the total supply. In 2009, sales had dropped to about 5,250 units.

Sales to all industries except for automotive and electrical/electronics increased by 37% in 2011. The robot suppliers reported a considerable increase of customers in the past years. However, the number of units which is ordered by these customers is often very small.



### Worldwide operational stock of industrial robots increased considerably in 2011

**Total accumulated sales**, measured since the introduction of industrial robots at the end of the 1960s, amounted to more than **2,310,000 units** by the **end of 2011**. 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 1, the IFR estimates:

**the total worldwide stock of operational industrial robots  
at the end of 2011 was in the range of 1,153,000  
and 1,400,000 units.**

The minimum figure above is based, as was discussed in chapter 1, 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 1,400,000 units**.

In 2011, the minimum stock considerably increased by 9%. 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\$8.5 billion**

In 2011, sales again surged by 46% to US\$8.5 billion, a new record. 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 2011 is therefore estimated to be \$25.5 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).

In 2011, the Republic of Korea reached the highest robot density in the world. Per 10,000 employees 347 industrial robots were in operation. The reason is the continued large volume of robot installations in the recent years. The robot density in Japan increased to 339, that of Germany to 261.

10 countries of the 45 surveyed countries have a robot density between 104 (Austria) and 149 (Italy), 5 countries from 50 to 100, 11 countries from 20 to 49 and all others 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 55 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. 1,584 industrial robots are installed per 10,000 persons employed in the automotive industry, and 221 are installed in all other industries. In **Germany** 1,176 robots per 10,000 employees were installed in the automotive industry. But in all other German industries the robot density is at 137 units, which is significant compared to other countries. Only Japan and the Republic of Korea had a higher rate, 221 and 261 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. Regarding the robot density in the automotive industry, **Italy** ranked second with a robot density of 1,215 units, down from 1,229 in 2010. In other sectors the robot density was 113 robots operating per 10,000 employees in 2011. In 2011, 1,104 industrial robots per 10,000 employees were installed in the automotive industry in the **United States**, but only 72 units were installed in all the 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 2011, it was up from 36 to 141 robots per 10,000 employees. All other sectors also increased robot installations but the robot density rate is only about 10 robots installed per 10,000 employees.

The overall conclusion indicates 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.

### **Continued increase but lower growth rates between 2012 and 2015**

Despite the weakening global economic situation a further robot sales increase of about 9% to about 181,000 units is likely. The sales increase will mainly be driven by the automotive industry and the electronics industry as well as by the increasing number of customers with low-volume orders from other industries. The main impulses are coming from North America, China, Brazil and Central- and Eastern European countries as well as from Japan due to the restoration of the damaged production facilities. Robot supply to the Republic of Korea will again grow in 2012, but only moderately after the strong investments of the past years. Robot sales in Germany will reach almost the peak level of 2011 while in Italy and Spain a decrease due to the worsening of the economic situation is likely. Robot supplies to France and the United Kingdom are expected to increase according to announcements of the automotive industry and other industries. Robot supply to the Americas will increase by 17% and to Asia/Australia by 12% while robot sales to Europe will only slightly increase by 2%.

Between 2013 and 2015 worldwide robot sales will increase by about 5% on average per year: about 5% in the Americas, about 6% in Asia/Australia, and about 2% in Europe. The opening up of huge consumer markets in the BRIC countries, in South East Asia, in Turkey and also in the Middle Eastern countries will guarantee the increasing consumer demand which is necessary for further investments in automation within these countries. Energy-efficiency and light weight construction materials are the main challenges for the manufacturing industry. The automotive industry will continue to be the innovator for new technology. However, a cyclical decrease of investments of the automotive industry is likely in this period. The electrical/electronics industry will continue to automate in order to increase productivity and to improve quality of work for employees especially in Asia. The number of more easy-to-use robots as well as robots collaborating with human workers will increase in small and medium size companies. Improved and easier integration of industrial robots will provide more applications for industrial robots.

Certain risks are involved with regard to this rather optimistic forecast: Financial problems of the major markets may reduce growth of the world economy or even cause a recession. This may result in decreasing investments also in robotics. In that case, although planned investments might be restrained for a while, the trend towards automation will continue at a later point in order to increase productivity, profitability and to guarantee sustainability of industrial production. But these are not the only reasons for the eventual increase of robot sales. Dangerous, tedious and dirty working conditions for human workers must be abolished worldwide and robots provide the only solution. Robots save jobs and create jobs because

- robots carry out work that would otherwise not be economically viable and save and increase manufacturing jobs by increasing the competitiveness of a manufacturing company
- robots save and increase jobs throughout the community in general. This means that restaurants, shops and the service economy also benefit from this valuable ripple effect

- robots carry out work which is dangerous, tedious and dirty for humans
- robots carry out work that would be impossible for humans.

Table 1

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

<b>Country</b>	<b>2010</b>	<b>2011</b>	<b>2012*</b>	<b>2015*</b>
<b>America</b>	<b>17,114</b>	<b>26,227</b>	<b>30,600</b>	<b>35,100</b>
North America (Canada, Mexico, USA)	16,356	24,341	28,000	31,000
Central and South America	758	1,886	2,600	4,100
<b>Asia/Australia</b>	<b>69,833</b>	<b>88,698</b>	<b>98,900</b>	<b>116,700</b>
China	14,978	22,577	26,000	35,000
India	776	1,547	2,000	3,500
Japan	21,903	27,894	31,000	35,000
Republic of Korea	23,508	25,536	26,800	25,000
Taiwan	3,290	3,688	4,400	5,500
Thailand	2,450	3,453	4,100	7,000
Other Asia/Australia	2,928	20,483	4,600	5,700
<b>Europe</b>	<b>20,483</b>	<b>43,826</b>	<b>44,100</b>	<b>47,200</b>
Czech Rep.	402	1,618	2,000	3,000
France	2,049	3,058	3,300	3,500
Germany	14,061	19,533	19,000	20,000
Italy	4,517	5,091	4,600	4,900
Spain	1,897	3,091	2,500	3,000
United Kingdom	878	1,514	2,000	2,200
other Europe	6,937	9,921	11,100	10,600
<b>Africa</b>	<b>259</b>	<b>323</b>	<b>350</b>	<b>500</b>
<b>Total**</b>	<b>120,585</b>	<b>166,028</b>	<b>180,950</b>	<b>207,500</b>

Sources: IFR, national robot associations.

\*forecast

\*\*including sales which are not specified by countries

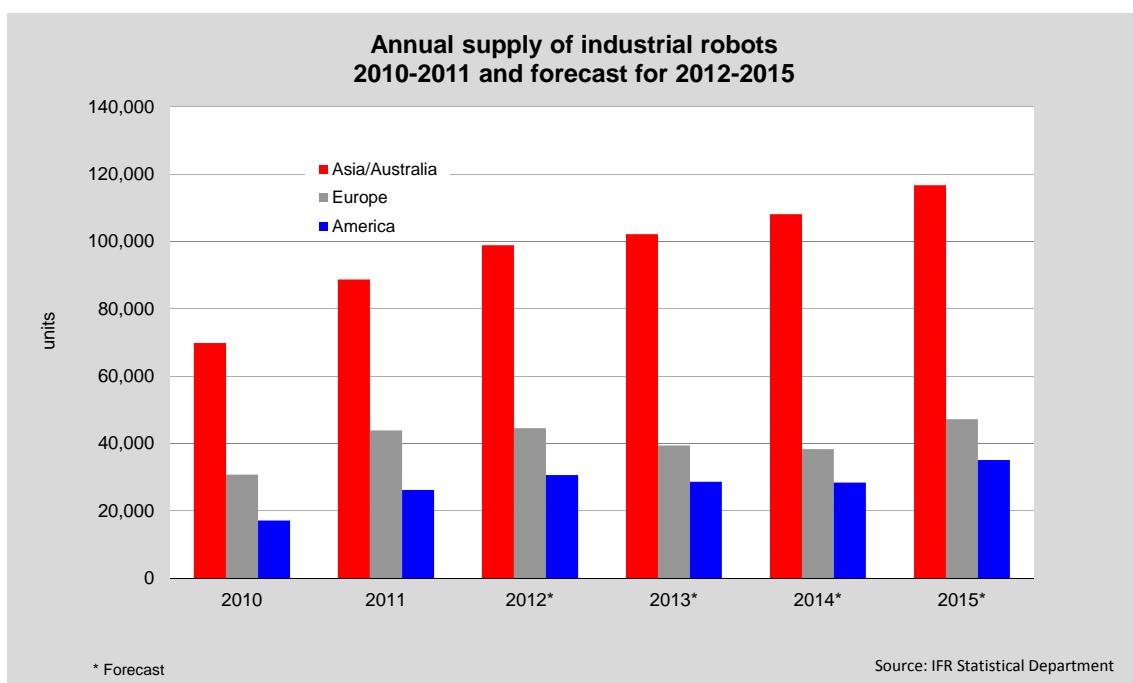


Table 2

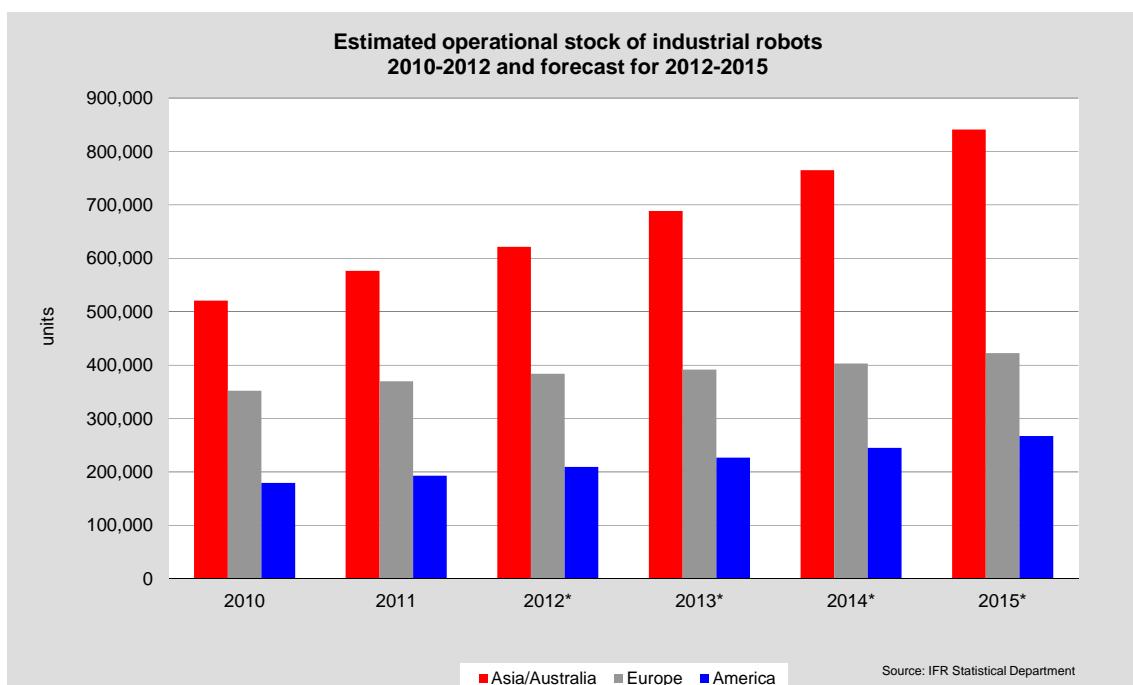
Estimated operational stock of multipurpose industrial robots at year-end in selected countries. Number of units

<b>Country</b>	<b>2010</b>	<b>2011</b>	<b>2012*</b>	<b>2015*</b>
<b>America</b>	<b>179,785</b>	<b>192,966</b>	<b>209,500</b>	<b>267,200</b>
North America (Canada, Mexico, USA)	173,174	184,679	199,693	248,232
Central and South America	6,611	8,287	9,807	18,968
<b>Asia/Australia</b>	<b>520,831</b>	<b>576,545</b>	<b>621,500</b>	<b>841,300</b>
China	37,312	52,290	74,317	157,700
India	4,079	4,855	6,352	13,700
Japan	332,720	307,698	307,201	303,100
Republic of Korea	79,003	101,080	124,190	187,200
Taiwan	24,365	26,896	29,837	42,600
Thailand	7,185	9,635	13,088	28,100
Other Asia/Australia	36,167	74,091	66,515	108,900
<b>Europe</b>	<b>352,142</b>	<b>369,965</b>	<b>383,800</b>	<b>422,500</b>
Czech Rep.	4,462	5,890	7,800	14,600
France	34,495	34,461	34,000	33,600
Germany	148,256	157,241	163,500	176,800
Italy	62,378	62,245	61,000	58,200
Spain	28,868	29,847	29,400	29,500
United Kingdom	13,519	13,641	14,100	16,600
other Europe	60,164	66,640	74,000	93,200
<b>Africa</b>	<b>2,232</b>	<b>2,495</b>	<b>2,800</b>	<b>3,900</b>
<b>Total**</b>	<b>1,059,162</b>	<b>1,153,097</b>	<b>1,235,600</b>	<b>1,575,500</b>

Sources: IFR, national robot associations.

\*forecast

\*\*including stock data which are not specified by countries



## 2. World Robotics 2012 Service Robots

The total number of professional service robots sold in 2011 rose by 9% compared to 2010 to 16,408 units up from 15,027 in 2010. The sales value increased by 6% to US\$ 3.6 billion. Since 1998, a total of more than 110,000 service robots for professional use have been counted in these statistics. It is not possible to estimate how many of these robots are still in operation because of the diversity of these products. Some e.g. underwater robots might be more than 20 years in operation. Others, like defence robots, may only be for a short time in operation.

With 6,570 units, service robots in defence applications accounted for 40% of the total number of service robots for professional use sold in 2011. Thereof, unmanned aerial vehicles seem to be the most important application as their sales increased by 11% to 5,053 units. The total number of field robots – mainly milking robots - sold in 2011 was about 5,000 units, accounting for a share of 31% of the total unit supply of professional service robots. The sales value of field robots increased by 18% to US \$879 million, accounting for about 25% of the total value of professional service robot sales. The continued considerable increase of sales demonstrates that milking robots are well established.

Sales of medical robots increased by 13% compared to 2010 to 1,051 units in 2011, accounting for a share of 6% of the total unit sales of professional service robots. The most important applications are robot assisted surgery and therapy with 994 units sold in 2011, 14% more than in 2010. The total value of sales of medical robots slightly decreased to US\$ 1,347 million, accounting for 38% of the total sales value of the professional service robots. Medical robots are the most valuable service robots with an average unit price of about US\$ 1.5 million, including accessories and services. Therefore, suppliers of medical robots also provide leasing contracts for their robots.

Due to more companies reporting their data and thus better information coverage, the data for logistics systems were revised. 2,141 logistic systems (courier and mailing factory logistic systems, which were mainly automated guided vehicles for factories) were installed in 2011, 3% less than in 2010, accounting for 13% of the total sales of professional service robots. 1,616 were supplied as well as 515 factory logistic systems, which were mainly automated guided vehicles for factories. Medical robots as well as logistic systems are well established service robots with a considerable growth potential.

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 2011, about 2.5 million service robots for personal and domestic use were sold, 15% more than in 2010. The value of sales increased by 19% to US\$636 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 and floor cleaning, lawn-mowing

robots, and entertainment and leisure robots, including toy robots, hobby systems, education and research.

Handicap assistance robots have not taken off to the anticipated degree in the past few years. In 2011 however, this market seemed to start up. 156 robots were sold, up from 46 in 2010. This is still quite a low number but the prospects are promising. A lot of national research projects in many countries concentrate on this huge future market for service robots. In contrast to the household and entertainment robots, these robots are high-tech products.

The market of robots for personal transportation as well as home security and surveillance robots will gain importance in the future.

In 2011, it was estimated that 1.7 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\$ 454 million.

As for entertainment robots, about 841,000 units were counted in 2011, 12% more than in 2010. Numerous companies, especially Asian ones, offer low-priced "toy robots". But among those mass products there are increasingly more sophisticated products for the home entertainment market. Since many years, the LEGO® Mindstorms® programme has belonged to the more high quality products. The total value of the 2011 sales of entertainment robots amounted to US\$ 166 million.

#### **Projections for the period 2012-2015:**

##### **About 93,800 new service robots for professional use to be installed**

Turning to the projections for the period 2012-2015, sales forecast indicate an increase to about 93,800 units with a value of US\$ 16.3 billion.

Thereof, about 28,000 robots for defence applications will be sold in the period 2012-2015. They are followed by milking robots with about 25,800 units. This is probably a rather conservative estimate. These two service robot groups make up 57% of the total forecast of service robots.

#### **Projections for the period 2012-2015:**

##### **About 15.6 million units of service robots for personal use to be sold**

It is projected that sales of all types of robots for domestic tasks (vacuum cleaning, lawn-mowing, window cleaning and other types) could reach almost 11 million units in the period 2012-2015, with an estimated value of US\$ 4.8 billion.

Sales of all types of entertainment and leisure robots are projected at about 4.7 million units, with a value of about US\$ 1.1 billion (see respective table and figures).

Sales of robots for elderly and handicap assistance will be about 4,600 units in the period of 2012-2015. This market will increase substantially within the next 20 years.

