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van Burg, J.C.; Giannopapa, Christina; Reymen, Isabelle M.M.J.

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Open Innovation in the European Space Sector: Existing Practices, Constraints and Opportunities

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Elco van Burg (corresponding author)

School of Business and Economics
Vrije Universiteit Amsterdam
De Boelelaan 1105, 1081 HV Amsterdam, The Netherlands
j.c.van.burg@vu.nl
Phone: +31 20 59 86050

Christina Giannopapa

Strategy Department
European Space Agency (ESA)
8-10 rue Mario Nikis
75738 Paris Cedex 15, France
christina.giannopapa@esa.int
Phone: +33 1 53 69 8218

Isabelle M.M.J. Reymen

Department of Industrial Engineering & Innovation Sciences
Eindhoven University of Technology
P.O. Box 513, 5600 MB Eindhoven, The Netherlands
i.m.m.j.reymen@tue.nl
Phone: +31 40 247 4283

Open Innovation in the European Space Sector: Existing Practices, Constraints and Opportunities

Abstract

To enhance innovative output and societal spillover of the European space sector, the open innovation approach is becoming popular. Yet, open innovation, referring to innovation practices that cross borders of individual firms, faces constraints. To explore these constraints and identify opportunities, this study performs interviews with government/agency officials and space technology entrepreneurs. The interviews highlight three topic areas with constraints and opportunities: 1) mainly one-directional knowledge flows (from outside the space sector to inside), 2) knowledge and property management, and 3) the role of small- and medium sized companies. These results bear important implications for innovation practices in the space sector.

Keywords: Open innovation, SME's, knowledge and property management, interviews

1. Introduction

The space sector has a long history of pushing the borders of knowledge through scientific missions. Exploring space required breakthrough innovations, which subsequently often spilled over to applications in the broader society. Yet, the space sector is experiencing a slow-down in innovation speed, and more and more its endeavors seem to result in incremental innovation [1]. Moreover, Europe suffered last decade from a severe financial crisis, which initially did not result in budget cuts to space programs [2], but in the end some countries reduced their spending on space activities, as part of their overall reform such as in Greece or Spain, or because their budget is a percentage of their shrinking GDP [3]. As a result, the innovative capacity and societal spill-over of the institutional/governmental space sector is at stake while at the same time commercial players gain more traction. This urges a rethinking of the space sector, in order to enhance innovative output in view of shrinking budgets and upcoming commercial players.

One way to approach this problem is by embracing the concept of open innovation [4]. Open innovation has evolved into a central topic in the innovation management literature over the past decade [5–7], drawing attention to how organizations engage with external partners to develop and exploit innovations [8]. Essential in the concept of open innovation is that organizational boundaries are considered as permeable for knowledge flows in two directions, involving both inbound and outbound technology flows [5]. For the space sector, and especially the space institutes like NASA and ESA, this would require two-way collaboration with other sectors. This way, the space sector may profit from breakthrough technology innovations from other industries, while also the spillover of space technology to broader use may be enhanced. Since 2007, NASA already has been implementing open innovation practices to solicit contributions from a broader public [9], and also in the commercial sector open innovation practices are gaining popularity [4]

However, a number of barriers seem to hinder the space sector to fully benefit from such bidirectional collaboration [4]. First, the institutional space sector is quite focused on developing what is considered special technology for exploring space, and therefore usually uses collaboration with other sectors through one-way interactions, aimed at absorbing much knowledge and technology into their programs. The other way around, the intentional transfer of technology from space applications to products and services in other sectors is to a lesser extent observed. Second, space technology is still considered highly proprietary and often secret technology, which resulted in space technology development in a closed environment [4]. Third, the technology for activities in space requires high levels of technological performance, which usually exceeds the performance levels for ordinary applications in other sectors. As a result, using these technologies may result in unnecessary high costs or might require significant adaptation, which forms a barrier for applying the technology in other sectors.

To overcome these barriers, we explore the constraints and opportunities of an open innovation approach to technology development in the space sector. We first introduce the essentials of the open innovation concept and its general application in innovation processes in firms. Then we turn to empirically studying the constraints and opportunities for a bidirectional open innovation approach for the space sector. We end with outlining a contextualized open innovation concept and providing a number of policy implications from our analysis.

2. Open Innovation

The notion of “open innovation” has been introduced to refer to all innovation activities that cross the boundaries of a single organization [8], and comprises inbound and outbound processes [5]. Inbound processes include the use of external ideas as a complement to in-

house innovation, with or without paying a financial compensation [10]. Outbound processes include sharing knowledge with outsiders [11] and selling intellectual property to other parties, thereby generating an external path to the market [8]. Inbound and outbound processes are typically combined in collaborative innovation projects, in which multiple organizations contribute to the technology development [12].

The idea that innovation processes can, and often do, transcend organizational boundaries is not new, and many studies of such “open” processes (most of them inbound) have been published before the term “open innovation” was coined. Past research investigated collaborative ties with different types of partners in the innovation process: collaboration with users [13], strategic alliances with technology partners [14], the integration of suppliers in product development [15], R&D consortia involving competitors [16], and sourcing from knowledge institutes [17]. What is novel in the concept of open innovation, though, is that the notion of open innovation brings seemingly disparate topics (such as on user innovation, technology alliances, supplier integration, knowledge sourcing, and IP licensing) together, enabling an integrated perspective on collaborative innovation. Moreover, the concept of open innovation stresses that the collaboration with external parties is only half of the battle, the other half being the integration in innovation activities within the organization [6].

Open innovation processes involving multiple parties inherently create tensions between different perspectives, interests, loyalties, histories, prejudices, goals and behaviors. One of the most pronounced tensions is that between cooperation and competition [18], which is particularly important for open innovation [19]. Often, open innovation involves *cooperation* to create value from combining inbound and outbound technology flows [20] and *competition* to divide and appropriate the created value [21]. Thus, two key concepts in the collaborative innovation process are value creation and value appropriation. *Value creation* involves expanding all potential benefits from the collaborative innovation efforts [22], which

may be available for all partners in the collaborative network. We define *value appropriation* as capturing an individual share of the created value [22]. In other words, value creation through joint innovation activities or bi-directional technology flows determine the size of the pie, while value appropriation determines the share of the pie [23]. Yet, both value creation and value appropriation are interrelated, as a strong focus on appropriability tends to limit efforts to draw in knowledge from multiple external parties, leading to reduced value creation [24].

Obviously, such joint innovation involves the risk that parties free-ride and do not as much contribute to value creation as they appropriate from it in the end [5]. Therefore, organizations seem to carefully weigh the perceived costs and potential value of open innovation and re-evaluate it over time. As innovation processes in the (aero)space sector are long-lasting projects, involving many parties, previous studies found that the organization's re-evaluation of those costs and potential value to be appropriated from the project often results in changes in collaborative networks [25].

3. Methodology

To gain insight in existing collaborative innovation practices in the space sector and to explore the constraints and opportunities for open innovation practices, 10 semi-structured interviews with key players in space agencies, institutions and companies were conducted in 2011 (primarily Dutch-based companies). The interviewees were selected in such a way that they represented the different perspectives on the sector; experts were selected from for instance the Dutch National Aerospace Laboratory and ESA, as well as entrepreneurs operating medium sized and large companies targeting space applications. The interview protocol was setup to cover innovation practices in the space sector, including questions about

the current business model of the firm, the way they deal with partnerships in the space sector and their impressions about opportunities for future collaborative practices.

Subsequently, the interviews were analyzed by means of coding the interviews, which is a procedure that identifies and clusters similar chunks of text across all interviews and subsequently clusters similar statements into themes and categories [26]. Thus, common themes, crosscutting these interviews, were identified as well as important insights regarding existing business practices and collaborative innovation. These themes in particular served to develop a description of current collaborative innovation practices and to identify constraints and opportunities for a bidirectional open innovation approach for the space sector. To validate this description and analysis, policy documents and sector reports were consulted.

4. ESA Open Innovation Policies and Initiatives

The European Space Agency's aim is to cooperate in developing space technologies, while being supported by its fifteen European member states. Six large system integrators, Airbus, Thales, Alenia, RUAG, Safran and OHB, are performing most of the large ESA space projects in the European Union, up to 73 percent of the total turnover in the European space sector [27], of which Airbus and Thales have about 55%. The share for small and medium-sized enterprises (SME's) is relatively small, as only about 5% of the employment in the space sector is provided by confirmed SME's [27]. Innovative activities cover space science and exploration, navigation (i.e., the Galileo project), telecommunications, earth observation, launchers and manned space.

In Europe, ESA is the main coordinating agency. With the exception of two smaller companies, all commercial businesses that were interviewed were tightly cooperating with ESA. The European member countries pay an annual contribution (as a percentage of their Gross National Product) to ESA, which is subsequently mainly invested in projects through

Invitations to Tender (ITT). After the tendering period, ESA selects the most suitable partner to work with on a specific project. The other smaller part of the ESA budget is used for in-house research, management and testing the solutions. Interviews indicated that in general parties are not able to execute these projects on their own, so that consortiums and partnerships have to be formed in order to apply for a certain tender. Some tenders specify that cooperation with multiple partners is required to cover expertise from multiple disciplines and countries.

Besides implicitly or explicitly imposing cooperation among companies, ESA also explicitly stimulates open innovation practices by dedicated initiatives. In general, these initiatives aim at creating more knowledge spillovers between space and non-space sectors. For instance, the ESA Innovation Triangle Initiative (ITI) aims at enhancing radical innovation in the space sector by facilitating cooperation among three important stakeholders: inventors, developers and (end) customers in the space sector. By combining the creativity from research centers with the technology development skills of commercial companies more innovative space applications may be developed through this form of technology transfer from non-space to space sectors. New ideas for products, processes or services can be submitted to ITI to apply for seed funding, technical support and help in getting the right network contacts.

A second initiative is called ESA's Networking/Partnering Initiative (NPI). The main goal is to increase interaction between ESA, European universities, research institutes and industry, resulting in spin-ins from other sectors to space applications and spin-outs from space sector to the non-space sector. Examples are consumer electronics and nanotechnology developments in non-space applications which could find an application in space technology. The philosophy behind NPI is to intensify interaction with universities in order to strengthen links with space institutions and industries. This interaction between those three parties is

facilitated by co-funding dedicated projects, giving access to facilities, providing technical support, and supporting the search for industrial cooperation partners.

A third initiative, focused on facilitating spillovers from the space sector to other sectors is the Technology Transfer Programme (TTP), which fosters technology transfer from space to non-space industries by making technologies developed for space applications also available for other industrial applications in Europe. To achieve this goal, the TTP tries to identify industrial needs and tries to link them to suitable space technologies, thus enabling companies to use space technologies in completely different domains. TTP also aims at supporting new businesses with implementing these technologies, and start-ups are provided with a network of support sources and initial funding. To coordinate these activities, the Technology Transfer Programme Office (TTPO) operates and or facilitates multiple business incubation centers throughout Europe.

5. Open Innovation Practices

To describe current open innovation practices in the European space sector, we discuss the knowledge and technology flows from non-space to space organizations and vice versa, following the model of Dahlander and Gann [5]. Moreover, value creation and appropriation activities are distinguished, to identify specific constraints and opportunities.

5.1 Flows from non-space to space sectors

Companies and agencies active in space have many incoming knowledge and technology flows, through tight cooperation, alliances or one-off relationships. Often, the larger parties in the sector mediate such technology flows, and ESA programs are typically considered the ‘end-customer’. For instance, a parts supplier explained how he contributed technology to ESA programs:

In the space industry, Dutch Space is our customer and finally their customer is ESA.

ESA is not our [direct] customer, that is a different level.

A coating supplier confirmed this long supply chain from non-space to space applications:

There is the [end customer]. Below them are a range of suppliers and usually, we are involved again one level below [those suppliers], where we have to perform our [surface] treatment.

This flow of knowledge and technology into the space sector is largely driven by the demand of ESA, as formulated in specific tenders. Respondents perceive ESA as defining the technological development opportunities, delineating the research direction and subsequently their task as technology developers is to follow this direction. This indicates a ‘technology pull’ from ESA’s side.

5.2 Flows from space to non-space sectors

As a result from the ‘technology pull’ by ESA programs, knowledge and technology transfer from space companies and space agencies to other sectors seems to be limited, at least with respect to specific technologies developed for space applications. Interviewees from established organizations in the space sector mention that government funds are shrinking, partly due to the enduring economic crisis at the time of the interviews (2011). As a consequence, they indicate that their companies should focus more on commercial space and non-space applications. Yet, they find it difficult to transform to such new domains and to get away from the technology pull from ESA and funding provided by accepted ESA tenders. One of the reasons might be that these established organizations are too much embedded in existing cooperation in the space industry, lack linkages with other parties and in fact do not identify business opportunities outside this sector. One respondent explained:

When you count the number of really novel collaborations, I feel that this is really disappointing. It is a very small world, they cooperate always with each other and then define a new project.

In this respect, small startup firms in the space sector are much more flexible, are less embedded in existing space networks and space programs, and might have learned new ways of operating, involving both tight cooperation within and outside the space sector. For instance, a respondent from a new venture which explores commercial human space flights expressed that they closely cooperated with local governments, technology providers and airlines to get their business running.

5.3 Value creation and appropriation

Companies in the space sector are heavily involved in collaborative innovation, in particular to create new technology and thus to create value. As a large player indicated:

I think that we do almost zero [innovation projects] just on our own. As partners, we also consider parties who are selected because they have particular knowledge, for instance in the area of tools or who can do particular trick with a material. Although we do not always pay them like a regular supplier, we need them to do something that we do not want to do on our own. ... Our biggest project within the R&D budget is a project in which every party brings his own funding and together we create something beautiful.

Facilitated by ESA or government funds, these joint projects form an important way of combining capabilities and competences in order to co-create knowledge and value.

An important constraint to implement more open innovation practices in the space sector is the fact that parties usually also want to appropriate the value created through cooperation. Interviewees stressed repeatedly their fear for uncontrolled knowledge leakages

to other parties who could then profit from their inventions. For instance, one technology supplier explained:

Recently, we developed a new process, to do something which is usually impossible. We have one Dutch competitor, and only a handful worldwide. So, this is something we developed completely ourselves. We did write and file a patent application, but before it became publicly available, we withdrew the application. Simply and solely to make sure that no knowledge about the invention becomes available, but at the same time we wanted to register that we were the first who invented it, in case someone else wants to file a patent [on this invention].

For small ventures, however, patents do not always help them to appropriate value from their innovation activities. They cannot afford patent litigation, and therefore they are more eager to open up their innovation process to other parties, as a founder of a recent startup explained:

We came to the conclusion that a patent is valuable as soon as we would be in trouble and want to sell [our business] to an existing company, a large company like Philips [Electronics] for instance. As such, a patent for a small firm does not help much, from our perspective. As soon as we have something new, [it is better that] we just throw it in the market, then nobody can get a patent on it. That's our strategy.

Threats for harsh competition in dividing the created value also influence the degree of cooperation and the selection of partners. If partners have clearly complementary strengths and capabilities, value can be distributed according to each other's contribution. However, too much overlap in capabilities may lead to competition, as a respondent indicated:

We are cautious with having partners with the same ambitions or capabilities. We consider potential threats in terms of increased competition, which may be a reason not to select a certain partner.

6. Main Open Innovation Constraints

These remarks by the interviewees imply a number of constraints for open innovation practices in the space sector.

6.1 One directional knowledge flows

The European space sector is mainly lined up to contribute to ESA programs, working closely together in repeated consortia and partnerships. Parties from outside the space sector are often involved as second or third tier suppliers. This is an efficient and effective way of applying new technologies up to the required development levels for space applications. Yet, as a result the ‘innovation chain’ is mainly one-directional. From an open innovation perspective – emphasizing bidirectional collaboration, knowledge and technology transfer – this is an important constraint which limits the innovative potential.

6.2 Knowledge and property management

Knowledge and intellectual property management play a crucial role in open innovation, and existing research in open innovation in general [7,28,29] as well as in the space sector [4] has not yet determined exactly which management and protection practices are the most favorable to enable both the creation and appropriation of the maximum value possible. Our interviews indicate that secrecy and ‘closed’ IP practices are important reasons that bidirectional collaboration, knowledge and technology transfer are difficult. An important condition for effective collaboration and knowledge transfer is that knowledge gets shared. Not only formal, codified knowledge should be shared, but more importantly also tacit knowledge which can be shared by personal interactions and working closely together in a certain project [30]. Many organizations, in particular the well-established parties, in the space sector are afraid of knowledge leakages and fear that other parties might appropriate the value they

created. In fact, the collaboration in the industry seems to become more closed, as an interviewee explained: “In the past, it was much more open, now it becomes more closed [innovation].” This results in less knowledge spillovers and thus also potential applications of the dedicated technologies are missed.

6.3 Role of startups and innovative small firms

We found that the role of startups and innovative small firms is not to the full extent acknowledged by the established, large players in the space sector. A manager from one of those large players explained:

[This small startup] has a completely different business model. Selling satellites via a website, I would never think it that was going to work out. ... These big players did not see [the opportunity]. These guys [from the startup] saw that narrow-band communication would easily fit on a small satellite.

These small firms are usually just suppliers to a few large space companies that have the appropriate connections, the capabilities and the systems to accept the large ESA technology tenders.

7. Recommendations to Overcome these Constraints

In response to the abovementioned constraints we see a number of opportunities, which are presented in this section.

7.1 Towards bi-directional knowledge flows

The ‘innovation chain’ in the European space sector is mainly one-directional. Bringing space technology to non-space applications has important benefits. First, this could give space technology more societal relevance, as its innovations will trickle down to customer

applications in many markets. Second, recombining knowledge through bi-directional innovation activities could bring in more ideas from other sectors. This might even result in novel concepts and identifying new technological opportunities for space applications.

7.2 Adapt knowledge and property management

Another constraint is formed by knowledge and property management in the space sector. Based on our analysis, we propose two ways in which such secrecy and IP practices could be changed. First, in government and institutional space programs, openness can be contractually enforced and/or IP rights can reside with the funding agency which then can stimulate using the knowledge more widely. Second, most dedicated technology developed for space applications could be applied to ‘earth’ products and services in other markets, ultimately increasing value appropriation by companies involved in the space sector. As our interviews suggested, many of those companies do not have the appropriate network to apply and sell their technology to business-to-business or even consumer markets outside the space sector. By intentionally creating alliances with firms in such markets, the technology could find more applications and eventually the value to be captured can even be increased by first ‘growing the pie’ in terms of multiple markets and applications and then ‘sharing the pie’.

7.3 Increase the role of startups and innovative small firms

Our analysis suggests that the role of startups and innovative small firms is less than optimal. In particular small firms seem to be able to change existing ways of working, and in particular they are much more open in sharing knowledge and engaging in bidirectional cooperation. Currently, their potential contribution to innovation in the space sector is limited to supplying their technology, parts, services and products to either commercial markets or as a third-tier supplier, which underutilizes the contribution they could make to the innovation practices in

the wider sector and further upstream directly within ESA tenders. This could be achieved, for instance, by requiring a certain degree of direct involvement of (non-space) small firms in funded projects.

7. Conclusions and Implications

This study explored how open innovation can be increased in the European space sector. As earlier studies already have shown [4,9], there are multiple opportunities for open innovation practices. In fact, most innovation practices *inside the space sector* involve multiple firms, research institutes and government agencies, and thus innovation practices require collaboration across firm borders. Given the definition of open innovation as innovation across a firm's borders [6–8], in fact most innovation practices inside the space sector have open innovation characteristics as firms frequently collaborate. This collaboration is facilitated by shared (technical) language and long-term collaboration, facilitated by large-scale projects that require long periods of time [30].

Yet, as our study suggests, collaboration with parties *outside the sector* is more difficult, due to two reasons. First, the large-scale institutional projects have the tendency to 'consume' knowledge and technology, but only in the direction from non-space to space sectors, not the other way around. That hampers mutual understanding and developing shared language and practices. Second, transfer from within the space sector to other sectors is difficult due to the lack of collaboration and mutual understanding. Only in the telecommunications industry, there are many successful applications [27] that use space technology and space data, which might be due to the exceptional reliance of the telecom sector on space applications and data.

The space sector is developing and changing, due to the influence of commercial space markets, but also because of initiatives targeting technology transfer such as ESA's

business incubation policies and related centers. Yet, the actual changes caused by commercial parties, as well as the influence of targeted policies, need to be studied in detail to evaluate these changes and policies. This study, as it is relying on interview data from a few years ago, provides a benchmark for follow-up studies that want to see what has been changed in the European space sector.

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References

- [1] C. Giannopapa, Key enabling technologies and open innovation: New impulse for the space sector, European Space Policy Institute, Vienna, 2010.
- [2] C. Venet, Space in the financial and economic crisis, in: K.-U. Schrogl, S. Pagkratis, B. Baranes (Eds.), *Yearbook on Space Policy 2009/2010*, Springer Vienna, Vienna, 2011: pp. 184–198. <http://www.springerlink.com/content/h265k54731354473/> (accessed January 31, 2012).
- [3] OECD, The space economy at a glance 2011, OECD Publishing, Paris, 2011. http://www.oecd-ilibrary.org/economics/the-space-economy-at-a-glance-2011/innovation-for-future-economic-growth_9789264113565-14-en (accessed January 31, 2012).
- [4] M. Johannsson, A. Wen, B. Kraetzig, D. Cohen, D. Liu, H. Liu, H. Palencia, H. Wagner, I. Stotesbury, J. Jaworski, J. Tallineau, K. Laïb, L.-E. Dubois, M. Lander, M. Claude, M. Shouppe, M. Gallagher, M. Brogan, N.L. Brito, P. Cyr, R. Ewing, S.D. Marcu, S. Bareksten, M.N. Suma, U. Sreerekha, T. Sharma, T. Li, W. Yang, W. Chen, W. Ricard, W. van Meerbeeck, Y. Cui, Z. Trolley, Z. Zhao, Space and Open Innovation: Potential, limitations and conditions of success, *Acta Astronautica*. 115 (2015) 173–184.
- [5] L. Dahlander, D.M. Gann, How open is innovation?, *Research Policy*. 39 (2010) 699–709.
- [6] J. West, M. Bogers, Leveraging external sources of innovation: A review of research on open innovation, *Journal of Product Innovation Management*. 31 (2014) 814–831.
- [7] J. West, A. Salter, W. Vanhaverbeke, H. Chesbrough, Open innovation: The next decade, *Research Policy*. 43 (2014) 805–811.
- [8] H.W. Chesbrough, *Open innovation: The new imperative for creating and profiting from technology*, Harvard Business Press, Boston, MA, 2003.
- [9] E.E. Richard, J.R. Davis, NASA Human Health and Performance Center: Open innovation successes and collaborative projects, *Acta Astronautica*. 104 (2014) 383–387.
- [10] K. Laursen, A. Salter, Open for innovation: The role of openness in explaining innovation performance among UK manufacturing firms, *Strategic Management Journal*. 27 (2006) 131–150.
- [11] J. Henkel, Selective revealing in open innovation processes: The case of embedded Linux, *Research Policy*. 35 (2006) 953–969.
- [12] E. Almirall, R. Casadesus-Masanell, Open versus closed innovation: A model of discovery and divergence, *Academy of Management Review*. 35 (2010) 27–47.
- [13] E. Von Hippel, Lead users: A source of novel product concepts, *Management Science*. 32 (1986) 791–805.
- [14] M. De Rond, *Strategic alliances as social facts: Business, biotechnology, and intellectual history*, Cambridge University Press, Cambridge, 2003.
- [15] K.B. Clark, Project scope and project performance: The effect of parts strategy and supplier involvement on product development, *Management Science*. 35 (1989) 1247–1263.
- [16] L.D. Browning, J.M. Beyer, J.C. Shetler, Building cooperation in a competitive industry: SEMATECH and the semiconductor industry, *Academy of Management Journal*. 38 (1995) 113–151.
- [17] W.W. Powell, K.W. Koput, L. Smith-Doerr, Interorganizational collaboration and the locus of innovation: Networks of learning in biotechnology, *Administrative Science Quarterly*. 41 (1996) 116–145.
- [18] A.M. Brandenburger, B.J. Nalebuff, *Co-opetition*, Doubleday, New York, 1996.
- [19] W. Vanhaverbeke, The interorganizational context of open innovation, in: H.W. Chesbrough, W. Vanhaverbeke, J. West (Eds.), *Open Innovation: Researching a New Paradigm*, Oxford University Press, New York, 2006: pp. 205–219.
- [20] T.-J.A. Peng, M. Bourne, The coexistence of competition and cooperation between networks: Implications from two Taiwanese healthcare networks, *British Journal of Management*. 20 (2009) 377–400.
- [21] T. Khanna, R. Gulati, N. Nohria, The dynamics of learning alliances: Competition, cooperation, and relative scope, *Strategic Management Journal*. 19 (1998) 193–210.
- [22] P. Ritala, P. Hurmelinna-Laukkanen, What's in it for me? Creating and appropriating value in innovation-related coopetition, *Technovation*. 29 (2009) 819–828.

- [23] R. Gulati, L.O. Wang, Size of the pie and share of the pie: Implications of network embeddedness and business relatedness for value creation and value appropriation in joint ventures, *Research in the Sociology of Organizations*. 20 (2003) 209–242.
- [24] K. Laursen, A.J. Salter, The paradox of openness: Appropriability, external search and collaboration, *Research Policy*. 43 (2014) 867–878.
- [25] H. Berends, E. van Burg, E.M. van Raaij, Contacts and contracts: Cross-level network dynamics in the development of an aircraft material, *Organization Science*. 22 (2011) 940–960.
- [26] A. Strauss, J. Corbin. *Basics of qualitative research: Grounded theory procedures and techniques*. Newbury Park, CA: Sage, 1990.
- [27] ASD-Eurospace, *The European space industry in 2014: Facts and figures*, ASD-Eurospace, 2015.
- [28] T. Felin, T.R. Zenger, Closed or open innovation? Problem solving and the governance choice, *Research Policy*. 43 (2014) 914–925.
- [29] A. Gambardella, C. Panico, On the management of open innovation, *Research Policy*. 43 (2014) 903–913.
- [30] E. Van Burg, E.M. van Raaij, J.J. Berends, Organizing knowledge sharing in networks: The theory, in: A.P. de Man (Ed.), *Knowledge Management and Innovation in Networks*, Edward Elgar, Cheltenham, 2008: pp. 32–53.