ROBO Global® Index - Industry Classification

Overview

In the absence of a benchmark industry classification system for identifying companies engaged in the global robotics and automation industry, the **ROBO Global® Industry Classification** was created by ROBO Global® in consultation with leading academic and industry experts. The ROBO Global® Industry Classification provides an industry analysis framework for investment research, portfolio management and asset allocation. Companies included are publicly listed on bourses around the world, and derive a substantial portion of revenues from automation or robotics-related activities.

ROBO Global® is responsible for the classification of companies within the **ROBO Global® Industry Classification,** maintenance of the database including historic changes, and timely communication of any updates.

Classification Committee

The Classification Committee is comprised of members from (1) ROBO Global® Management Team and (2) the Strategic Advisory Board to ROBO Global® which is made up of leading industry and academic experts. In addition, there is collaboration with industry associations across the globe that support robotics and automation, and direct contact with companies engaged in the robotics and automation industry. A full list of the Management Team and Strategic Advisory Board can be found at: http://www.roboglobal.com.

The Classification Committee will meet semi-annually, normally in September and March, to discuss and review the structure of the database and company classifications.

Structure and Changes to the ROBO Global® Industry Classification

The Committee will rely chiefly on audited annual reports, and discussions with industry experts and participants to vet firms for inclusion and determine their classifications. Companies are allocated into a sub-classification based on the key focus of their business. In cases where a company's business straddles two or more sub-sectors, the business line with the largest revenue stream will determine the classification.

Qualified and newly listed companies are assessed and approved by the Classification Committee for inclusion in the ROBO Global® Industry Classification.

Given the robotics and automation industry continues to evolve, the structure of ROBO Global® Industry Classification will also be evolutionary. Any adjustments to the tier system or subsectors

will be based on long-term trends driving the robotics and automation industry, and will be announced well in advance of implementation.

In the event of a significant change to an individual company's structure, its classification may be reviewed. Such corporate events include but are not limited to: merger, acquisition, takeover bid, trading halt, delisting, and insolvency.

A company's classification may also be reviewed at the request of the company or a professional adviser acting on its behalf. Any change in a company's classification (as determined by the Classification Committee) will be announced immediately and implemented 10 trading days later, becoming effective on the next trading day after implementation.

No changes in ROBO Global® Industry Classification will be based on non-public information.

Classification Guidelines

To capture the full economic value of the robotics and automation industry, the ROBO Global® Industry Classification has identified companies all along the production value chain. This ranges, for example, from companies that physically manufacture robots and automation machinery, to companies specializing in the types of software and technology that enable automation. This approach allows the ROBO Global® Industry Classification to truly capture today's and tomorrow's "makers" within the robotics and automation industry. A summary of tiered approach to classification is provided below:

Tier 1 - In the first instance, the Classification Committee aims to identify publicly listed companies (globally) that derive all or a "material" proportion of their revenues from robotics-related and/or automation-related products and/or services.

Tier 2 – sub-classification as "bellwether" or "non-bellwether": ***"****Bellwether"* companies are well established leading companies, whose core business is directly related to robotics and automation. These companies are also referred to as "pure plays". *"Non-bellwether"* companies have a distinct portion of their business and revenue in robotics and automation and the potential to grow within this space through innovation and/or market adoption of their products and/or services.

Tier 3 – sub-classification of sectors: Companies within the ROBO Global® Industry Classification are organized into a number of sub-sectors which are expected to increase in number as the robotics and automation industry continues to evolve. Currently, the Classification Committee has identified the following 13 sub-sectors within the ROBO Global® Industry Classification which can be easily bifurcated into either Technology or Applications.

TECHNOLOGY - captures all index companies that manufacture or provide services related to any machinery, equipment, devices or sensors supporting a robot performing its task. It also includes those companies that provide key-enabling software and processing technologies used to advance the conversion to autonomous systems. Essentially, we are looking at the companies that enable robots to sense, process and act:

1. **Sensing** - In order for a system to exhibit autonomy, it must be able to sense its environment, in addition to determining its own internal state. For human beings, these are called exteroception and proprioception. Sensing is important for the same reasons that our exteroceptive senses (sight, sound, etc.), and our proprioceptive senses (ability to know where our limbs are and what they are doing without directly observing them) are important for human beings. For robotic systems, however, we are not limited to the standard senses. Almost anything that can be measured can be made into a sensor.

2. **Processing** - Autonomous systems must make decisions at various levels, ranging from basic motion control, to determining the state of the environment they are operating in, to optimally planning actions. Part of this processing is thus making sense of the information received from sensors, but also to plan actions in order to achieve a desired objective.

3. **Actuation** - Actuation is the means by which machines interact with the physical world. For human beings this mainly refers to our limbs, and in particular, our hands, but for machines, we are not limited to manipulation. Almost anything that has an effect on the physical world can be made into an actuator. Actuation techniques include electric, hydraulic (compressed fluid), mechanical, and pneumatic (compressed air).

4. **Computing** - The path from sensing, to processing, to actuation, requires computation. It is analogous to our brain, and is what allows the processing of information to produce actuation to take place. Computing can vary from embedded systems smaller than a fingernail to server-farms implementing sophisticated algorithms.

5. **Integration** - An autonomous system is made of up many components (sensors, actuators, and computational units), which can be distributed over large spaces. Integration consists of architecting a system – figuring out how to put all of these components together – in order to achieve a desired objective in a robust, high performance, and cost-efficient way.

APPLICATIONS - highlights all index companies that incorporate multiple robotic and automation technologies into their product or manufacturing process to improve efficiency in traditional business lines as well the development of entirely new business propositions:

6. **Manufacturing & Industrial Automation** - Broadly speaking, this is the main way in which companies take raw materials through a manufacturing process to create products. It is also

the earliest successful application for robotics and automation – for example, automobile assembly - and continues to be one of its largest growth areas.

7. **3D Printing** - Traditionally, things are built either by assembling separate parts together, or by removing material from a larger work-piece. 3D printing adds yet another capability by depositing different types of materials where they are needed. One of its main benefits is the potential for customization that is not economically feasible with traditional techniques, also called additive manufacturing.

8. **Logistics Automation** - The manufacturing of items is incomplete without the material handling and distribution channels that bring the objects to their intended users. The many economic advantages to speedy and error-free distribution, such as operating with low-inventory and being responsive to customer demands, is a significant growth area for robotics and automation, and is continually reducing the costs to end-users, both businesses and consumers.

9. **Agriculture** - Feeding and sustaining the world continues to be one of our most important economic activities. A new generation of autonomous systems are bringing the benefits of traditional automation – such as precision and the elimination of rote labor – to this domain. For example, precision agriculture offers to greatly reduce costs – and in the process lower our environmental footprint – by applying water and fertilizer on an as-needed basis.

10. **Surveillance / Security** - Removing people from harm's way has always been one of the main drivers for robotics research. This has been a very difficult problem, due to the flexibility and cognitive skills that humans possess, and that up until recently, have been difficult to duplicate with automated means. With the new capabilities offered by today's technologies, however, this is rapidly changing with unmanned aircraft and ground vehicles now able to detect hazardous materials, dispose bombs, operate in space and perform critical national defence functions (surveillance).

11. **Energy** - Exploration, extraction, and maintaining the energy infrastructure operational require extensive, and growing, resources. As robotics and automation continues to expand from structured environments -- such as warehouses and factories -- to unstructured ones - such as outdoors, underground, and in the oceans – the Energy sector will reap the rewards of this transition, with the main benefits being much lower operational costs.

12. **Healthcare** - As healthcare costs continue to rise globally, robotics and automation is poised to provide a countering force to this trend. Using robotics and autonomous systems in areas ranging from rehabilitation, diagnostics, exoskeletons and care for the elderly promises to

drastically reduce costs and improve the quality of life for many people. In addition, as in all other application areas, robotics and automation can enable new capabilities that transcend cost-cutting, such as the use of robots for many types of difficult surgeries and neurological treatments.

13. **Consumer Products** – These are companies that produce robots in the areas of toys, games, interactive robots, household cleaning, and other tasks done at home that can be automated. The Internet of Things promises to usher in a new area of interconnectivity. By communicating through the existing internet infrastructure, devices will no longer be isolated islands of limited capabilities. This impact will be particularly pronounced for these type consumer products, which need to be inexpensive for wide adoption. Through the internet, robotics and automation will finally become broadly affordable to individuals.

Questions and Classification Queries

Market participants who have questions about our sub sector classifications can contact enquiries@roboglobal.com or go to the Contact page at www.roboglobal.com.