

## WORLD DISRUPTIVE INNOVATIONS (based on *Thomson Reuters Report, 2016*)



Since 2008, *Thomson Reuters* PR & Thought Leadership has been preparing annual reports on the development of priority area of global innovations. The expert group is specialized on analytical materials for corporation, legal firms, and government bodies throughout the world.

For the purpose of analysis, twelve areas have been distinguished, namely: Aerospace & Defense; Automotive; Biotechnology; Cosmetics & Well-being; Food, Beverage & Tobacco; Home Appliances; Information Technology; Medical Devices; Oil & Gas; Pharmaceuticals; Semiconductor; and Telecommunications. The parameters to be analyzed are number of patents done for each area, number of published articles, and their distribution among the continents, countries, and corporations. This year, Report contains comparison of number of publications and patents for 2015 and 2014, shows trends for the recent seven-year period, and gives information on citation of publications of the top 10 institutions for each area.

The results are based on data of Derwent World Patents Index (DWPI) and Web of Sciences (WoS) platform.

Derwent World Patents Index (DWPI) is the world most trusted and authoritative source of global patent information, covering 50 patent-issuing authorities. Bibliographic patent information is translated into English and editorially enhanced to bring clarity to a patent's true intentions.

WoS platform is well known for Ukrainian researchers. It is the world top database of citations of various scholarly-related documents, a univer-

sal standard of search and analysis of scholarly research, a tool for formulating and selecting administrative solutions in the scientific field. This fundamental global database covering multidisciplinary fields has been used by more than 7000 R&D and educational establishments, government bodies, foundations, and publishers in more than 100 countries.

Global innovation as invention that has found its market, i.e. has paved the way from discovery to commercialization, is reported to show a record-breaking increase of almost 14%. It experienced gains across 11 of the 12 sectors throughout 2015, with the largest leaders being Medical Devices, Home Appliances and Aerospace & Defense. The only slumping field was Biotechnologies.

The reported high gain in innovation activity (patents and highly-cited publications) was possible due to collaboration between the private corporations and universities, R&D centers and government bodies, startups and market leaders. The communication between them are facilitated by developing information network. It enables studying the global publication activities and identifying the most interesting areas and topics and the sectors losing its attractiveness.

The longer-term view, covering the seven years from 2009–2015 (inclusive), highlights just how robust and active innovators have been. The combined output across all 12 technology areas was on a consistent upward climb (Figure 1). The largest overall increase for the extended period was in Food, Beverage & Tobacco, Aerospace & Defense, and Home Appliances which grew more than twice.

This is an outcome of global innovation efforts and indicative of how our world has been evolving. For example, the production of disease-resistant crops and genetically modified foods, aimed at ensuring an ample food supply for a world population projected to hit 10 billion later this century; the development of appliances that communicate with one another and reflect their owners' preferences; the actualization of the IoT; and the exploration of space to get new knowledge of the universe beyond our galaxy and to find new frontiers for future humans, as well as continued military investment.

Innovation drives economic growth and evolution of both individual countries and mankind as a whole. Effective and quick implementation of new technology requires joint efforts of strategic partners. This trend has been persistent in the recent decades and is unlikely to change in the near future.

Analysis shows that scientific and scholarly research typically precedes discovery and the protection of innovation rights by a few years. It's therefore prudent to look at what topics, institutions and regions lead globally in research to get an even deeper insight of what the future holds.

In order to visualize the data, information in *Disruptive, Game-Changing Innovation. 2016 State of Innovation* report for each of 12 innovative areas is given in several tables: increase in publications (total of patents and articles, percentage) in 2015 as compared with 2014 by individual industrial segments; 10 world innovation leaders in 2015 by number of inventions; 10 leading innovators in industry for 2011–2015 in Asia, Europe, and North America; the world most influential R&D institutions for 2005–2015 by number of publications and citation (average-weighted by industry and year of publication).

The mentioned 12 areas can be conditionally divided into three large groups: 1) Healthcare (Biotechnology, Cosmetics & Wellbeing, Food, Beverage & Tobacco, Medical Devices, and Pharmaceuticals); 2) Means of Human Comfort (Automotive, Home Appliances, Information Technology,

Oil & Gas, Semiconductors, and Telecommunications); and 3) Exploration of New Spaces for Human Inhabitation (Aerospace & Defense).

Naturally, this classification is quite conditional, however, the innovation of area is prudent to consider within these key groups.

Hence, the areas related to human health, beauty, and longevity care.

Biotech reported a relatively small number of inventions. The world innovator (*DuPont*, US) patented 407. And all but one of the subsectors, General Biotechnology, declined from the earlier period. China, France, Germany, South Korea and the United States lead the world in biotech innovation.

Biotechers are clear collaborators. Seven of the top 10 global biotech innovators (by number of inventions patented) are either a university or research center. No other sector has this mix in its top 10. The United States dominates biotech scientific-and-scholarly research output with 80 percent of the top 10. The remaining two institutions are from Europe, one of which is headquartered in the UK and the other is in Germany.

It appears that Biotech has leveled off somewhat, but it remains to be seen whether this sector will pull ahead again in the future. The technologies are still in early stages and the players are still coming into their own. Hence, in the next future, a vivid growth in area is expected.

Social media and other outlets set new beauty standards spurring today's cosmetic-conscious fad. New highly effective means of individual care and makeup, use of nanotechnology, creation of new molecular formulations, affordability of new treatment underlie a boost in Cosmetics & Well Being. The world most active Cosmetics & Well Being innovators are headquartered in Asia. Germany has the most significant presence in Europe, as more chemical companies branch into cosmeceuticals.

In the Make-up subsector, *L'Oreal* leads the pack with more than twice as many inventions (1,636) as the next nearest innovator to a great extent due to contribution of CNRS (France), ranked 6<sup>th</sup>, 107 inventions). Brazil once again takes the top

spot in terms of cosmetics related scientific research, with the University of Sao Paulo and State University of Campinas taking the first and eighth spots in terms of research output, respectively. Among others there are six universities and corporations from the United States, the National University of Seoul (South Korea) and the Academy of Sciences of China.

While food-related innovation can be found in the Biotechnology sector where GMO crops and engineered organism inventions are categorized, the Food, Beverage & Tobacco technology area covers inventions specific to the manufacturing and composition of items outside of what is genetically modified. The sector remained predominantly flat over the last year. The largest growth was in the area of Brewing, which bubbled over 18 percent to 7,662 unique innovations last year. The top 10 most active innovators in this category are all from China except one. At the top of the list of most influential R&D institutions there is University of British Columbia (Canada). The others are three universities from Spain, and institutions from Portugal, Finland, Australia, Germany, United States, and China.

Medical Devices innovation got a shot in the arm to become the most active of all technology sectors covered showing a gain of 17–45% as compared with 2014, with Medical Aids & Oral Administration seeing the largest increase. Japan is home to 40 percent of the world's top 10 Medical Device companies. Five of 10 leading innovators in Europe (2011–2015) are from Germany. All of the top 10 most prolific medical device research institutions are from the United States.

As for Pharmaceuticals, the most significant increase occurs in inorganics, which jumped up almost by 200 percent. The main trend is balancing price and cost of design, as well as the development of new cure methods using bioengineering mechanisms. Globally, China is the world's leading region for Pharmaceuticals innovation with 50 percent of the top 10 pharmaceutical companies residing there. The collaboration between the public and private sectors is also clear in this

industry, as all of them are from academia. The leader is Swiss Roche (351 inventions). For the six recent years, it has been holding leadership among European innovators in Heterocyclics. In the subsector for Heterocyclics, Contrary to Asia, nearly all of the top 10 organizations in Heterocyclics in Europe and North America are from the private, corporate sector. The most influential top 10 scientific research organizations in pharmaceuticals have balanced representation across China and the United States as each has three representatives in top 10. The WHO is ranked fifth by citations.

Having summarized the data for this group, one can see that the top innovators are from Asia, with China leading in the three areas, while the most influential institutions are mostly from the United States except for Food, Beverage & Tobacco where Europe has taken lead. China rivals the United States in terms of publications.

The second group of innovative areas are purposed for **the creation of comfortable environment for human being** and customization of products.

*Automotive* innovation reported the largest gains in Seats, Seatbelts & Airbags, followed by Suspension Systems and Alternative Powered Vehicles. Asia continues to dominate the field overall with 60 percent of the Top 10 headquartered there (4 in Japan, 1 in South Korea, and 1 in China). In Europe, the leading innovators are Germany and France (7 and 3 corporations, respectively).

The most prolific automotive research institutions have a more diverse global footprint, representing the United States, Italy, Germany, China, India, Sweden, and South Korea. *Toyota* has patented the largest number of inventions, with over 4 out of 10 thousand inventions patented within 2011–2015 dated 2015.

Home Appliances experienced 20 percent year-over-year growth for each subsector on average.

The largest increase occurred in Human Hygiene, which was up 29 percent over the prior period.

The promising trend and the most cutting-edge inventions are related to new ways of using Internet, including smart house and Internet of things. Asia is the undisputed leader in Home Appliance innovation. All but one of the top 10 innovators reside there (4 in Japan, 3 in China and 2 in South Korea), the lone wolf being based in Germany.

China takes the first three spots with *Midea Group* at the top. Throughout the year it patented about 5.5 thousand inventions. In Europe (2011–2015) the leading innovator is Germany. Asia is also home to 70 percent of the world's top 10 most prolific scientific-research institutions with a focus on home appliances. Japan leads with four, followed by China with two and Taiwan with one.

Information Technology is adjacent to the Home Appliances area. Here, innovation gains 10 % on average. The highest demand is reported for software, chips, and sensors for connecting various home appliances to Internet, as well as the development of cloud technology. The companies leading the top 10 in the global IT pack are predominantly from Asia, with just two from the United States. Each of these leaders' activity is significant, with unique inventions ranging 2.4 to 7.5 thousand annually. Computing is by far the most active subsector, comprising 82 percent of IT's overall activity. This includes inventions to see through walls (Vayyar), etch 3-D printed logos into almost any surface (Glowforge), charge smartphones at stations (NRG-Go) and uniquely light objects to photograph them in high detail.

Academic and scientific research in computer science has a more global footprint, with Asian institutions interestingly absent from the world's top 10 in scholarly research. Five of them are based in the United States, two in the United Kingdom, the rest is from Germany, France, and Poland. Poland is home to the most impactful institution, the Technical University of Czestochowa.

In the Oil & Gas sector, Refining sees the largest subsector jump (2015). Search of energy saving technologies and alternative energy sources to reduce dependence on fossil fuels entailed in

the industry decay as 59 oil and gas corporations in the United States bankrupted as a result of recent drop in prices for crude oil and *Shell's* quarter profit fell by 70%.

China leads the world's innovation activity taking four spots, the United States is the next most active region making the top 10 list as it has 4 representatives as well. The rest belongs to Japan and Russia. The leader in inventions is China's *Sinopec* (1991). Five most influential scholarly research institutions in the Oil & Gas sector originate from the United States, two from the United Kingdom, the remaining ones are from Norway, Netherlands, and Estonia (Technical University of Tallinn), with the publications ranging from 102 to 339 (2005–2015).

Asia continues to lead in the overall Semiconductors landscape. This area is changing essentially in line with automotive trends and evolution of IoT, as well as with demand for the most environment friendly solutions. Probably, that is why Memories, Films & Hybrid Circuits shows the most impressive jump among the subsectors. The other segments, including Semiconductor Materials and Processes, Discrete Devices, and Integrated Circuits however, slightly declined over the period. *IBM* of the United States is the only non-Asian corporation in the top 10 innovators list, with *Samsung Electronics* taking the top position and logging 4,144 unique inventions in just one year versus *IBM's* 969. *Samsung* also dominates the subsector category for Semiconductor Materials & Processes. Japan fares well with 50 percent of the top innovators in this subsector. In the scholarly research realm, Asia again leads as the Academy of Sciences of China ranked first reported 7,121 publications in 2005–2015. The Academy of Sciences of Russia is the next to it with 3,566 publications. The others are four Japanese universities and institutions from France, the United States, Singapore, and Taiwan.

Telecommunications sector sees a trend towards technology convergence, from 5G to IoT and NFC. The key vectors of further technology development are streaming broadcast services,

mobile devices, and network software solutions. The subsector Telemetry & Telecontrol, which covers measuring, transmitting and receiving apparatus, experienced the most impressive gain. Like in the Semiconductor sector, Asian companies lead the top 10 list in Telecommunications innovation having a 80 percent share in the representation. *Samsung* (South Korea) takes the most innovative spot. In addition to the two companies from South Korea and three from China, there are three Japanese organizations and one each from Sweden (*Ericsson*) and the United States (*Qualcomm*) in the leading 10. *Samsung* truly dominates in Mobile Telephony with 300 percent more activity than the nearest European competitor (*Ericsson*). It's worth noting that despite the fact that Asia leads in having the most top innovators in Telecommunications, the leading scholarly research organizations do not hail from there, but rather primarily come from the United States that leads with 90 percent of the most impactful Telecommunications scholarly research organizations, the top three of which are Rice University (with a rather small number of publications, 323), University of California Berkeley and University of Texas Austin (1130 publications). The only non-US institution in the top 10 is Switzerland's Federal Institute of Technology Zurich. *Microsoft* is the only corporate organization to make it to the list of most impactful with 700 publications.

Telecommunications organizations.

As one can see, Asian, chiefly Japanese, innovators are undisputable leaders in all areas, except for Oil & Gas, as they occupy the half of list. The leading scholarly research institutions also are mostly from Asian countries, the majority of them is resided in Japan. However, in subsectors of Information Technology, Telecommunications, and Oil & Gas the garland of victory has been held by

the United States organizations with European ones listed among the top 10 as well.

The third group aimed at exploring new space for inhabitation *Aerospace & Defense* sector saw a significant jump of 15 percent over prior year activity, with the largest jumps occurring in Space Vehicles & Satellite Technologies followed by Production Techniques and Propulsion Plants. The top 10 innovators in this sector who patented from 334 to 716 inventions in 2015 hail from the United States (3), China and South Korea (each having 2), France, Germany, and Japan. Among the top innovators in Europe, in 2011–2015, there are five corporations from the Russian Federation, four ones from France, and one from Germany. The United States lead in the impact of its academic research in aerospace, with 80 percent of the top 10 institutions coming from that country. European organizations (Technical University of Delft, the Netherlands, and CNRS, France) take the two remaining top 10 spots. Each of these 10 organizations have about 400 publications in WoS database, in 2015.

The aim of scholarly research institutes, R&D centers, and universities is to obtain new knowledge. This new knowledge underlies innovative solutions in various fields of human life. The next to scholarly research and R&D works is technology transfer in close partnership with industrial corporations and manufacturers. Innovation is a way towards the development of open world, with advanced techniques for processing, analysis and use of information playing an important role in its efficient implementation. These techniques enable to choose strategic vectors of development and proper tactical solutions.

*Based on Disruptive,  
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