

Article

A Comparison of Websites by Robot Manufacturers in Germany and Japan: “The Ethical Relationship Between ‘Robot’ and ‘Human Body’ as a Management Challenge”

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Beginning in science-fiction literature a century ago, the concept of robot today has become a technical reality. Industrial robots are mature and used in large scale – and the technicality of service robots is improving rapidly. This technical success made possible by competent management has in future to be safeguarded by integrating a balanced ethical relationship between ‘robot’ and ‘human body’ as an enlightened self-interest for enterprise.

The analysis of Japanese and German companies based on companies’ web pages shows that progress in robots is a global phenomenon. The competition between robot-companies is a strong positive driver so that non-technical factors starting from R&D to production up to the delivery to the customer may play a crucial role in future: “ethics” as a management challenge in the context of the global robot markets may be an important success-factor for future robot-generations. Ongoing monitoring of the topic discussed is crucial — it is a joint task for management and science.

Keywords: Robot, Ethics, Management, Japan, Germany

Introduction

Robots grow quickly to technical maturity and a number of resources were used during the recent decades to realize this success. According to the EU-Commission, the global market for robots is 22 Bio. Euro.¹ The Japanese Prime Minister Shinzo Abe said: “In 2020, I want to gather all the world’s robots and aim to hold an Olympics where they can compete in technical skills. We want to make robots a major pillar of our economic growth strategy.”² When robots are successfully implemented on a large scale, many social, economic and in particular ethical questions will result. Issues such as the impact on the relationship between society and robots are presently in the early stages of discussion: regarding its development, the broader roles they will play, their effect on change in enterprise, at large and on society and culture itself. However, this not a question that is beyond enterprise – rather the opposite: do enterprises risk their competitiveness if they ignore obtaining knowledge about these topics? Isn’t it necessary that robot-makers include ethical matters in their business mission simply to survive in global competition?

¹ HAASS, Uwe: „2,8 Milliarden Euro zur Staerkung der Fuehungsrolle der Robotik in Europa“, press-release by „EU-Robotics“, without date, (http://media.nmm.de/36/15052014sparcpressreleasegerman_27743236.pdf, 2014 Sept 29). According to this paper, Europe has a global market share of 35 %.

² DEMITROU, Danielle: “Japan’s PM plans 2020 Robot Olympics”, ‘The Telegraph’ from June 20, 2014, (<http://www.telegraph.co.uk/news/worldnews/asia/japan/10913610/Japans-PM-plans-2020-Robot-Olympics.html>, 2014 Sept 29)

To shed light on these questions: The discussion will debate the relationship of ‘robots’ and ‘human body’ with the aim of bringing these topics closer together, first from a legal and second from a cultural point of view. In a third step robot manufacturers web sites will be analyzed, initially German companies and later Japanese companies. Based on the presented examples, similarities and differences in Japanese and German robot manufacturers are determined. In a fourth and concluding step the previous concept will be set into context to focus on a theoretical framework, so that management will be able to act accordingly towards society.

What is a ‘robot’? The word ‘robot’ (translated from Czech as “work”) was created in 1920 by the Czech artist Josef Čapek for his play: R.U.R: Rossum’s Universal Robots. Before the creation of this word these machines were called ‘automat’ or ‘semi-automat’. The word ‘robot’ itself went through many metamorphoses with the result that a general accepted definition does not exist. It is generally agreed that a robot is a machine with a degree of autonomous function. The question is: what specifically distinguishes it as being a robot rather than simply an automated machine?

The US-American ‘Robotic Industries Association’ indicates, “a robot is a reprogrammable, multifunctional manipulator designed to move material, parts, tools or specialized devices through variable programmed motions for the performance of a variety of tasks.”³ Following the ‘Association of German Engineers’ (VDI), industrial robots are universal usable automated moving devices with several axes, operating according to programmed motions. The sequence of movements is free – they may be guided by sensors (VDI-Guideline No. 2860).⁴ The ‘Japanese Industrial Standard Association’ defines a robot as “a mechanical system which has flexible [autonomous] motion [and intelligent] functions analogous to ...living organisms, or combines such motion to the human will. In this context, intelligent functions mean the ability to perform at least one of the following: judgment, recognition, adaptation or learning.”⁵ The different definitions make it difficult to compare the robot industry on an international level, for example the number of produced robots.⁶

In the following definition, a ‘robot’ is beyond a machine capable of self-guided actions, capable in that these actions constitute responses to external stimuli. Such external stimuli can be spoken questions (requiring an answer by the robot), moving (avoiding collision) or identification (recognizing individuals). Fulfilling these criteria, in this paper, a robot may be considered an autonomous, responsive and stand-alone machine. This means a robot must have by definition sensors (“eyes”) and a physical body – a robot is more than a virtual environment such as a machine working based on artificial intelligence. How to deal with the ‘autonomy’ of entities without bodies will be discussed at the very end of this research – and in the next section the association between robots and ethics will be illuminated.

³ WIKIPEDIA (ed.): “Roboter” (<http://de.wikipedia.org/wiki/Roboter>, 2014 Sept 29). The web page of the association is: (<http://www.robotics.org/>, 2014 Sept 29)

⁴ FORUM SONDERMASCINENBAU (Ed.): “Industrieroboter” (<http://www.forum-sondermaschinenbau.de/seiten/Industrieroboter.htm>, 2014 Sept 29) translated into English by the author.

⁵ SHENKAR, Oded.: “The Robot Masters: How Japan Has Won the Race to the Roboticised Workplace”, in: International Journal of Human Factors in Manufacturing, Vol.1, Issue 2, 1991, p.145. The ‘Japan Robot Association’ specifies and categorizes robots in: Manual Manipulator, Fixed Sequence Robot, Variable Sequence Robot, Playback Robot, Numerical Control Robot, Intelligent Robot. In: WIKIPEDIA (ed.): “Roboter” (http://de.wikipedia.org/wiki/Roboter#Definition_nach_JARA, 2014 Sept 29)

⁶ In the segment of industrial robots, 179.000 industrial robots were globally sold in 2013: about 100.000 in Asia, 43.000 in Europe and 30.000 in North-America – the rest in other parts of the world. In the same year, companies in Japan, the USA, Korea and Germany installed about 50 % of the global robot-production. Litzberger, Gudrun: International Federation of Robotics, Statistical Department, Press Release June 04, 2014 (http://www.worldrobotics.org/uploads/tx_zeifr/June_04_2014_PI_IFR_Weltmarkt_Roboter.pdf, 2014 Sept 29). Since the definition of robot varies a lot from country to country, a comparison in between countries is impossible: In 1983 the Japan Robot Association characterized in 1983 47.000 machines as robots. Using the German criteria (Verein Deutscher Ingenieure, Guideline 2860) for the same machines, only about 3.000 of these machines would have been defined as robots. In: WIKIPEDIA (ed.): “Roboter” (<http://de.wikipedia.org/wiki/Roboter>, 2014 Sept 29)

1. Robots and Human Body – Legal Academic Approaches for an Ethical Edging Closer

With robots, human beings are approaching the production of intelligent and autonomous entities. This necessitates the developers and manufacturers of robots analyze and understand the human body from an outside perspective – and as an inside reflection of intelligence. It includes learning, evaluation and decision making. Setting that into an ethics framework indicates that a human has to set himself within a robots perspective which may result in the fact that an intelligent robot may have a different point of view of learning, evaluation and decision making.⁷ Many disciplines must be included in this process: Medicine and psychology, literature and linguistics, engineering, management and law, to mention a few.

For bringing together robots and ethics, the thoughts of the science fiction author Isaac ASIMOV may give some direction. He described in his short story “Runaround”, published in 1942, what is today called the ‘Three Laws of Robotics’ or ‘Asimov’s Laws’.

Law 1: “A robot may not injure a human being or, through inaction, allow a human being to come to harm.”

Law 2: “A robot must obey the orders given to it by human beings, except where such orders would conflict with the First Law.”

Law 3: “A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.”⁸

Other science fiction-authors added laws. They can be divided into two genealogical trees:

A. The 1974 the Bulgarian science-fiction-writer Lyuben DILOV introduced in his novel, “The Trip of Icarus”, what he called ‘fourth law of robotics’:

*Law 4: “A robot must establish its identity as a robot in all cases”.*⁹ (Interpretation: Designers of a tool must not follow that the new tool has to have the same design as existing tools – psycho-robots do not need exactly to look like humans what may cause misunderstandings between human and robots.)¹⁰

In 1983 the Bulgarian science-fiction writer Nikola KESAROVSKI entitled a short-story “The Fifth Law of Robotics”:

Law 5: “A robot must know it is a robot”. (Interpretation: Killing of a human by a robot is a violation of the first law. It is also a violation of Dilov’s fourth law. But it is crucial from a legal perspective to add the fifth law to hold the robot responsible.)

B. Harry HARRISON wrote in 1986 his story entitled, “The Fourth Law of Robotics”.

Law 4: “A robot must reproduce - as long as such reproduction does not interfere with the First or Second or Third Law.”¹¹ (Interpretation: To liberate robots, they built new robots who view their creator robots as parental figures. The question behind this is: are intelligent robots human-being with human rights.)

In 2013 Hutan ASHRAFIAN proposed an additional sixth law, also called “AionAI” (artificial intelligence-on-artificial intelligence) law.

Law 6: “All robots endowed with comparable human reason and conscience should act towards one another in a spirit of brotherhood.” (Interpretation: When and where future artificial intelligences will interact amongst themselves, this may lead to exploitation. In this situation, robots would benefit from adopting a universal law

⁷ FISCHER, Roland: “Das Kind in der Maschine”, in Technology Review of Sept 30, 2013, (<http://www.heise.de/tr/artikel/Das-Kind-in-der-Maschine-1953206.html>, 2014 Sept 29)

⁸ WIKIPEDIA (ed.): “Three Laws of Robotics”, (http://en.wikipedia.org/wiki/Three_Laws_of_Robotics, 2014 Sept 29); FIELD, Chris: “Asimov’s Three Laws of Robotics” (<http://akikok012um1.wordpress.com/asimovs-three-laws-of-robotics/>, Sept 29, 2014)

⁹ WIKIPEDIA (ed.): “Lyuben Dilov” (http://en.wikipedia.org/wiki/Lyuben_Dilov, 2014, Sept 29)

¹⁰ WIKIPEDIA (ed.): “Three Laws of Robotics”, (http://en.wikipedia.org/wiki/Three_Laws_of_Robotics, 2014, Sep.29)

¹¹ A book edited by Martin H. Greenberg in 1989 book written in honor of science fiction author Isaac Asimov with the title: “*Foundation’s Friends, Stories in Honor of Isaac Asimov*”, in: WIKIPEDIA (ed.): “Three Laws of Robotics” (http://en.wikipedia.org/wiki/Three_Laws_of_Robotics, Sept 29, 2013)

of rights to recognize inherent dignity and the inalienable rights of artificial intelligences. Such a consideration may help prevent exploitation and abuse of rational and sentient beings, but would also importantly reflect on a human moral code of ethics and the humanity of human civilization.)¹²

The six (seven) laws touch in profound way the relationship between robots and the human body including its integrity and physical safety, but also its creation. They touch the most cognizant moments of human existence: ‘giving birth’ and ‘passing away’.

The legislator has a robust interest in promoting a balanced relationship between robots and ethics that would generally be accepted in public. States which host innovative companies with a high market share in robot-technology do not benefit only from the accumulation of knowledge in this high-tech-field. Robots, and in particular humanoid robots, allow states to position themselves as high-tech hubs as a whole – robots are high tech cultural representatives par excellence. States will closely cooperate with management by creating a legal framework and by giving incentives for technology development.

The Republic of Korea has gone further than any other country in the world. It implemented a ‘Robot Ethics Charter.’ The government had targets for doing so: (i) Korea should serve as a test bed country for robots, (ii) Preparation of the future society towards a partnership between human and robots according to dynamic changes both in society and technology, (iii) Social and consumer demands for robots which enhance the wish for a partnership between people and robots, (iv) Confirmation of national consensus on robot ethics in Korea.¹³

The legal effect of the charter may serve as example that law supports innovation, for example by companies, instead of hindering it. More crucial: The charter may help management to create the general atmosphere needed for introducing a new technology needed for a positive climate of investment.¹⁴ This relates to the next topic of discussion: What should management consider before making a decision in the context of robots?

2. Robots and Human Body – Cultural Academic Approaches for an Ethical Edging Closer

The ‘Robot Ethic Charter’ is a good example for merging not only robots and ethics, but also of robots and ethics with management. The most advanced robot being able to improve the quality of human life may be a flop if not being accepted by the people whose life will be affected. And society which perceives new robots as a threat rather than a blessing may result in shifting business chances into other regions of the world. The crux is that from the very early stage of the product-life-cycle of a robot, the phase of research and development, ethical questions have to be strongly considered. These ethical questions touch the global perspective, so it is important to set standards and define structures of business models or even entire markets.

Knowing about different perceptions of ethics and culture are crucial for management. With the examples of Germany and Japan in mind, robot-related thoughts in the fields of ethics, culture and science-fiction literature will give greater insight for management when compared among the two countries.

¹² ASHRAFIAN, Hutan: “AIonAI: A Humanitarian Law of Artificial Intelligence and Robotics”, in: (<http://link.springer.com/article/10.1007%2Fs11948-013-9513-9#page-1>, Sept 29, 2014)

¹³ Ministry of Commerce, Industry and Energy of Korea (ed.): “Establishing a Korean Ethics Robot Charter”, Seoul, April 14, 2007, Handout of the Ministry, p.4-6, (http://www.robethics.org/icra2007/contributions/slides/Shim_icra%2007_ppt.pdf, Sept 29, 2014)

¹⁴ HILGENDORF, Eric; KIM, Mink-Yu: Legal Regulation of Autonomous Systems in South Korea on the Example of Robot Legislation, without date and location, p.6 and p.13 (http://www.jura.uni-wuerzburg.de/uploads/media/Legal_Regulation_of_Autonomous_Systems_in_South_Korea_on_the_Example_of_Robot_Legislation_-_Hilgendorf_Kim_05.pdf, Sept 29, 2014)

Ethics has many manifestations – it is crucial to underline the difference between East and West.

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| <p>In Western philosophy, three ethics groups are of particular relevance:¹⁵</p> <p>Aristotle argues that virtues, such as justice or charity, are dispositions to act in ways that benefit both the person possessing them and that person's society.</p> <p>Kant makes the concept of duty central to morality: humans are bound, from knowledge of their duty as rational beings, to obey the categorical imperative to respect other rational beings.</p> <p>Bentham works out that the principle of conduct should follow utilitarianism so as to be the greatest happiness or benefit for the greatest number of people.</p> | <p>In Eastern philosophy, there is no strict dividing line between ethics on the one hand and religion and philosophy on the other.</p> <p>Confucian ethics is focused around ideals of character and the constituting traits or virtues. Among the traits connected to ethical nobility is the ability to judge what the right thing to do is in the given situation: philosophy is grounded on evidence and rigorous thinking.¹⁶</p> <p>What Shintoism, Buddhism, and Daoism combine is that ethics is understood as spontaneous caring and concern for others that has been achieved by lifelong practice yielding a transformation of both understanding and action. Thus, true ethical action results from being ethical through and through. For those who follow the way, there are still rules, regulations, calculations, and precepts, but the goal and heart of ethics is the spontaneous and selfless expression of human-heartedness.¹⁷</p> |
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Also culture has different manifestations in Germany and Japan. Important topics which touch the relation between 'robot' and human body' are:

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| <p>Role of Objects: In Europe, several movements focused on the idea that natural objects and man-made objects are in contradiction to each other. The Christian god provided a world which is as such good for humans -who have a soul- as it exists.¹⁸</p> | <p>Role of Objects: In Japan, man-made objects can be used to recreate nature without any hesitation. Nature and technology are interconnected. There is no religious contradiction as well since all things have in Shintoism its spirit ? whether natural or man-made.¹⁹</p> |
| <p>Labor: New technologies may destroy jobs of old industries.²⁰</p> | <p>Labor: At least theoretical Japanese core-staff cannot be fired which reduces competition between machines and labor.²¹</p> |

¹⁵ AGALGATTI, B.H.; KRISHNA, S.: "Business Ethics", Pune 2007 p.51 <https://books.google.de/books?id=WlkcJq5Y3t8C&pg=PP3&lpg=PP3&dq=AGALGATTI+2007&source=bl&ots=nwgrWjQChQ&sig=0nydxPLBOBJBOCmDFSTXi8R1fcM&hl=ja&sa=X&ei=yWeOVK6BHpL08QWx7YcBg&ved=0CCUQ6AEwAQ#v=onepage&q=AGALGATTI%202007&f=false>, Sept. 29, 2014

¹⁶ WONG, David, "Chinese Ethics", in: ZALTA, Edward N. (ed.): The Stanford Encyclopedia of Philosophy (Spring 2013 Edition), (<http://plato.stanford.edu/archives/spr2013/entries/ethics-chinese/>, Sept 29, 2014)

¹⁷ CARTER, Robert E.: "Japanese Ethics", in: EDELGLASS, William; GARFIELD, Jay L.: The Oxford Handbook of World Philosophy, Sept 2011 edition, doi:10.1093/oxfordhb/9780195328998.003.0027 (<http://www.oxfordhandbooks.com/view/10.1093/oxfordhb/9780195328998.001.0001/oxfordhb-9780195328998-e-27>, Sept 29, 2014)

¹⁸ WIKIPEDIA (ed.): "Teleological argument" (http://en.wikipedia.org/wiki/Teleological_argument, Sept 29, 2014)

¹⁹ GLASER, Peter: "Wo sind die Roboter?" in Technology Review of March 25, 2011, (<http://www.heise.de/tr/blog/artikel/Wo-sind-die-Roboter-1213900.html>, Sept 29, 2014)

²⁰ British Broadcasting Corporation (BBC) (ed.): "Swing Riots" (http://www.bbc.co.uk/history/familyhistory/bloodlines/workinglife.shtml?entry=swing_riots&theme=workinglife, Sept 29, 2014), MATTHES, Sebastian: „Technikfeindlichkeit: Die Angst der Deutschen vor neuen Technologien“, in: The Huffington Post from June 29, 2014 (http://www.huffingtonpost.de/2014/06/29/technikfeindlichkeit-deutschland_n_5541202.html, Sept 29, 2014)

²¹ POHL, Martin: „Arbeitsmarkt und Arbeitsbeziehungen in Japan“, in: Woedemann, Raimund; Yamaguchi, Karin (ed.): Laenderbericht Japan. Die Erarbeitung der Zukunft, Bonn 2014, p.262

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| Time spirit: the scientific rationalization of nature within the Age of Enlightenment was opposed, by such as Romanticism, but in part also by modern philosophies such as the Frankfurt School. ²² | Time spirit: Since the Meiji-period, the large majority of Japanese intellectuals see machines as an enlargement of human ability. |
| Decision-making structure: It is based on a stringent legal structure trying to insure individual freedom and self-esteem. The legal system is easily accessible and with reasonable cost to and for citizens. ²³ | Decision-making structure: It is based on experience and seniority. As a result it can be described as a combination of superior-dependent and both with uncertain outcome and finding a pragmatic solution. ²⁴ |
| Communication in politics: In a bottom-up communication active public groups talk about robots and its impacts on the process of designing and manufacturing, but also the role of robots in society. ²⁵ | Communication in politics: In a top-down communication politicians discuss robots in the context of the aging society and as growth industry without questioning it. The general public gives minimal input in the process of designing and manufacturing of robots. ²⁶ |

In addition, there are particular cultural stand-alone specificities in Germany and Japan. In Germany generally speaking culturally robot makers follow the idea that function dominates design: core function is how a robot cooperates with a human. It is not a target to duplicate human in the design of a robot, except if that is part of the core function.²⁷ In Japan, school-education is still focused on providing workers for industrial mass-production. Today, the large majority of robots “work” in that field. In that sense it is easy for people develop a feeling about what robots may do. On the other hand, robots are outside any human hierarchy, so a machine-like human counterpart is a rather relaxing alternative to the pressure and the complex Japanese way of communication with “real” people.²⁸ Another, tough different point is: Formally Japan has a differentiated legal system similar to that of Western-Europe. However, the application of this legal system is different. The Japanese understanding allows – with all its advantages and disadvantages – flexibility in research and development, but also in application of robots.

Science fiction literature was and is crucial for modern robot development. Many robot researchers and entrepreneurs developed their first relationship with robots from literature, for example the president of Softbank, Masayoshi Son invested in the robot “pepper”, see section 3.2. Are there also different manifestations in science fiction literature between East and West?

In European science fiction literature of the early 20th century new technologies were on the one hand praised such as in the work of Hans DOMINIK, but also their danger was pointed out. In the film ‘Metropolitan’ by Hans LANG robots were associated with fear. If humans ignore the laws of nature or even want ‘to play god’, humans will fail. In Japan, science-fiction literature in part adopted this reflection between enthusiasm and

²² ENCYCLOPÆDIA BRITANNICA (ed.): “Romanticism”, (<http://global.britannica.com/EBchecked/topic/508675/Romanticism>, Sept 29, 2014)

²³ DANNENMANN, Gerhard: “Access to Justice: An Anglo-German Comparison”, (<http://www.iuscomp.org/gla/literature/access.htm>, Sept. 29, 2014)

²⁴ POHL, Martin: “Arbeitsmarkt und Arbeitsbeziehungen in Japan“, in: Woedemann, Raimund; Yamaguchi, Karin (ed.): Laenderbericht Japan. Die Erarbeitung der Zukunft, Bonn 2014, p.262

²⁵ GLASER, Peter: Die Roboter kommen. Waschmaschinen in Frauengestalt, in ‚Focus‘-Magazine of July 26, 2007, (http://www.focus.de/digital/multimedia/glasers_modernste_zeiten/die-roboter-kommen_aid_67643.html, Sept. 29, 2014)

²⁶ KIMURA, Takeshi: “Introducing Roboethics to Japanese Society: A Proposal”, in: Kimura, Takeshi et al.: Cybernetics Technical Reports. Special Issue on Roboethics, Tsukuba 2011, p.98

²⁷ Without editor: „Rund um Roboter: Wichtigste Robotik-Konferenz eröffnet“, in ‚Focus‘-Magazine of May 07.2013, (http://www.focus.de/wissen/diverses/zukunft-auf-der-icra-rund-um-roboter-wichtigste-robotik-konferenz-eroeffnet_aid_983234.html, Sept. 29, 2014)

²⁸ GLASER, Peter: “Wo sind die Roboter?“ in Technology Review of March 25, 2011, (<http://www.heise.de/tr/blog/artikel/Wo-sind-die-Roboter-1213900.html>, Sept 29, 2014)

anxiety towards new technologies. But, at the same time, since the re-opening of Japan, modernization, especially technical modernization, were seen as the core target of the country. Robots were – when they were described in the first half of the 20th century, a major cultural representation for success in science and in a larger sense a status of political and economic power. Thus characters such as ‘Tanku Tankuro’, a military robot who appeared in Japanese comics in the 1930s, gained significant popularity as a symbol of the technology that would aid the Japanese conquest of Asia.²⁹ Since the 1950’s, ‘Tetsuwan Atomu’ (translated as “Ironarm Atom”) and named in English ‘Astro Boy’, is a manga series from the Japanese author Osamu TEZUKA with a total of 2000 pages written from 1952-68.³⁰ ‘Tetsuwan Atomu’ had a strong impact on the Japanese population and many Japanese developed their interest in robots due to this fictional figure.³¹ ‘Tetsuwan Atomu’ works together with humans in a friendly way – and points out that war creates innocent victims. He “is shown fighting crime, evil, and injustice. Most of his enemies are robot-hating humans, robots gone berserk, or alien invaders.”³² TEZUKA pointed out, that “the publishers wanted me to stress a peaceful future, where Japanese science and technology were advanced and nuclear power was used for peaceful purposes”.³³

However, setting the development of robots in this dividing cultural context only falls short. There are factors which both regions have in common such as the craftsmanship of Japan and Germany and a balanced structure of large and small companies, also in the robot business. But it is rather global competition between companies, their scientists and managers, which are dominating the development of robots. Nevertheless, culture plays an important role as an invisible hand. Focusing the thoughts of ethical and cultural contexts in a more operational context: Since a robot is based on a management decision and the product of technical development, it is an important object to reflect ethically the relationship between ‘human and its body’ versus ‘machine and its body’ in an ethical context. “How far and how much will human beings be mechanized? And will this be acceptable?” “How far and how much will a machine be humanized? And will this be acceptable?”³⁴ These four questions give a direction for both German and Japanese enterprise in their environment, where they may orientate ethical guidance. To explain this, examples of robots made in Germany and Japan using company web pages are introduced in the next step.

3. Robot Manufacturers Websites – Business Reality in Global Competition

To make the research comparable, only web pages of German and Japanese companies written in English language are considered for this paper. In addition to company web pages, reference sites by other providers referring to the selected companies may be used as evidence. Providing information in the English language is a management decision, indicating a focus on the global market.

When analyzing web pages, the perspectives view between ‘reality’ and ‘the web’ incur changes: Physically, robots are three-dimensional. Pictures, however, show artifacts and humans only in two dimensions. Furthermore, pictures show only the outside of robots as a snapshot. Using the example of a humanoid robot: this robot is different from a doll because it moves based on software. Computational intelligence researchers in

²⁹ HORNYAK, Timothy N.: “Loving the Machine. The Art and Science of Japanese Robots”, Tokyo 2006, p.56

³⁰ WIKIPEDIA (ed.): “Astro Boy” (http://de.wikipedia.org/wiki/Astro_Boy, Sept 29, 2014)

³¹ The SoftBank chairman Masayoshi Son has said Pepper is a result of his time spent watching the TV show ‘Astro Boy’, an animated 1960s series based on a character who couldn’t experience emotions. In: ICHINO, Rin; AMANO, Takashi: “SoftBank to Sell Robot in U.S. Stores Within 12 Months” (<http://www.bloomberg.com/news/2014-09-02/softbank-to-sell-robot-in-u-s-stores-within-12-months.html>, Sept 29, 2014)

³² WIKIPEDIA (ed.): “Astro Boy” (http://de.wikipedia.org/wiki/Astro_Boy, Sept 29, 2014)

³³ SCHODT, Frederik L.: “Inside the Robot Kingdom: Japan, Mechatronics and the Coming Robotopia”, Tokyo 1988, p.76

³⁴ SANKAI, Yoshiyuki: “Cybernetics and Roboethics”, in: KIMURA, Takeshi et al.: Cybernetics Technical Reports. Special Issue on Roboethics, Tsukuba 2011, p.4

robotics are working to reproduce the models of human brain to trigger robot's appropriated actions from perceived information from environment and results of knowledge from cumulated past experiences registered in the memory. It is these algorithms for operation, programming, safety and control of robots, which makes it possible for humans and robots to interact and even cooperate with each other.³⁵

There are many producers of robots – and even more functions robots may fulfill. The function of a robot has a crucial influence on design of the body of a robot. The relationship between 'robot' and 'human body' can be seen from two perspectives: one is a human being with its human body. The robot may interact with a human being and its body. The other is a robot which has a body, within a larger sense, a human shape – or at least parts of it such as head with an arm, a leg etc. The question, if a robot needs a body to be a robot will be discussed in the last chapter.

The companies and institutions selected in this paper are randomly based on two criteria: (i) Large robot manufacturers. These companies have an extensive know-know of robot-technology with focus on customers, very often the industry. (ii) Robot makers with humanoid robots in their portfolios. The focus analyzes the variety of robots in the context between 'robot' and 'human body' – not the robot market as a market research, so the picture of robot-makers must remain incomplete. The more realistic the human shape mirrors robots designed, the less likely it is that these robots may have a market, at least not in the near future, since the technology to duplicate people in robots is still very limited and as such the ability of humanoid robots. As a result, the research and development for these makers is usually funded by the taxpayer, whether the maker is a private company or a public research facility. To round out the picture of robots, beyond private companies public research institutions are included, if their products have the long-term potential for finding customers.

The order of companies based on their web pages web-information below follows the line: the more humanoid the shape of the robot, the later the robot will be quoted.

3.1. German Companies

A. No relation 'robot' – 'human body' – DUERR

Beside the fact that the company is one of largest robot-manufacturers in Germany, the web pages do not refer to any humanoid-robot relations.³⁶ The USB-Stick in a humanoid-robot design offered as a public-relations instrument cannot be set in the context of company thought towards any relation between human and robot, though unspoken the company may think of it. It is typical for a maker of industrial robots.

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|  | <p>Duerr AG Source of Photo:³⁷</p> |
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B. Robots cooperate with humans - KUKA

The company produces robots acting together as synchronized robot-teams. The technology concept is based on the intelligent networking of standard controllers. Each robot thus retains its own controller which

³⁵ KASTANIENBAUM (ed.): "Kastanienbaum' company web page" (<http://www.kastanienbaum.com/news.html> , Sept 29, 2014)

³⁶ DUERR (ed.): "'Duerr' company web page" (<http://www.durr.com/>, Sept 29, 2014)

³⁷ DUERR (ed.): "'Duerr' company web page" (http://www.durr-collection.com/uploads/tx_rrshop/101029-001_01.jpg, Sept 29, 2014)

communicates with those of the other “team members”. In this way, robots can exchange all relevant data and synchronize their motions with one another. The cooperating robots can furthermore form a team with a human.³⁸ Though the robots produced by KUKA do not have a human shape, the invisible software running the robot has been programmed in a way that the robot can communicate with a human body without hurting him.

C. Robots with elements of human shape - ABB

YuMi (“You and Me”³⁹) is a collaborative, dual arm solution with the ability to feel and see. The robot can work cage-free. It is based on a dual arm concept. The company underlines the human – machine collaboration: “humans and robots sharing tasks side-by-side.”⁴⁰

The core communication to customers: the robot is “safe” when people are around. The robot has a camera in each shoulder. It is about 50 cm high and has no legs. When the arms are folded, the robot has a humanlike design; however, at all times humans may not confuse a real human and robot.

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|  | <p>Asea Brown Boveri (ABB) AG (Swedish-German-Swiss Company) Source of Photo: ⁴¹</p> |
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D. Robots – in direct interaction with human body - METRA LABS

SCITOS A5 shopping robots are in service in the “Toom Baumarkt” home store chain within Germany. The robots know the locations of more than 60,000 products and can guide customers to any product placed in the store. The integrated barcode reader can be used to get pricing information. This allows the stores’ employees to concentrate on sales conversations with their customers.⁴²

The SCITOS G5 main application is research in the field of human-robot-interaction. The mobile base can be enlarged and improved to a fully-pledged interactive robot. Therefore, modules like an omni-directional camera, a touch screen monitor etc., are available. Packed with this equipment, the customer can accomplish research for and studies in detection, tracking or identification of individuals and objects as well as develop and investigate techniques for an adaptive conversational control.

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|  |  | <p>MetraLabs GmbH Source of Photo Left:⁴³ (SCITOS A5) Right Scitos Head:⁴⁴</p> |
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³⁸ KUKA (ed.): “KUKA’ company web page” (http://www.kuka-robotics.com/en/pressevents/productnews/NN_050912_HumanAndRobots.htm?wbc_purpose=Basic, Sept 29, 2014)

³⁹ The phonetic English pronunciation “me” is written is German as “mi”.

⁴⁰ ABB (ed.): “ABB Unveils the Future of Human-Robot Collaboration”, Press Release from Sept 9, 2014, (http://new.abb.com/docs/librariesprovider89/default-document-library/gp_rdualarmrobotyumi.pdf?sfvrsn=2, Sept 29, 2014)

⁴¹ ABB (ed.): “ABB’ company web page” (<http://new.abb.com/products/robotics/yumi>, Sept 29, 2014)

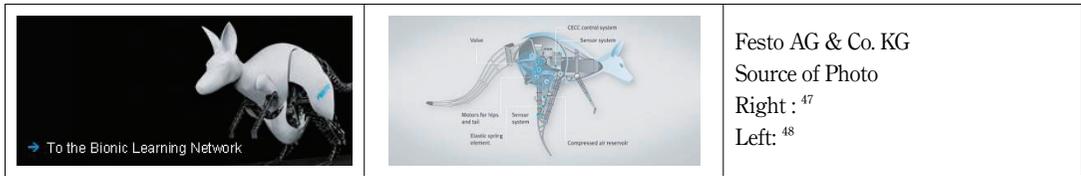
⁴² METRALABS (ed.): “METRALABS’ company web page” (http://metralabs.com/index.php?option=com_content&view=article&id=73&Itemid=87, Sep 29, 2014)

⁴³ METRALABS (ed.): “METRALABS’ company web page” (http://metralabs.com/index.php?option=com_content&view=article&id=73&Itemid=87, Sep 29, 2014) A film about the robot in use is provided: (http://www.e2lxx.de/automation21xx/13582_st3_robotics/default.htm, Sept 29, 2014)

⁴⁴ METRALABS (ed.): “METRALABS’ company web page” (http://metralabs.com/index.php?option=com_

E. Company which set the relation ‘robot’ – ‘human body’ as business field - FESTO

Festo has a comprehensive approach in building robots, asking: How will humans and robots work together in the future? On its webpage on “innovation and technology”⁴⁵ the company is posing questions on the relation between human and robots and discussing robot-related topics such as “Robot learns to see”.⁴⁶ One of the projects by FESTO is a robot-kangaroo. The kangaroo is based on interdisciplinary company research including the relation between robot and human.

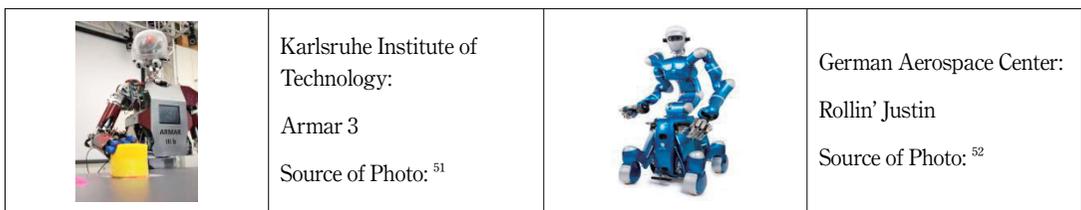


F. Digression: humanoid robots for the household: ‘Karlsruhe Institute of Technology’ and ‘German Aerospace Center

In the future humanoid robots are envisioned in household applications as well as in other contexts such as the space environment. The capability to carry out complex manipulation tasks is a key issue.

The ‘Karlsruhe Institute of Technology’ developed the Armar 3, a completely independent acting humanoid robot for the household. It can learn by itself and work in any kitchen doing home helpers work.⁴⁹

The ‘German Aerospace Center’ (Deutsches Zentrum für Luft- und Raumfahrt) utilizes its humanoid robot Rollin’ Justin as a research platform for autonomous dexterous mobile manipulation in human environments. The compliant controlled light weight arms and the two four-fingered hands of the robot make it an ideal experimental platform for these research issues. The mobile platform allows the long range autonomous operation of the system. Motion sensing sensors and stereo cameras allow the 3D reconstruction of the environment of the robot. Unstructured, variable and dynamic environments require a robot to act based on the given situation without human intervention. On the other hand, cooperating with a human is sometimes the only way to solve a certain task.⁵⁰



content&view=article&id=48&Itemid=75, Sept 29, 2014)
⁴⁵ FESTO (ed.): “FESTO’ company web page” (http://www.festo.com/cms/en_corp/12925.htm, Sept 29, 2014)
⁴⁶ FESTO (ed.): „Robots Learn to See“, PR-paper from June 27, 2014 (http://www.festo.com/cms/en_corp/13976.htm, Sept 29, 2014)
⁴⁷ FESTO (ed.): “FESTO’ company web page” (http://www.festo.com/cms/en_corp/index.htm, Sept 29, 2014)
⁴⁸ FESTO (ed.): “FESTO’ company web page” (http://www.festo.com/cms/en_corp/13704.htm, Sept 29, 2014)
⁴⁹ Karlsruhe Institute of Technology (ed.): “Armar Family” (<http://his.anthropomatik.kit.edu/english/241.php>, Sept 29, 2104)
⁵⁰ German Aerospace Center (ed.): “Rollin’ Justin“ (<http://www.dlr.de/rmc/rm/en/desktopdefault.aspx/tabid-5471/>, Sept 29, 2014)
⁵¹ WIKIPEDIA (ed.): “Amar 3” (http://de.wikipedia.org/wiki/Armar_3#mediaviewer/File:KIT_Armar_08.jpg, Sept 29, 2014)
⁵² German Aerospace Center (ed.): “Rollin’ Justin“ (<http://www.dlr.de/rmc/rm/en/desktopdefault.aspx/tabid-5471/>, Sept

3.2. Japanese Companies

A. Companies with no websites relation ‘robot’ – ‘human body’

Many large, global operating robot-manufacturers do not show any web pages with humanoid robots. Their business is industrial robots, which represents the large majority of the market. Major makers are among others: Fanuc, Hirata, Kawasaki Heavy Industries, Mitsubishi Electric, Nihon Densan Sankyo and Denso.

B. Robots with elements of human shape – YASKAWA ELECTRIC and EPSON

The dual arm robot can carry out varying tasks almost autonomously using its arm geometry based on human physiology and wide-ranging integral sensors such as cameras, force sensors and acceleration meters.⁵³ The cameras are fixed in a stylized head. The robot can interact with a human.⁵⁴

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|  | <p>Yaskawa Electric (Trademark: Motoman) Source of Photo:⁵⁵</p> |  | <p>Epson Source of Photo:⁵⁶</p> |
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C. Robots which have additional human displays - PANASONIC

Panasonic works on robots in hospitals. The ‘Hospi-R’ robot delivers medicines to patients in hospitals. The robot itself has no human shape; however, on a screen a stylized head appears with a smile. Stumps are fixed on both sides of the robot arm. The company says that it frees nurses to do more important work.

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|  | <p>Panasonic ‘Hospi-R’ Source of Photo:⁵⁷</p> |
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D. Robots with Humanoid shape – HITACHI, TOYOTA and HONDA

Hitachi: The robot EMIEW2 was developed as part of Hitachi’s efforts to create a service robot with diverse communication functions that could safely coexist with humans while conducting necessary services. To ensure agility and safety in an office environment, EMIEW2 was designed to a compact height of 80 cm and a portable

29, 2014)
⁵³ EPSON (ed.) “EPSON’ company web page” (<http://www.epson.de/de/en/viewcon/corporatesite/cms/index/11075/>, Sept 29, 2014)
⁵⁴ YASKAWA (ed.) “YASKAWA’ company web page” (<http://www.yaskawa.co.jp/en/vision/robotics/01.html>, Sept 29, 2014)
⁵⁵ KAISER, Arvid: „Japan will Olympische Spiele fuer Roboter“, in ‚Manager Magazin‘ of July 24, 2014 (<http://www.manager-magazin.de/fotostrecke/roboer-fuer-olympia-wie-japan-in-den-wettbewerb-der-zukunft-geht-fotostrecke-117318-13.html>, Sept 29, 2104)
⁵⁶ EPSON (ed.) “EPSON’ company web page” (https://neon.epson-europe.com/files/pressimages/D/Doppelarm_6_mid.jpg, Sept 29, 2014)
⁵⁷ FALCONER, Jason: “HOSPI-R drug delivery robot frees nurses to do more important work” in: GIZMAG Magazine, October 28, 2013, (<http://www.gizmag.com/panasonic-hospi-r-delivery-robot/29565/>, Sept 29, 2014)

weight of 14kg. Further, to enable harmonious interaction while working with people, EMIEW2 is able to travel at the same speed as humans.⁵⁸

Honda: The company says about its robot, ASIMO, that it is advanced to an ‘autonomous machine’ with the decision-making capability to determine its behavior in concert with its surroundings such as movements of people. At the beginning of the development process, the following three factors were identified as necessary for a humanoid robot to perform as an autonomous machine which in practical term coexists with people:⁵⁹ (i) high-level postural balancing capability which enables the robot to maintain its posture by extending its leg in an instant, (ii) external recognition capability which enables the robot to integrate information, such as movements of surrounding people, from multiple sensors and estimate the changes that are taking place, (iii) the capability to generate autonomous behavior which enables the robot to make predictions from gathered information and autonomously determine its next behavior without being controlled by an operator.

Toyota: The company postulates that humanoids are friendly people, is a partner robot of bipedal walking with adaptation to the living environment.

Toyota says that its robot ‘Robina’ can help providing medical and nursing care or perform housework. ‘Robina’ is able to think and move for itself, carry and use objects and even converse with people. Toyota hopes, that ‘Robina’ will become a trusted partner, assisting doctors and nurses and looking after patients and the elderly wherever medical and nursing care are provided.⁶⁰



E. Robots who have high ability to communicate with people: Kirobo-Consortium, SOFTBANK

A consortium of private companies and public research institutes developed Kirobo, or ‘Kibo’, the Japanese humanoid robot who is modeled after Astro Boy.⁶⁴ The consortium defined its mission for Kibo: The robot should “help solving the problems brought about by a society that has become more individualized and less communicative. Nowadays, more and more people are living alone. It is not just the elderly – with today’s challenging lifestyles, its people of all ages. With a new style of robot-interface, perhaps a way to solve this

⁵⁸ (http://www.hitachi.com/rd/portal/research/robotics/emiew2_01.html, Sept 29, 2014) . Its obstacle evasion technology Developed as part of a joint research project between Tsukuba University and Hitachi, Ltd. This technology incorporates the results of cooperative research conducted by Professor Takashi TSUBOUCHI, Shinichi YUTA (Director of Tsukuba Industrial Liaison and Cooperative Research Center), and Hitachi, Ltd., A film can be seen: (<http://www3.nhk.or.jp/nhkworld/english/news/techtrends/20140828.html>, Sept 29, 2014)

⁵⁹ HONDA (ed.): “HONDA’ company web page” (<http://world.honda.com/ASIMO/technology/2011/index.html>, Sept 29, 2014)

⁶⁰ TOYOTA (ed.): “TOYOTA’ company web page” (http://www.toyota-global.com/innovation/partner_robot/family_2.html#h201, Sept 29, 2014)

⁶¹ HITACHI (ed.): “HITACHI’ company web page” (http://www.hitachi.com/rd/portal/research/robotics/emiew2_01.html, Sept 29, 2014)

⁶² HONDA (ed.): “without title”, News Release of Nov. 8, 2011 (<http://world.honda.com/news/2011/c111108All-new-ASIMO/photo/pages/14.html>, Sept 29, 2014)

⁶³ TOYOTA (ed.): “TOYOTA’ company web page” (http://www.toyota-global.com/innovation/partner_robot/family_2.html#h201, Sept 29, 2014)

⁶⁴ Kirobo was developed by a collaborative effort between Dentsu, University of Tokyo’s Research Center for Advanced Science and Technology, Robo Garage, Toyota, and JAXA (Japan Aerospace Exploration Agency).

problem could be found. This is the goal we have in mind for this project.”⁶⁵ To fulfill this task, communication software is one of the core-elements of Kibo. In 2014, a Kibo was brought on the international space station to entertain astronauts in space.⁶⁶

Softbank will sell a robot to individual consumers: robot ‘Pepper’ will go in sale in Japan in 2015.⁶⁷ Pepper is a humanoid robot that takes his surroundings into consideration to react pro-actively using proprietary algorithms. The robot is equipped with capabilities that enables communication with people, including gesture and voice recognition technology, and emotion recognition that analyzes expressions and voice tones. In addition, Pepper can make jokes, dance and amuse people thanks to a wide variety of entertainment capabilities. With these technologies, people can communicate with Pepper in a natural way.⁶⁸

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|  |  | <p>KIROBO Source of Photo Left:⁶⁹ Right:⁷⁰</p> |  | <p>SOFTBAN K ‘Pepper’ Source of Photo:⁷¹</p> |
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G. Real model robots: ‘University of Osaka’ and ‘National Institute of Advanced Industrial Science and Technology’ (AIST)

The ‘Geminoid-F’ developed at the University of Osaka is a very humanoid robot – the picture shows the “original” human being and robot styled after the lady on the right side. - AIST developed HRP-4C “Miim”. The robot can move like a human, utilizing 30 body motors and another eight dedicated to facial expressions such as happiness, anger and surprise. Miim can sing and respond to speech using speech recognition software, and is capable of recognizing ambient sounds.⁷²

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|  | <p>UNIVERSITY OF OSAKA ‘Geminoid-F’ Source of Photo:⁷³</p> |  | <p>National Institute of Advanced Industrial Science and Technology HRP-4C “Miim” Source of Photo:⁷⁴</p> |
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⁶⁵ KIBO Robot Project (ed.): “without title” (<http://kibo-robot.jp/en/project/mission.html>, Sept 29, 2014)

⁶⁶ BURTON, Bonnie: Japan’s ISS Kirobo robot is lonely in space, in CNET-Magazine of Sept 2, 2014 (<http://www.cnet.com/news/japans-iss-kirobo-robot-is-lonely-in-space/>, Sept 29, 2014). A film about Kirobo in space is provided in youtube: (<https://www.youtube.com/watch?v=xqShesZ3v-g>, Sept 29, 2014)

⁶⁷ The price of the robot will be 198.000 Yen. See: ICHINO, Rin; AMANO, Takashi: “SoftBank to Sell Robot in U.S. Stores Within 12 Months” (<http://www.bloomberg.com/news/2014-09-02/softbank-to-sell-robot-in-u-s-stores-within-12-months.html>, Sept 29, 2014). “Aldebaran” is a French company ? the majority of shares are held by Softbank.

⁶⁸ ALDEBARAN (ed.): “‘Aldebaran’ company web page” (<http://www.aldebaran.com/ja/softbank-mobile-and-aldebaran-unveil-pepper>, Sept 29,2014)

⁶⁹ KAISER, Arvid: „Japan will Olympische Spiele fuer Roboter“, in ‚Manager Magazin‘ of July 24, 2014 (<http://www.manager-magazin.de/fotostrecke/roboter-fuer-olympia-wie-japan-in-den-wettbewerb-der-zukunft-geht-fotostrecke-117318-3.html>, Sept 29,2014)

⁷⁰ KIBO Robot Project (ed.): “without title” (<http://kibo-robot.jp/en/report>, Sept 29, 2014)

⁷¹ KAISER, Arvid: „Japan will Olympische Spiele fuer Roboter“, in ‚Manager Magazin‘ of July 24, 2014 (<http://www.manager-magazin.de/fotostrecke/roboter-fuer-olympia-wie-japan-in-den-wettbewerb-der-zukunft-geht-fotostrecke-117318-2.html>, Sept 29, 2014)

⁷² WIKIPEDIA (ed.): “HRP-4C” (<http://en.wikipedia.org/wiki/HRP-4C>, Sept 29, 2014)

⁷³ KAISER, Arvid: „Japan will Olympische Spiele fuer Roboter“, in ‚Manager Magazin‘ of July 24, 2014 (<http://www.manager-magazin.de/fotostrecke/roboter-fuer-olympia-wie-japan-in-den-wettbewerb-der-zukunft-geht-fotostrecke-117318-3.html>, Sept 29, 2014)

3.3. Similarities and Differences in Japanese and German Robot Manufacturers

Japanese and German makers are intensively involved in robot manufacturing and a broad range of robots are developed and produced in both countries.

However, there are cultural differences. In Japan, politicians, including the Prime Minister himself, play an important stimulus role. In contrary, it is unimaginable that a German Chancellor would suggest during a well-prepared press-conference a (international) Robot Olympics while setting it in the context for boosting a particular, still small, national industry. There are many other competing technologies at a seed stage with the chance to become a break-through technology. Chris FIELD points out, “the fact that the Japanese government has chosen to invest a huge amount of money in robotics over easing immigration restrictions, or making working conditions less hostile to women and mothers, says as much about the ‘reactionary postmodernism’ of contemporary Japanese politicians, as it does about the Japanese affinity with robots.”⁷⁵ Furthermore, a positive return in investment of the public investment in robots – beyond industrial robots – at this early stage is rather uncertain. It is a government market intervention with the risk of market distortion. However, for Japanese management this government policy is the prevailing circumstance for decision-making.

Not an ethical but a crucial management aspect: Japanese companies mainly follow in their robot research and development a philosophy based on what is called “kaizen”. Its formula for success is based on traditional know-how and continuous improvement in *small steps* embedded in group work. Its focus is the human being. On an operational level, Japanese companies tend mainly to use their domestic market at an early stage of technology life and high penetration rate during the growth phase of diffusion. As such, Japanese robot development –except when subsidized by the treasury– is focused on consumer applications and on larger, low-risk markets such as automobile and electrical appliance manufacturing. Based on government stimuli, Japanese makers are much more willing to engage in humanoid robots than their German counterparts. However, these robots cannot yet be sold, but in best case are used to polish the company image. Example: US-President Barak Obama played soccer with the ASIMO-robot during an official visit to Japan.⁷⁶ The probability to use the gained know-how for future projects is uncertain – or could in part have gained as well by investing in other, related technologies.

German companies mainly follow in their robot research and development a philosophy based on what is called “innovation”. Its formula for success is based on new invention and improvement in *big steps* based on individual ideas. Its focus is the technology. The German government supports within the legal framework of the EU-Commission research institutions such as public large-scale research-institutions and universities. Research money for private companies is only available within strictly defined limitations. Products developed with public money usually have as seed-technology only long-term opportunities for a market-entry.

What Japanese and German management has in common is that companies in both countries concentrate on technical matters of the hard- and software of their robots. Engineers and computer scientists dominate development. However, some companies with a long-term vision based on an excellent management include ethical thoughts in their R&D out of a self-enlightened interest.

117318-8.html, Sept 29,2014) A film about ‘Geminoid-F’ is provided in youtube: (<https://www.youtube.com/watch?v=MaTfzYDZG8c>, Sept 29, 2014)

⁷⁴ AIST (ed.): “AIST” official web page” (http://www.aist.go.jp/aist_j/press_release/pr2009/pr20090316/pr20090316.html, Sept 29, 2014)

⁷⁵ FIELD, Chris: “Creative Perspectives on Future Human-Robot-Relations in Japan”, Sidney 2010, p.28 (<https://dl.dropboxusercontent.com/u/6132601/CFL001/Exegesis.pdf>, Sept 29, 2014)

⁷⁶ Associated Press (ed.): “Raw: Obama Plays Soccer With Japanese Robot”, film provided in “you tube” (<https://www.youtube.com/watch?v=ag2vk6coBpI>, Sept 29, 2014)

4. Robots and Human Body - Merging Academic Approaches and Business Reality

Setting the production of robots by companies in an ethical context, a decision should undergo a two-step process: (i) an analysis if the robot production can be ethically justified from a management point of view – and if so, (ii) does the robot fulfill the ethical criteria towards society, including a balanced relationship between ‘robot’ and ‘human body’.

The justification for robot production must lie outside the company: it must be in society. Creating a customer is the core of any business and as such the customer decides what the business is. Management should not ask intrinsic: ‘Is it right what we do?’ but rather research: ‘Is that, what we do, what society wants and what the customer pays to us?’ The test of any management is not the maximization of profit, but the achievement of sufficient profit to cover at least the risks and its potential losses of every company activity.⁷⁷ In a market-orientated economy, companies are responsible for their impacts. Even minor impacts are likely to result in serious damage to business. The job of the management is to realistically imagine and identify impacts.

This is challenging: Of the SONY-made entertainment robot AIBO 150.000 units have been sold, though, production and further research was halted in 2006.⁷⁸ Setting the ethical relationship between ‘robot’ and ‘human body’ in context within a technology assessment, there is the risk that the result may lead to the encouragement of the wrong technologies and the discouragement of the technologies society needs at a particular time and which customers are prepared to pay for. Obviously, Japanese society is keen on new robots, though, and the previously introduced robot PEPPER sold by SOFTBANK will be the next large-scale test.

The long-term future impacts of robots are beyond anybody’s imagination. To avoid prophecy, operating robots, including the humanoid robots, which are already advanced enough to be judged and to be evaluated, have to be observed. That has to go far beyond technological assessments: crucial as well are non-technological impacts, such as social innovations and developments. They are just as hard to predict, to evaluate and to measure. This justifies, demands, enterprise working out a clear position regarding roboethics⁷⁹. The balanced relationship between ‘robot’ and ‘human body’ as an ethic condition is for robot-makers an important, often underestimated or even ignored management task.⁸⁰ These criteria are needed regardless of whichever understanding the company holds of what robots are: (i) nothing as machines, (ii) as entities with ethic dimensions or (iii) as moral agents. It is rather the customers who decide what robots are, and customers’ ideas are diverse.

One topic of roboethics needs at this stage deeper debate. It is the prediction: “what robots characterize is ‘autonomy’”. Obviously, what makes a robot in particular different from an automat is its ‘autonomy’. But what is ‘autonomy’? Makoto NAKADA analyzed systems characterized by their creators as ‘autonomous’. The results were for example: “The ability to produce the values of measurements supported by a set of devices and a calculation method” or “capacity of generating new and modulated ...walking ... patterns based on a certain set of artificial neurons.”⁸¹ NAKADA concludes that robots are hybrid-entities of independency and dependency; this means that the notion of robot ‘autonomy’ itself is a hybrid concept involving independency

⁷⁷ DRUCKER, Peter: Management: Tasks, Responsibilities, Practices, New York 1993, p.73

⁷⁸ WIKIPEDIA (ed.): “Aibo” (<http://en.wikipedia.org/wiki/AIBO>, Sept 29, 2014)

⁷⁹ Roboethics is a short expression for ethics of robotics. Very likely the expression was used first time by Gianmarco Veruggio, University of Genoa. 2004 the first symposium on roboethics was held in Italy.

⁸⁰ BARTFAI, Aniko: “High-Tech Assistive Devices for the Disabled and Elderly: Ethical Issues and Clinical Experiences in Use and Assessment”, in: KIMURA, Takeshi et al.: Cybernics Technical Reports. Special Issue on Roboethics, Tsukuba 2011, p.38

⁸¹ NAKADA, Makoto: “Ethical and Critical Analysis of the Meaning of Autonomy of Robot Technology in the West and Japan”, in: KIMURA, Takeshi et al.: Cybernics Technical Reports. Special Issue on Roboethics, Tsukuba 2011, p.76–77

and dependency.⁸² This is an important hint for management how to set their robots into a frame of ethic values.

A management policy which is not embedded in profound theory and evident nature is without orientation. Keeping the hybrid nature of robots regarding 'autonomy' in mind, the list of criteria for roboethics worked out by Rafael CAPURRO may give management direction: (i) human dignity and human rights, (ii) equality, (iii) justice and equity, (iv) benefit and harm, (v) respect for cultural diversity and pluralism, (vi) non-discrimination and non-stigmatization, (vii) autonomy and individual responsibility, (viii) informed consent, (ix) privacy, (x) confidentiality, (xi) solidarity and cooperation, (xii) social responsibility, (xiii) sharing of benefits, (xiv) responsibility towards the biosphere.⁸³ These broad, comprehensive criteria may be used as a checklist by companies to approach sensitivities towards their business-activities with particular reference to their robot-related products and services. But such a checklist may only be one among other tools to work out a knowledgeable company-mission defining ethical relationship between 'robot' and 'human body' in particular and roboethics in general. Every company must find its own mission.

What will be the outlook for roboethics? In which direction does visionary management have to think? Robots themselves and human beings will become part of a system, where no single robot is considered to think, and nor is any single person. In this sense, the 'autonomy' of robots, based on presuppositions of independent entities, no longer has meaning.

An example for this development is a 'network-robot-system'. Still, such systems will have at least one physical robot which incorporates hardware and software capabilities, so the embodiment of robots will remain. And this physical robot must have autonomous capacities. But there are significant changes vis-à-vis a "traditional" robot: The robot, environment sensors and humans must communicate and cooperate through a network. Besides the sensors of the robots, the environment must include other sensors, such as vision cameras and laser range finders, and other actuators, such as speakers. And last but not least: The system must perform a human-robot related activity.⁸⁴ Within such systems, the necessity of (hybrid) 'autonomy' for robots is decreasing, because systems themselves have their own environment sensors, 'eyes' and 'ears'. The development of highly organized and networked systems might herald the end of the necessity of discussions 'regarding the autonomy of robots', and perhaps the end of the necessity of concepts or the presence of robots themselves, because robots without 'eyes' and 'ears' can no longer be considered robots. However, at the same time, an environment with sensors but without bodies also cannot be considered being a robot.⁸⁵

As an example for this post-robot age, the eMotionSpheres may serve, developed by FESTO: several flying objects can move in a coordinated manner and within a defined space in collision-free motion of autonomous systems. Ten cameras installed in the room record the spheres via their active infrared markers and pass on the position data to a central master computer. The actions calculated from this process are sent back to the spheres, which then implement them locally. The intelligent networking system creates as guidance and monitoring system, which could be used in the networked factory of the future.⁸⁶ The system is not any more a robot.

⁸² NAKADA, Makoto: "Ethical and Critical Analysis of the Meaning of Autonomy of Robot Technology in the West and Japan", in: KIMURA, Takeshi et al.: Cybernetics Technical Reports. Special Issue on Roboethics, Tsukuba 2011, p.74

⁸³ CAPURRO, Rafael: "The Quest for Roboethics: A Survey", in: KIMURA, Takeshi et al.: Cybernetics Technical Reports. Special Issue on Roboethics, Tsukuba 2011, p.43

⁸⁴ NAKADA, Makoto: "Ethical and Critical Analysis of the Meaning of Autonomy of Robot Technology in the West and Japan", in: Kimura, Takeshi et al.: Cybernetics Technical Reports. Special Issue on Roboethics, Tsukuba 2011, p.78

⁸⁵ NAKADA, Makoto: "Ethical and Critical Analysis of the Meaning of Autonomy of Robot Technology in the West and Japan", in: Kimura, Takeshi et al.: Cybernetics Technical Reports. Special Issue on Roboethics, Tsukuba 2011, p.78

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The end of the information age will coincide with the beginning of the robot age. Information technology and robotics will gradually fuse so that people will likely only notice when robot technology is already in use in various locations. ⁸⁸ But as the example eMotionSpheres shows, it can be predicted already now that also the robot age will come to an end and open a new, post-robot age with a new relationship between ‘whatever will follow’ and ‘human body’. It will once more be an obligation of science to work out the theoretical framework which may be called “post-roboethics”, so that management will be able to act accordingly towards society.

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