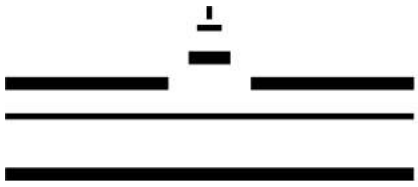

The Role of Hackers in the Open Innovation Process of the Pharmaceutical Industry

- non-confidential version -

Master's Thesis

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August 2016

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„ A good scientist is someone who succeeds in getting the different disciplines to work in harmony with one another.“

Paul Janssen, 1926 – 2003 chemist and entrepreneur

Sperrvermerk*

** Due to possible confidential information in the interviews the original version needed to be labeled with a lock flag. In order for the thesis to be readable and shareable by anyone the interviewees agreed on publishing a version which does not include the full transcripts.*

Diese Masterarbeit basiert auf internen und vertraulichen Daten der Unternehmen Roche, Leo Pharma, Novozymes. Diese Arbeit darf Dritten, mit Ausnahme der betreuenden Dozenten und befugten Mitglieder des Prüfungsausschusses, ohne ausdrückliche Zustimmung der Unternehmen und das Verfassers nicht zugänglich gemacht werden. Eine Vervielfältigung und Veröffentlichung der Masterarbeit ohne ausdrückliche Genehmigung – auch in Auszügen – ist nicht erlaubt

Preface

This thesis constitutes the end of my studies in business chemistry and reflects next to my acquired theoretical knowledge and gained practical experiences, also my passion for innovation in the life science sector. It is part of my personal quest to understand and embrace innovation and entrepreneurship. But I would like to take this moment and thank all the people who accompanied me in this exciting, inspirational and empowering time.

First of all, I would like to thank my parents who made the participation in this study course possible for me and not only were supportive in financial terms. Additionally, I would like to thank my friend and fellow student Marius Stoffels who not only during this thesis, but in all our other innovation related discussion was a great source of knowledge and inspiration.

At the department of business chemistry at the University of Münster I would like to thank my supervisor Jan-André Pramann who always encouraged my curiosity and helped with his advice and experience in all my scientific problems. Furthermore, I would like to give a special thanks to Prof. Dr. Jens Leker who enabled me to follow my curiosity within this thesis and of whom I still remember the encouraging and inspirational words in his first lectures about leadership and innovation.

As this thesis is based on my experience in a research internship abroad, I would like to thank the European Union for the possibility and financial support. Also I would like to thank the Waag Society and especially Pieter van Boheemen for the valuable experience and insights while my time in Amsterdam.

Finally, I would like to thank all the open-minded people I encountered during my research for their trust, the inspiring exchange of thoughts, concepts and ideas and most importantly for their openness.

Christian Schulz

Erlangen, August 2016

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Abbreviations

CI	Collaborative innovation
CS	Crowdsourcing
ICT	Information and communication technology
RD	Research and development
SME	Small and medium sized enterprises
SG&A	Selling, general and administrative expenses

1. Introduction

Drug discovery and the subsequent development from a first lead to a marketable product are both fascinating and full of challenges along the way to be truly innovative. Although the pharmaceutical industry is rich in talented minds, experience, infrastructure and also financial resources, it is struggling to cope with many of these challenges over the last decades and finds itself in an innovation crisis. The crisis is manifested for example in the decreasing approval rate of new therapeutics by the US Food and Drug Agency over the last 30 years. Simultaneously, research and development (RD) spending increased by 262,5 % within 10 years from 1995 to 2005.[1] The dilemma gets even more serious because of ongoing cost-cutting and cost efficiency. Facing the high odds of failure in the long process and additional the fact that only 20 % of the drugs which were successfully introduced to the market make more money than have cost in RD,[2] it seems internal RD becomes more and more a luxury expenditure with high risk of failure and less output.

As the business model of the pharmaceutical industry is straightforward [3] and traditionally rely on product innovation, the industry requires a steady flow of new drugs coming to the market. So companies are forced to find ways to compensate their internal RD inefficacies and fill their innovation pipeline.

An often used solution to do so is the acquisition of outside ideas and innovations. But because of the high risk nature of drug development big pharmaceutical firms tend to acquire mostly companies with promising late-stage products. Buying such companies promises a higher probability to come up with a blockbuster and lower risk to fail. The downside of this kind of late stage acquisition is that there seems to be a bidding war on such promising pharmaceutical small and medium sized enterprises (SME) and biotech companies. One of leaders of the industry, chairman of Sanofi Serge Weinberg, said: "*We looked at potential deals but found the asking prices to be too high for the businesses* (..)". In 2015 merges & acquisition of the pharmaceutical industry increased by 94 % in comparison to 2014 with in total $ 59.3 billion.[4] Although buying SMEs and thereby their innovations is a well-established practice and might be as well needed in

[1] Cf. Niedergassel (2009), p. 1197.
[2] Cf. Khanna (2012), p. 1088.
[3] Cf. Garnier (2008), p. 70.
[4] Cf. Abboud (2015)

the pharmaceutical ecosystem, because small firms often focus on research and do not have the capacities of production and commercialization in-house. It still remains questionable if mostly relaying on acquire outside innovation is a sustainable business model for the future. Especially seen in relation to the R&D spending of the top 20 pharmaceutical companies of $ 98 billion.[5]

Furthermore, the strategy of the pharmaceutical industry can be questioned by taking into account another expense which is undoubtedly mandatory but has grown into excess: Selling, general and administrative Expenses (SG&A). In 2006 the top 7 pharmaceutical companies spend with about 33 % of revenues double on SG&A than on RD (about 16 %).[6] Due to longer product introduction cycles companies are facing shorten product monopolies and embrace the need to overcompensate this by a tremendous sales and marketing force and find themselves in a "*fueled marketing war*".[7]

Facing a lack of internal innovation, a bidding war on external innovation and a "marketing war" the strategy, the business model as product based hightech RD company and the whole industry is under pressure. Consequently, an improving RD productivity while finding the right balance between internal and external initiatives is one key concern of all big pharmaceutical companies and their innovation management.

So addressing this key concern, several changes have redefined the innovation landscape in the pharmaceutical ecosystem over the past years. Innovation leaders started to rethink the way to innovate, opened up the firms' boundaries and stopped thinking in paradigms and categories. So for example even competitors can become brothers in arms in pre-competitive consortia. This type of collaboration showed to be useful and effective to tackle the big challenges and problems and it focuses often on the early stage of drug discovery.[8] How efficient such pre-competitive collaborations can be, demonstrate the example of the AIDS crisis. In record time the necessary HIV protease inhibitors were identified and developed through the collaboration of several companies, next to partners in government and university.[9]

Shifting from big to small partner the way to jointly generate value in the ecosystem shows also new facets. Several big pharmaceutical companies have transformed their

[5] Cf. Khanna (2012), p. 1088.
[6] Cf. Garnier (2008), p. 71.
[7] Cf. Garnier (2008), p. 71.
[8] Cf. Hunter (2014)
[9] Cf. Bunin (2011), p. 643.

way of interacting with startups. The perception shifts more and more away from solely being an object of purchase with ready-to-use innovation towards participating in the co-development and being an innovation partner. This early engagement not only helps filtering and accessing new ideas, but also can prevent to pay premium prices for later stage acquisition. This approach might give companies an competitive advantage in the ongoing bidding war. An example for such an initiative is Bayer Healthcare with its "CoLaborator" spaces. By hosting startups bench-to-bench to own employees Bayer was part of the development plenty of emerging life science startups. It further helped Bayer to attract other such institutions and "*have created a scientific community with a spirit of collaboration and entrepreneurialism*".[10]

Also Sanofi can be seen as an example for growing willingness to tap into all kind and diverse innovation sources. At the time Sanofi was cutting down its internal RD activities Chris Viehbacher, as chief executive officer at the time, describes the shift in innovation and the firms strategy not as cost issue, but furthermore he sees the potential to work hand in hand with people outside big pharma and achieve a productive interaction in the early stage RD: *"You don't really do things because it's cheaper. The reality is the best people who have great ideas in science don't want to work for a big company. They want to create their own company. So, in other words, if you want to work with the best people, you're going to have go outside your own company and work with those people […]."*[11] So in exchange for knowledge, infrastructure and even funding by these new efforts of incubators, venture capital funding, other startup related activities or even internal intrapreneurship programs big pharma is not exclusively interested in the outcome, but also highly interested in and motivated by identifying and getting to know the individual minds behind these innovations.

A challenge and at the same time a possible competitive advantage in this complex, but highly open ecosystem, is on the one hand constantly to be able to explore and discover new sources of innovations and on the other hand to find, engage and interact with new innovation players. In order to get fresh ideas and inspiration where and for whom to look for it is a good time to get off the beaten and crowded path - even if there are uncertainties and different challenges in front – and take a closer look on how other highly innovative industries deal with new, highly creative innovators, dexterously internalize their generated values, jointly create innovation and build a culture of creativity and productivity. Furthermore, this shift of how to innovate has to be

[10] Cf. Busch (2014)
[11] Cf. Vinluan (2012)

considered under the interdependency of current global trends in economics, technology and also society – which the pharmaceutical industry simply should not ignore.

In a societal model dominated by "knowledge worker"[12] and knowledge as one key economic resource Chesbrough (2003) predicted the breakdown of the monopolies on this key resource owned by large institutions.[13] After the invention of the book print by Gutenberg the beginning of the digital age - with its core technologies the computer and especially the internet – is revolutionary due to the universal accessibility and distribution of knowledge. The amount of information in data on the internet shows an exponential growth rate. In numbers Hilbert et. al estimated that alone in 2007 there were around 2.9×10^{20} bytes (298 billion gigabytes) in information and about 94 % of it in a digital format.[14] In an interview in 2010 Eric Schmidt, chairman of Google, gave an insight on this trend as *„the real issue is user-generated content"*.[15] This impressively demonstrates how technology is used to fulfill the urge of people to create, to share, to express themselves and their creativity. Additional the rise of social media and networks helps people to connect with each other worldwide and gives a variety of efficient and almost free communications tools to share on ideas or even work collaboratively on projects.

A prime example for such collaborative project is the raise of open source software with its popular showcases of Linux as operating system or the Apache web server. The power of this development approach is manifested by the dominance of open source based application in the telecommunication sector: 84 % of all mobile phones are based on the Linux-kernel of Android[16] and up to 70 % of all active websites in 2005 run on an Apache server.[17] This new world order and coherence between open source and commercialization even made Microsoft – the dominant player in the world of proprietary operating systems – to rethink their business strategy and shifted their business model recently with a focus on cloud and data management more towards services.[18] But the idea of open and collaborative project development is not exclusive to bits and bytes and starts to show success in the world of physical products as the "open hardware license" initiative of the CERN demonstrates.[19] In 2014 with Tesla

[12] Cf. Drucker (1969), p. 185
[13] Cf. Chesbrough (2003), p. x ff
[14] Cf. Hilbert (2007), p. 60
[15] Cf. Siegler (2010)
[16] http://www.gartner.com/newsroom/id/3323017
[17] http://news.netcraft.com/archives/2016/05/26/may-2016-web-server-survey.html
[18] Cf. Hillis (2016)
[19] http://cerncourier.com/cws/article/cern/46054

Motors even a car manufacturer declared its intention – maybe as publicity stunt or with hidden agendas - to open their patent portfolio *"in the spirit of the open source movement, for the advancement of electric vehicle technology"*.[20] The open source framework itself can be seen as organizational innovation and v. Hippel described it as the private-collective innovation model,[21] which involves the engagement of individual contributors and therefore taps into the creativity and problem solving skills of individuals.

Given the empowerment by knowledge distribution combined with all those trends, changes and advancements in technology researchers are predicting a democratization of innovation[22] and the rise of a whole new range of actors with the ability to innovative and push their innovation to market fueled by funding possibilities like venture- or crowdfunding.[23] One leading journalist is even claiming a "*New Industrial Revolution*" in which by technology empowered individuals are responsible for *"(...) more innovation, in more places, from more people, focused on more narrow niches"*.[24]

So with or without an actual revolution taking place the absorptive capacities of innovation systems of the pharmaceutical industry are challenged anyway. Therefore this thesis is focusing on exploring new external sources for innovations and trying to identify a highly creative and inventive group of people outside the traditional ecosystem: Hackers in the field of biotechnology and life science.

Inspired by a group of computer and internet pioneers who are constantly pushing the technological frontiers there is a formation by like-minded people in the life science area into local or virtual communities or movements, but they could also be seen as the birth of a new innovation community. The challenge in business and innovation studies therefore is to explore the community, gather information and understand these communities in order for pharmaceutical companies and other industries to leverage and internalize generated values. Consequently, an explorative study of this group needs to be conducted to get an idea about who is part of the community and why, next to what value and assets are created and are accessible. Consequently, it has to be analyzed if existing open innovation interaction processes are suitable.

[20] http://www.teslamotors.com/blog/all-our-patent-are-belong-you
[21] Cf. v. Hipple (2003), p. 209
[22] Cf. v. Hipple (2005), p. 63
[23] Cf. Chesbrough & Bogers (2014)
[24] Cf. Anderson (2012), p. 13-16;229

2. Theory and Hypotheses

2.1. Open Innovation

2.1.1. Open Innovation - a Paradigm Shift in Research and Development

Over the last few years there is term for a new approach to organize the RD activities not only in the pharmaceutical companies: "open innovation". This open innovation model coined by Henry Chesbrough refers to "*the use of purposive inflows and outflows of knowledge to accelerate internal innovation and expend the markets for external use of innovation, respectively"*.[25] As innovation from every origin are being used and all possible pathways for commercialization of innovation are being exploited the center of innovation activities is no longer the own RD department. All kind of external facilities like start-ups, academia and other external organizations are more and more in the focus of interest for the innovation process.[26]

2.1.2. Modes of Open Innovation

One key aspect to understand and differentiate open innovation processes is the direction of flow of some of the key resources of innovation: e.g. ideas, knowledge, experience and technology. Enkel (2009) was analyzing three flow directions and defines three modes of open innovation:[27]

- outside-in (inbound) → gain external knowledge
- inside-out (outbound) → bring ideas to the market
- coupled → combination of both

It is not only the flow which is characteristic for each mode, but also change of the perception where the locus of innovation and where the locus of commercial exploitation is.

In outside-in mode of enriching the firms knowledge base by external sources is dealing with the fact that in RD driven industries and a knowledge society in general the majority of knowledge relevant to the firm is created externally.[28] So as with changing dynamics and parameter of innovation the firms relay on the capability to find, absorb and integrate outside knowledge in the internal innovation process.[29]

[25] Cf. Niedergassel (2009), p. 1197., Chesbrough, H. (2006), p. 1-12
[26] Cf. Niedergassel (2009), p. 1197.
[27] Cf. Enkel (2009), p. 312
[28] Cf. ibid, p. 312
[29] Cf. Christensen (2006), p. 35

In contrary the inside-out mode is more focused on the exploitation of knowledge outside the firms boundaries.[30] It implies that the locus of the innovation not necessarily needs to be the same as the commercial exploitation. This understanding represents new opportunities for firms to intentionally open up their innovation process and benefit from internal created knowledge in several aspects. First of all, the potential direct financial return in licensing-fees and second of all, strategic non-monetary benefits.[31] So it can help firms to gain access to other markets than the original served ones. According to a quantitative study by Lichtenthaler (2007) this kind of leverage of internal knowledge can result in an increase in overall revenues.[32]

Another strategic advantage of this approach is based on cross-licensing agreements with other firms to get access on future development later on.[33] This hook already indicates how knowledge in the open innovation can be traded and thereby the flow intentionally can be used as strategic tool. Taking this to a next level and start combining both concepts in a more coordinated and focused way of co-creation it can be understood as coupled mode. Strategic alliances, cooperation, collaboration and joint ventures can be seen as vehicle for this concept with a variety of different partners.[34, 35]

2.1.2. Open Innovation – In the Pharmaceutical industry

There are plenty examples for this kind of transformation from a closed to an open innovation process which helped firms to enhance their innovation power, e.g. Procter and Gamble increased its success rate by 50 % and its RD efficiency by 60 %.[36] A survey of the Fraunhofer Institute in cooperation with H. Chesbrough with 2840 participating firms reveals that 78 % of the surveyed firms are practicing open innovation and in comparison to three years ago 82 % are practicing open innovation more intensively in their firms. Especially high-tech companies use the concept of opening up their firm boundaries, so it should be well suitable for pharmaceutical companies, too .[37] So, if most of the high-tech companies are applying open innovation, how about the pharmaceutical industry in specific?

[30] Cf. Enkel (2009), p. 312
[31] Cf. Hung (2013), p. 368
[32] Cf. Lichtenthaler (2007), p. 383
[33] Cf. Grindley (1997)
[34] Cf. Enkel (2009), p. 313
[35] Cf. Gassmann (2004)
[36] Cf. Hunter (2010), p. 87.
[37] Cf. Chesbrough and Brunswicker (2013), p. 2.

Concerning the pharmaceutical industry it has to be outlined that there is already a high level of openness. According to a study by Blumentahl et al. in the USA over 90 % of the life science companies with own RD activities formed relationships with academia. Furthermore, from 1997 – 2005 the Top 20 of pharmaceutical companies had nearly 1500 alliances with biotechnology companies.[38] And it is not only about biotechnology and startup companies – furthermore, there can be identified a biomedical ecosystem with variety of partners including: academia, nonprofit and for-profit research institutions, government agencies and disease foundations.[39]

So given this general openness towards cooperation in the pharmaceutical industry there are a few critical questions: What positive effects are motivating all the contributing partners in such cooperation? What are general problems in an open innovation process and what is the current bottleneck to fully leverage the potential of open innovation and to create a more efficient innovation process?

For the pharmaceutical industry as high-tech industry with a complex scientific background and rapid growing need for interdisciplinary knowledge this kind of open innovation process offers a lot of advantages[*]:[40]

1) shorten innovation cycles
2) reduction of uncertainty in terms of cost and risk
3) deal with regulation and industry standards more effectively[41]
4) leverage unused intellectual property
5) access to external funding mechanism
6) access to networks of talent[42]

These are the general advantages shared over all sectors, but each partner has specific benefits from cooperation. Besides a financial support and expertise, big pharma is able to supports at some of key issues of the drug discovery process in which small enterprises lack in. This includes for example infrastructure and resources like compound management, high throughput screening, clinical trials, manufacturing and marketing.[43] For example academia gains access to research resources such as high

[*] not listed in a specific order
[38] Cf. Niedergassel (2009), p. 1197.
[39] Cf. Chaguturu, Rathnam (2014), p. xix.
[40] Cf. Geum (2013), p. 211–222.
[41] Cf. ebd.
[42] Cf. Hunter (2014)
[43] Cf. Duncan (2013), p. 316.

throughput technologies, small molecules libraries and even manufacturing. The industry can support and show them how to perform the development and cost-intensive clinical testing steps. On the other side the benefits to industry next to access to new innovation are for instance a greater understanding of scientific proof of concept and valuable insights in mechanisms through academic studies and fundamental research. This kind of early stage insights allow the industry to detect new "druggable" targets.[44]

Besides all this advantages firms are facing problems in this kind of open interaction and cooperation. First of all, the flow and type of knowledge can be seen critical. For example in an industry-university survey by Leker et al. 81 % of the respondents judge knowledge sharing in such alliances as not efficient enough. Based on this survey some key issues could be identified by Leker et al.[45] A balanced and mutually flow of knowledge is only given with trustful, frequent communication between the cooperation partners. This requires a well set relationship as solid starting point for a successful cooperation. As a reason for a misbalance the traditional role of academia in the drug discovery process might be seen. For a long time academia was seen just as a resort for fundamental research and mechanistic aspects in diseases, wherefrom the results as "golden nuggets" are then chosen by pharmaceutical industry to drive its drug discovery engine.[46] But even if a solid trustful and communicative relationship as mutually partners is given, it is often neglected that certain part of the essential knowledge for the other partner can be tacit. This means it is based on experts and their experiences. So it is hard to be verbalized and to be transferred.[47]

Next to the knowledge issue it needs to be taken into account that, when the pharmaceutical industry is forming an alliance with a smaller partner as academia or for example with start-ups, two different worlds in term of culture and mindset are clashing. There are more critical aspects as only big vs. small organization structures. Start-ups have their own research culture, which is driven by creativity and risk-taking attitude. Those attitudes, their company´s values and the ongoing dynamic in this industry sector open a huge gap between them and big pharma.[48] Also in university-industry alliances such a problem occurs. Academia is focused on the creation of knowledge. Research in academia is different in matter of times and goals. Although there is no need for

[44] Cf. Without Author (2010), p. 31.
[45] Cf. Niedergassel (2009), p. 1197.
[46] Cf. Chaguturu, Rathnam (2014), p. xix.
[47] Cf. Niedergassel (2009), p. 1198.
[48] Cf. Niedergassel (2009), p. 1198.

commercialization, it has to conduct research under the harsh pressure of "publish or perish".[49]

In order to overcome those kind of problems, capture the best of all ecosystems and become more efficient in matter of innovation, big pharma developed internal and as well external approaches. Internally, several companies have reorganized their drug discovery departments into smaller autonomous startup-like units[50] and are applying startup-like methods like the Ely Lily Chorus model[51] which can be seen as kind of lean startup approach.[52] External approaches revealed a variety of different practices of open innovation such as customer co-creation, crowdsourcing, RD services, informal networking, out-licensing, spin-off activities and joint ventures.[53]

2.2. Collaborative Innovation

Not only since the creation of the explicit term "open innovation" there is tremendous amount of collaboration. Consequently, there is a variety of well documented practices for cooperation and collaboration in the innovation and management literature.

For the given innovation case of trying to interact with individuals and their communities the concept of Collaborative Innovation (CI) as one type of open innovation is of particular interest. For this reason, this concept itself and the existing literature should be reviewed with a strong focus on the pharmaceutical industry and afterwards some examples for key practices should be briefly outlined and explained.

Collaboration in terms of business organization is defined by Thomson et al. as *"a process in which autonomous or semi-autonomous actors interact through formal and informal negotiation, jointly creating rules and structures governing their relationships and ways to act or decide on the issues that brought them together; it is a process involving share norms and mutually beneficial interactions"*. [54]

To analyze this definition of collaboration step-by-step might be beneficial to adapt that knowledge and insights later on. The first question is: Who in the pharmaceutical

[49] Cf. Niedergassel (2011), p. 145.
[50] Cf. Duncan (2013), p. 315.
[51] Cf. Owens (2015), p. 17-28.
[52] Cf. Eisenmann (2012); Cf. Blank (2013)
[53] Cf. Chesbrough and Brunswicker (2013), p. 2.
[54] Cf. Thomson (2009), p. 24-25.

ecosystem are the actors in such a relationship? Analogous to open innovation, the leading actor is big pharma with partners in academia, other public institutions and in the rapidly growing sector of tech start-ups. But also industry-industry collaborations are more and more common, which is a real paradigm shift in such an otherwise competitive industry.[55]

This increasing variety of possible partners in collaboration is challenging to handle, so there is a need for specific models for all those combinations and alignments. But as complex the science is in such collaborations as specific each collaboration itself is. So there is no standard out of the box solution.[56] But accordingly to the definition of collaboration this is not necessary, because "(..) *jointly creating rules and structures* (..)" indicates that partner can liberally create their adequate model by negotiation.

The focus of the collaboration is addressed by the part "(..) *on the issues that brought them together*". In contrast to traditional cooperation modes the focus is wider. Instead of creating a project with a joint task-force to solve just one particular problem, today more and more collaborations are bonded to follow higher or different goals. Higher goals are innovative, complex projects which are too big for just one company. By different goals it should be outlined that for example the current market driven approach[57] and "low risk and high reward" attitude[58] of the pharmaceutical industry in drug discovery is not suitable for neglected and rare diseases such as malaria or tuberculosis.[59] These therapeutic areas are seen as non-commercial viable for the traditional pharma business model.[60] So far this gap was filled by the research of academia and nonprofit-based disease foundation.[61] Thus those partners shared incredible valuable scientific contributions, their discoveries need the pharmaceutical industry and its drug development capabilities to turn them into viable medicine.[62]

Here collaboration can be seen as driving factor and evidently there appears to be a pooling of resources in an open and collaborative environment in order to finally take the fight against those diseases.[63] This trend is further pushed by financial support of

[55] Cf. Wild (2013), p. 2749.
[56] Cf. Wild (2013), p. 2750.
[57] Cf. Bhardwaj (2011), p. 479.
[58] Cf. Chaguturu, Rathnam (2014), p. xxii.
[59] Cf. Ekins (2013), p. 267.
[60] Cf. Duncan (2013), p. 316.
[61] Cf. Chaguturu, Rathnam (2014), p. xxii.
[62] Cf. Chaguturu, Rathnam (2014), p. xx.
[63] Cf. Duncan (2013), p. 316.

charity in this area (e.g. Bill Gates Foundation).[64] To name two collaboration in this therapeutic area there are: CDD and HEOS, which are both based on the idea of sharing research data and finding adequate partners. Interestingly, collaborations are most advanced in this kind of rare and neglected diseases, in which funding contribution from public sources is high, potential profits are estimated low and all contributing partners show a high willingness to share data and IP with another.[65]

At first sight in an industry, in which IP is essential as competitive advantage, it seems unreasonable to share any information and data at all with anyone. This is based on two assumptions: possession of data especially in the early stage is a real competitive advantage and such a closed innovation process is bringing the appropriate return of investment.[66] The latter one is obviously doubtable in consideration of the current RD crisis. Also the first one is at least questionable and should be re-evaluated.[67]

The definition further emphasizes that the process involves shared norms and mutually beneficial interactions. Norms are the rules of behavior arising from the ideology of the team members, which reflect their values.[68] It is similar to the cultural criteria as mentioned in the open innovation chapter. Only if both partners are adapting norms as well as their mentalities and culture the collaboration can be successful. The same applies for interactions in the collaboration. Possible benefits require both partner to actively work for a collaboration. A major misconception here is that all collaborations require direct funding. For example, a lot of researchers in academia are motivated by tangible and intangible benefits such as access to tools, reagents and expertise.[69]

In conclusion, the key of CI is the shift in the relationship between big pharma and its innovation partners, bridging the above mentioned gaps between all sectors and create an innovative ecosystem which both support and enable collaborations.[70] For this purpose, CI is not only about the proactive use of intellectual property and resources as input or output of its RD as in traditional open innovation mode.[71] It is more about working together in symbiosis to unleash each other's innovation power.

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[64] Cf. Duncan (2013), p. 316.
[65] Cf. Ekins (2013), p. 267.
[66] Cf. Hunter (2014)
[67] Cf. Ekins (2013), p. 267; Barnes (2009) p. 707
[68] Thistlethwaite (2012), p. 22.
[69] Cf. Hunter (2010), p. 88.
[70] Cf. Without Author (2010), p. 27-28.
[71] Cf. Hunter (2014)

2.3. Crowdsourcing

One practice that aims to harness the masses and make any kind of knowledge and even individuals as its source accessible to organization is crowdsourcing (CS). Although the term itself was coined relatively recently by Howe (2006),[72] there is already a variety of examples in practice and definitions in the literature. In study Estellés-Arolas et al. developed an integrated definition of crowdsourcing[73]:

"Crowdsourcing is a type of participative online activity in which an individual, an institution, a non-profit organization, or company proposes to a group of individuals of varying knowledge, heterogeneity, and number, via a flexible open call, the voluntary undertaking of a task. The undertaking of the task, of variable complexity and modularity, and in which the crowd should participate bringing their work, money, knowledge and/or experience, always entails mutual benefit. The user will receive the satisfaction of a given type of need, be it economic, social recognition, self-esteem, or the development of individual skills, while the crowdsourcer will obtain and utilize to their advantage that what the user has brought to the venture, whose form will depend on the type of activity undertaken."

Key aspects to understand the possibilities of crowdsourcing projects are that there are several kind of tasks which can be given and performed by individuals. These tasks can vary according to complexity and degree of involvement integration in the value creation or innovation process. Next to the actual task the study of Estellés-Arolas pays close attention to other key elements in crowdsourcing: initiator, crowd and process.

The process of engaging with the crowd and leveraging it includes ways to raise awareness, communicate the task, absorb the work efforts, but also transfer the return to the individuals. This can be achieved by a web-based communication platform. An example for such a platform and its process is the nowadays non-pharma specific platform Innocentive.[74] This CS platform has been started in 2001 by the pharmaceutical company Eli Lilly. It happened "*out of frustration of the officials that despite their massive scientific staff they couldn´t solve certain problems*."[75] An experiment of Roche Diagnostics shows what impressive results such a tool can produce: first, six problems were posted internally to more than 2,400 people in the firm of which only less than 20 % participated. The internal result was 50 proposals with just

[72] Cf. Howe (2008)
[73] Cf. Estellés-Arolas (2012)
[74] Cf. Wild (2013), p. 2749.
[75] Cf. Travis (2008)

one remarkable one. Then, in comparison the external approach using Innocentive with just one single problem, the company was struggling for over 15 years, delivered over 113 detailed proposals by 1000 readers.[76] Eli Lilly with its phenotypic drug discovery project PD2 can be named as example of non-web based CS in the pharmaceutical industry. It enables scientists to screen their compounds against phenotypic, diseases-relevant assays.[77] Doing so within only a few years Lilly created a network with 70 small biotechnology companies and 174 academic institutions. Motivated by this success Lilly initiated another similar project called TargetD2. Interesting about this approach is the handling of IP issue, because the investigators retain their IP right.[78] Other companies start to launch their own platforms such as Grants4Targets of Bayer Healthcare, Pharma in Partnership program of GlaxoSmithKlines[79] or the two already mentioned platforms Collaborative Drug Discovery CDD and HEOS.[80]

Although everyone could start a crowdsourcing project, typically initiator are companies who need to solve a certain problem, get a particular job done or source new ideas. A reason for this could be the necessary resources which have to be allocated to start and successfully guide such projects. The engagement and communication requires time and in cases of monetarized challenges even prize money. Therefore the business model of Innocentive - as now independent entity - is based on this need and problem. As an idea and problem-solving intermediary it is selling companies the access and infrastructure to a broad and diverse audience. About the audience the literature agrees on the motivation aspects to be of intrinsic and extrinsic factors, but there is an ongoing debate about demographic information and in particular if the crowd consists more of amateurish participants than professionals.[81, 82] A study of Saxton (2013) revealed that it depends on the nature of the used crowdsourcing model and the task.[83] So crowdsourcing should not be seen as a new form of cheap outsourcing.

Even if the existing systems showing positive results, it might be reasonable to challenge the method: Whether the current models of crowdsourcing are leveraging the full potential of the crowd? If they are suitable and attractive to reach the kind of people who are skilled, creative or passionate about a task and who would be valuable partner?

[76] Cf. Hunter (2014); cf. Birkinshaw (2009), p. 17.
[77] Cf. Wild (2013), p. 2749, cf Hunter (2014)
[78] Cf Hunter (2014)
[79] Cf. Wild (2013), p. 2749.
[80] Cf. Ekins (2013), p. 267.
[81] Cf. Brabham (2012)
[82] Cf. Lakhani (2007)
[83] Cf. Saxton (2013)

2.4. Hacker

2.4.1 Etymology and Definition

To immediately deal with stereotypes about hacking, it seems helpful to understand where this term aroused and to what activities and intentions it includes. According to the self-given community dictionary and compendium called "Jargon file"[84] - which is since it was first published in 1975 by R. Finkel at Stanford under constant debates and updates - originally a "hacker" was considered someone who makes furniture with an axe. The key element about this is that it is about the talented and creative use of tools.

The use and strong connotation to technical fields is better understood through the chronologic development which is well described by Levy (1984). It was in the late 1950s in a subcommittee of the Signal and Power department called Tech Model Railroad Club at Massachusetts Institute of Technology the term "hack" and "hacker" was first used in a broader technological context.[85] Till today this group advocates for their original meaning of the word to describe a "hacker" as "*someone who applies ingenuity to create a clever result, called a hack.*" Levey describes the emergence of the term as young students of this group started to divert all kind of electronical parts like telephone switches from its intended use, but to control model trains instead.[86] They called themselves "hackers" with a feeling of pride for which you need to qualify by coming up with "hacks". Their criteria for a "hack" were:

> *"the feat must be imbued with innovation, style and technical virtuosity"* (Levy)[87]

The system of controlling model trains was a perfect technical playground[88], so it was not a wonder that the first computers - which were at that time mainly used for calculation and had limited access - have been re-appropriate to be hacked as well for this reasons. This was the first touching point for many engineers and the fascination about the opportunities quickly spread and grew a community. What started as playful interaction with technology in this particular and other hacker communities was the source of many innovations like the first computer game, the personal computer or the internet.[89] Due to this origin around the connotation towards computer technology is comprehendible.

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[84] http://www.catb.org/jargon/html/H/hacker.html
[85] http://tmrc.mit.edu/hackers-ref.html
[86] Cf. Levy (1984), p. 8.
[87] Cf. Levy (1984), p. 10.
[88] Cf. Levy (1984), p. 9
[89] Cf. Levy (1984), p. 39, p. X

But instead of appreciating hacker for their help in technological progress, there is a wide spread bad perception in the general public. A "hacker" is typically seen as "*a malicious meddler who tries to discover sensitive information by poking around*" (Jargon file)[90]. This bad reputation can be traced back to news coverage in the 1980s.[91] The way of news coverage in a sensational way about computer crime leads not only the general public perception of hacker, but also scholars placed hackers in the context of deviance, crime or the expression of an obsessed user subculture with gang mentality. Researchers invariably situate hackers in the field of computer network security.[92]

This trend might be fueled by the urge of hackers to "*having an intimate understanding of the internal workings of a system, computers and computer networks in particular.*"[93] It cannot be denied that even "true hacker" crossed lines in terms of legal understanding. An example is one of the early hacker named J.T. Draper alias Captain Crunch who exploited a loophole in the telecommunication system to gain free phone calls worldwide by using a children-whistle to imitate a signaling frequency. These hacking activities are called phreaking and are a good case to discuss the intention of hackers. Mostly it was the pure urge to discover and explore without doing harm. In an interview in 1971 about the time J. Darper got both famous and arrested by the FBI and sentenced to five years in prison for his activities. He said this about his intention:

"(...).I do it for one reason and one reason only. I'm learning about a system. The phone company is a system. A computer is a system, do you understand? If I do what I do, it is only to explore a system. Computers, systems, that's my bag. The phone company is nothing but a computer."[94]

Due to the rise of the internet and the fact that computer run our modern world, the possibility to do harmful, dangerous or criminal things with a computer is strongly attached to the term "hacker" and "hacking". It goes as far as politicians framing hackers as more dangerous as terrorists.[95] Understandable there is an effort to distance oneself from this negative reputation. So both the Tech Model Railroad Club and the community-based definition in the jargon file are doing so and emphasize the benevolent meaning of the term.[96] In order to overcome that problem other terms were coined which try to differentiate between "hacker" with harmless intention and so called "cracker" who illegally obtain access to systems and use it with bad intentions. E. Raymond differentiates these two in an essay about "hacking" as following:

"The basic difference is this: hackers build things, crackers break them."[97]

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[90] http://www.catb.org/jargon/html/H/hacker.html
[91] Cf. Marbach (1983)
[92] Cf. Lin (2007), p. 36
[93] http://www.catb.org/jargon/html/H/hacker.html
[94] Cf. Rosenbaum (2011)
[95] Cf. Medosch (2001)
[96] http://tmrc.mit.edu/hackers-ref.html,
[97] http://www.catb.org/~esr/faqs/hacker-howto.html

Besides that, there is a differentiation by using the terminology of "white", "grey" or "black" hat hacker which aims on the different intention in adherence to the law and a clear criminal intent.
Considering all these different uses and perceptions of the term "hacking" the view of computer scientist B. Harvey (1985) in response of the negative news coverage argues that the discussion about *"true"* meaning about "hacking" is *"silly (...), as the word will mean whatever people use it to mean."*, but still an understanding of the etymological history may help to understand this social phenomena.[98]

Therefor two definitions have been selected which should not be seen as complete nor representative, but they should function in this thesis as foundation to scope an definition for hacking / hacker during the research process:

(1) "One who enjoys the intellectual challenge of creatively overcoming or circumventing limitations."

(2) "To interact with a computer in a playful and exploratory rather than goal-directed way."

Both express the playful, explorative and creative way of hacking. In contrast to the other one definition (1) addresses the intent of the activity more clearly by speaking about a "challenge" and "overcoming or circumventing limitation". This includes both problem solving and advancing technology. Definition (2) is limiting "hacking" to computer as medium or technology of choice which has to be seen critical. In the spirit of "hacking" limitations have to be overcome and as indicated it seems applicable to use the term "hacking" in connection with all kind of systems and technologies like biology.

2.4.2 Sociology, Ethics and Attitudes of Hackers

Hackers are often framed to be a subculture, but this can be seen critical. There are a lot of aspects advocating this classification: shared roots, shared interest in technology, identification with group, development of own common language or slang, shared values and norms.

But for example Lin outlines critically in her study not to constantly overstate the group as homogeneous.[99] Also Voiskounsky et al. show, while using the terminology subculture, that it consist of various subgroups depending on expertise, areas of interest and behavior patterns.[100] Turgeman-Goldschmidt notes that speaking about the hacker culture is as fuzzy as the definition about hacking itself.[101] The Jargon file developed and maintained by the members themselves gives an interesting self-evaluation:

[98] https://people.eecs.berkeley.edu/~bh/hacker.html
[99] Cf. Lin (2007), p. 35
[100] Cf. Voiskounsky (2003)
[101] Cf. Turgeman-Goldschmidt (2008)

The 'hacker culture' is actually a loosely networked collection of subcultures that is nevertheless conscious of some important shared experiences, shared roots, and shared values. It has its own myths, heroes, villains, folk epics, in-jokes, taboos, and dreams.[102]

In any case it is not the dedicated task of this research to categorize this complex phenomena as culture, subculture, counterculture, movement or community. In this thesis the term community will be used because focus will be about interaction with local groups with face-to-face interaction in physical places named hackerspaces. According to N. Farr (2009) hackerspaces are "community-operated physical places where people can meet and work on their projects". An early pioneer of hackerspaces J. Ohlig referred about it like this in an interview:

"An alternative educational institution, a place where people can learn about technology and science outside the confines of work and school. It´s where people build things because they want to, not because they need to make money." [103]

The formation of the first hackerspace was in 1995 with the foundation of c-base in Berlin.[104] The idea of creating such local spaces quickly spread all over the world and according to hackerspaces.org - the global database for hackerspaces – there are around 1262 active places and 352 currently in the planning. Although it seems widespread according to Kostakis (2014), this phenomena of individuals with strong emphasis on technology and experimentation was subject of only a few studies yet.[105] One was a study by Moilanen (2012) which revealed the motivation of members. Their participation was driven by intrinsic factors such as: communication, interaction with other members, learning, community commitment and fun. He also stresses that next to sharing infrastructure the social aspect plays an important role. [106]

Local hackerspaces can be identified as communities as they meet sociological criteria defined by R. Redfield [107]: Distinctiveness, smallness, self-sufficiency, homogeneity. Distinctiveness means that each local hacker community can be clearly distinguished from other community. People identify themselves with the community and feel a sense of belonging. Smallness implies not a certain number of members, but more a sense of people knowing each other. Self-sufficiency is expressed in the definition of being community-led and therefore to be economically and socially autarkic. The aspect of homogeneity not necessarily equals that people having the same background. F. Tönnies described already in 1887 the possibility of being part of a community "des Geistes" in contrast to blood relation or geographical ties.[108] The central role here are certain believes, values and moral standards. All this is manifested in the "Hacker Ethic"[109]:

[102] http://www.catb.org/jargon/html/introduction.html
[103] Cf. Sanchez (2014), p. 12
[104] Cf. Farr (2009)
[105] Cf. Kostakis (2014)
[106] Cf. Moilanen (2012)
[107] Cf. Redfield (1989), p. 4.
[108] Cf. Tönnies (1887)
[109] Cf. Levy (1984), p. 27-39.

- *Access to computers—and anything which might teach you something about the way the world works—should be unlimited and total. Always yield to the Hands-On Imperative*
- *All information should be free*
- *Mistrust authority—promote decentralization*
- *Hackers should be judged by their hacking, not criteria such as degrees, age, race, sex, or position*
- *You can create art and beauty on a computer*
- *Computers can change your life for the better*

Levy conceptualized the "hacker ethic" out of everyday practice and created a mix of aesthetic and pragmatic imperatives. This includes "*the commitment to information freedom, mistrust of authority, heightened dedication to meritocracy and the firm belief that computers can be the basis for beauty and a better world*."[110]

2.4.3 Hacker as Innovation Community

Next to this set of moral, E.S. Raymond summarizes in an essay about "How to become a hacker?" the attitudes of hacker[111] which are interesting from an innovation perspective:

- *The world is full of fascinating problems waiting to be solved*
- *No problem should ever have to be solved twice*
- *Boredom and drudgery are evil*
- *Freedom is good*
- *Attitude is no substitute for competence*

In the same essay he mentions that *"creative brains are a valuable, limited resource."* So it might be interesting for innovation management to tap into this resource and to engage with these creative people with such a specific mindset or even to jointly create value. One concept suitable for this might be "Innovation communities".

Gerybadze outlines in his development of a definition that for innovation in general there is a need for novel reconfiguration and this unites individuals to groups. He differentiates that the goals of these formed communities can either be exclusively focused on the development of an innovation or see the innovation as product along the way of other tasks.[112] In his work he is focusing on groups who prioritize the development and implementation of innovation. Hacking communities seem not to be primarily driven by the development and implementation in a classical business way, still they are technology-driven and seem highly motivated to push technology forward.

[110] Cf. Coleman (2013), p. 17.
[111] http://www.catb.org/esr/faqs/hacker-howto.html#attitude
[112] Cf. Gerybadze (2003), p. 147.

According to Gerybadze other concepts like innovation or technology networks which only represent maps of relationships misses the intensity of the innovation pursuit, the cohesion of the group and most importantly the collective understanding. Also he emphasis the presence of the concept about intergroup-relation. This allows members of the group to form strong interdepend relationships with other groups, but structure themselves among each other in groups of identities with a common ideology.[113]

There are three differentiate types of innovation communities, which is based on the focus of the community. As hacker communities is not focused on doing fundamental research, nor on production and process technology, it is more categorized in the user-induced innovation community which is focused on functionality of technology and the exploration of latent needs.[114] As example the ICT hacking community was leading the development of computer games or sound systems.[115] The hacker community used a technology which was focused on working needs like calculation to serve the latent need of entertainment. Or as described in study by Flowers about hackers as so called "outlaw users" in the context of user driven innovation. He defines the outcome as "outlaw innovation" because the tinkering process of the hackers includes violations of intellectual property rights. This study again focused on ICT innovation and emphasizes in its outlook that non-ICT industries would be of research interest.[116]

Leaving the outlaw character aside as special case - but if in general hacker communities can be categorized as innovation communities and companies start to see them as potential innovations partner this raises the question about importance factors and implications for the innovation management. Fichter outlines in his work several key characteristics. First of all, stimulated by work of Witte (1973), Hausschildt and Gemünden (1999), he highlights the important role of the promotor model in such cross organizational setups. Secondly, he puts focus on interpersonal relationships which are driven by informal networking processes. He relates the capility of an innovation community to the level of trust and the personal relationships present between the promotors of different partner. He emphasizes the finding of Gerybadze (2003) on the perception and understanding as one crucial success factor.[117]

2.4.3 Biology as one new Technological Focus of Hacking Communities

Analogical to hacking in the ICT there is a novel and interesting stream to be observed which approaches biological systems in a playful, creative and interactive way: biohacking. Interestingly there is a synonym "Do-it-yourself Biology" (or "DIYbio") widely in use which seems to try to overcome the bad connotation of hacking about

[113] Cf. Gerybadze (2003), p. 148
[114] Cf. Gerybadze (2003), p. 150.
[115] Cf. Levy (1984),p. 39-61, p. 21
[116] Cf. Flowers (2008), p. 178
[117] Cf. Fichter (2008), p. 7-8.

criminal activities and the relation to ICT. Either way both try to "*break down institutional barriers and bring science to the people.*"[118] So like the ICT hackers tinkering for ways to generate access to computers, biohackers try to increase the accessibility for biotechnology. Consequently, there might be a rise of innovators at private homes in kitchen, garages or basements and in local community labs all over the world like it happened during the last 50 years in ICT. These labs are also called biohackerspaces and there are already 87 of them listed on DIYbio.org (July 2016). The subject itself was focus of only a few studies from several perspectives: Kera[119], Delgado[120], Landrain[121], Ledford[122], Bennett[123], Delfanti[124], Keulartz[125], Seyfried[126] and Penders[127] This thesis should focus on the innovation management perspective on this novel phenomena.

[118] Cf. Alper (2009)
[119] Cf. Kera (2014)
[120] Cf. Delgado (2013)
[121] Cf. Landrain (2013)
[122] Cf. Ledford (2010)
[123] Cf. Bennett (2009)
[124] Cf. Delfanti (2012)
[125] Cf. Keulartz (2016)
[126] Cf. Seyfried (2014)
[127] Cf. Penders (2011)

3. Research & Methodology

3.1. Research Context

To frame the research and the motivation of the researcher it is necessary to understand the evolution of this explorative research endeavor. The researcher himself was initially interested in what the life-science industry could learn from the ICT industry to become more innovative and to fertilize entrepreneurship. His interest was from the start into physical places of interaction to thrive both innovation and entrepreneurship. With a special focus on the life-science industry he examined startup incubators, accelerators and even more collaborative models in a seminar thesis. But to his opinion all this models have in common that they were focused on the development of already existing ideas and consequently were already one step ahead. So next to well-known and examined sources of innovation like RD departments and university laboratories he was interested in alternative and more unconventional places. The personal encounter with the model of hackerspaces as physical place for the interaction of people with technology in an open and social atmosphere raised his personal and research interest. This was intensified after realizing such places are existing for life-science technologies and tapping into the relatively young community.

After visiting a few of such places he took the initiative to experience and learn more about this on a practical level. He became a research intern for four months at the Waag Society in Amsterdam at their Open WetLab. With his background in business chemistry, but also in chemistry and screening microbial sources for new drug candidates he was responsible for the project development of "BioStrike" – an collaborative and open antibiotic research endeavor of several DIY biology communities worldwide. Meanwhile his task he asserted that the project was missing an important link to the pharmaceutical industry in order to push it to make any scientific and societal contribution accessible. By consulting the innovation and management literature for practical advice to deal with this unconventional collaboration he recognized that it was not in focus of research so far – neither in the ICT ecosystem nor in the biology or life-science. Consequently it is to his knowledge an unexplored practice. This lack of experiences and recommendation for both parties has consequences on the ability in how to initiate, set up, run and evaluate such interaction. In discussions he experienced that representatives of the pharmaceutical industry showed strong interested in the hacker community in general and their way to approach the problems. But in the follow-up the potential upside of being unconventional seemed to be also the downside at the same time. The lack of uncertainty and experience seemed to kill most of the initial momentum. So he was not able to initiate any collaboration for the project he was responsible for.

3.2. Research Question

Therefore the motivation of this research was to explore and illuminate the phenomena biohacking and their local communities. At the beginning the focus was on understanding the motives and profile of people engaging in this communities. Next to that the physical place as locus of ideas and inventions should be examined. Another part of this research step was to explore and estimate other potential valuable assets for the pharmaceutical industry like creativity and problem-solving skills. After developing an understanding of these communities and a first evaluation of their potentials as collaboration partner it should be possible to test existing interaction models for suitability. The overall goal of this research is to help both parties to engage and interact together in valuable and business-oriented interaction. This is necessary to make the proposed values in such communities fully accessible for society.

These motivations are concluded and formulated in the following research questions:

1) *What are the profiles and the motivations of the people engaging in local biohacking communities?*
2) *What are values and assets of interest for the pharmaceutical industry in local biohacking communities?*
3) *How can the pharmaceutical industry engage and interact with local biohacking communities in order to internalize values and assets?*

3.3. Research Design – Exploratory Study

In general there are several different research designs, but for the given challenge an exploratory study seems to be the most appropriate choice. Exploratory studies are the research design of choice, if at the beginning of the research there is a lack of clarity of the problems faced on the way and if important variables may not be known or thoroughly defined. This is the case due to the novelty of the whole phenomena hackerspaces – especially in the context of management and innovation studies. Exactly for this context it helps to build a first basic understanding of the problem by obtaining insights. It should be strongly stressed out that the findings based on this research design should not be the basis for decision-making. The immediate purpose of exploration is much more the development of first concepts and operational definition. The most significant benefit of this research design is to help in a quick and cheap way to draw conclusions about the question whether and about what future formal research should be conducted.[128]

The essential consequence of choosing an exploratory design is the degree of structure which tends to be more loose which is comprehendible due to the fact that the problem

[128] Cf. Cooper (2014) p. 126; p. 129-130.

itself is clear and research might adapts accordingly. About the type of techniques used to accomplish the exploration the researcher benefits again of freedom to operate freely as both qualitative or quantitative methods are applicable. Although most of the exploration in its nature relies more heavily on qualitative methods.[129] These granted degrees of freedom in structure and data collection method was applied in this research setup. In the following the research development and process over time, the subsequent use of different methods including intention to help finding answers for the the research questions will be outlined.

3.4 Research Process and Methods

3.4.1 Participant observation

Due to the exploratory nature of the research first simple observations in a unstructured way were conducted. This method and the obtained insights were intended to serve as starting point for further exploration and to generate hypothesis for more a structured approach. The focus of the observation was not to dive directly into business interaction, but to gain basic understanding of the phenomena. The researcher gained access to his observations by working as a research intern at the Waag Society in Amsterdam from February 2016 till the end of May 2016. In the following two different kinds of observations should be outlined exemplarily: a weekly, free of charge community event and a ten week in depth training course with costs.

Dutch DIYbio Community

During this time he was responsible for the co-organization of the weekly open evenings of the Dutch DIYbio Community [130]every Tuesday from 6 pm till 10 pm. This format was hosted at the Open WetLab of the Waag Society and allows the general public to freely access and use the well-equipped biology laboratory for their projects. The visitors were able to use consumable and material of the lab up to certain extent free of charge. There was no fee and no background knowledge about biology necessary to attend to these open evenings. The format of these events was design in a four week project cycle in order to foster collaboration on community projects.

Therefore the researcher in his active role as co-organizer, supervisor and himself as community member perceived firsthand observations about the background, motivations and experiences of the community. The observer-participant relationship has to be seen as direct as there was interaction with the group. Additionally, both the presence of the observer and his role as research intern was known as every open evening open with a round of introduction of all present people.

[129] Cf. Cooper (2014) p. 126; p. 129-130.
[130] http://www.meetup.com/de-DE/Dutch-DIY-Bio/

Biohackacademy

Meanwhile his research stay there was also the Biohackacademy. An 10-week educational course on the basics in biotechnology took place at the Waag Society. It syllabus consists of building the open-source lab equipment and teaching the basic techniques and protocols to interact with biological matter. The program costs a participation fee up to 2000 Euro and are two full week days either in Amsterdam or remotely via video streaming of the lectures and online support. The participants do not need any prior knowledge to enroll in this program.

Therefore the researcher was able to observe the participants and their developed projects over the period of the course and to access their backgrounds and motivations in several private talks. In this case the observer-participant relationship has the be seen as direct but only in form of passive observation by working next to each other on projects or by attending on project presentations. The presence of the observer and his role as research intern was known by the participants.

3.4.2 Questionnaire

Next to simple observations the first more structured approach of getting an understanding of who is engaging in local hacker communities and such activities with focus on the life-science was a questionnaire (Appendix). The questionnaire was conducted at two different beginner events on two different occasions and places with a total sample size of 49 participants. The focus was on background and initial motivation of the people getting interested in biohacking activities. Furthermore, the questionnaire should quantify the intensity of people interacting with technologies and science in their spare time, evaluate if people tinker on their private projects and if their professional work ever benefited from these private activities.

Table 1: Beginner events as occasion for the questionnaire

Name of Event	Date	Place	Organization	Cost	Description of event	Received questionnaire
Hacking Health Biohacking: Become Gene Scientists In One Day	12. March 2016	Gläsernes Labor, Berlin	Hacking Health Community Berlin	42 Euro	Workshop about the fundamental practical skills in genetic – gen extraction, isolation, PCR analyzes and gel electrophoresis	33
Do It Together Bio #14: Genetic Modification	22. March 2016	Open WetLab, Amsterdam	Waag Society	20 Euro	Workshop about fundamental practical skills in genetic editing	16

As it aimed at initial motivation the questionnaire was handed out by the researcher right before the actual events started. At event in Berlin this was done by an short announcement about his research on "biohacking in the context of innovation management" in front of all participants, the voluntary and anonymous character of the questionnaire was emphasized and the participants had the possibility to ask questions while completing it. Due to organizational issues such a structured approach was not possible at the event in Amsterdam. The questionnaire was handed out to individuals at the door of the event with a short introduction about the topic of research. The voluntary and anonymous character was also emphasized, but the participants had no possibility to ask question while completing the questionnaire. Furthermore, the researcher disclosed that he was working for the hosting organization, but the purpose of this questionnaire was a only for research purposes.

In terms of validity and reliability this questionnaire has to be seen critically because of several issues. First of all, the setting and the environment of both communities attract a certain target group. As well as the events were workshops and beginner events where the people who attended are not necessarily active members of a community. Nevertheless the purpose of the questionnaire was not to obtain quantitative, reliable data, but more to sharpen the scope and test first hypothesis about motivations.

3.4.3 Interviews

As main source of primary data of this exploratory study seven interviews were conducted. The approach was split in two separate rounds. In the first round four influential people of the biohacking community were interviewed in order to follow and investigate hitherto findings in the research about biohacking in general, the engaged people and their communities, but also to explore the matter of interaction with the pharmaceutical industry. After that in the second round three representatives of the industry were interviewed to explore their perception of "hacking", the awareness about as potential interaction partner and the possibilities to interact with them.
The overall approach benefited from discovery of two showcases of such collaboration and the possibility to interview both counterparts of two existing collaborations. This allowed both to compare the singular cases from the perspective of both parties.

Table 2: Overview on existing industry-biohacking communities collaboration

Industry Partner	Community Partner	Name of Collaboration	Objective
Roche France	La Paillasse	Epidemium http://www.epidemium.cc/	Open big data challenge as initiative on cancer epidemiology
Novozymes	Biologigaragen	Baessy http://biologigaragen.org/baessy	Open source hardware prototyping on measuring bioethanol during Fermentation

It has to be noted that this circumstance also might be a weakness in the approach, because the participants might be biased and tend to speak in idealization, overemphasize their experiences and trivialize problems due to their invested time and money. So such a possible conformation bias of the interviewees need to be taking into consideration while analyzing the interviews and rating the overall reliability. Also a researcher bias could not be eliminated completely, because of the preconception of his research and his personal involvement the researcher might have tended to influence the conversation unwillingly. The researcher was aware of this possibility and tried to minimize them by creating the surrounding for the interview as neutral as possible for example by using neutral questions and keep discussion to a minimum. Additionally the approach of the researcher and the introduction of his research to his potential interviewees was kept as brief and general as possible. It was referred to investigating "biohacking and its implication on the open innovation processes in the pharmaceutical industry" or in case of existing collaboration he expressed interest in this approach.
The interviews were semi-structured and were adapted accordingly in case of existing collaboration to the answers of the counterparts in the biohacking community or in general during the course of the interview. Consequently, instead of general questions the researcher was able to ask more specific questions on valuable insights and to focus on key issues in the collaboration like process design, benefits and faced problems. Five interviews were conducted via telephone, one face-to-face and one via video-meeting. The interviews were recorded and transcribed verbatim. Both the interviews and the transcripts are attached to this thesis.

For the evaluation of the transcribed interviews directed content analysis was applied to see if existing innovation frameworks are suitable or have to be extended for coping with such business-community interaction. As directed content analysis relay on existing theoretical frameworks as starting points, the concepts of crowdsourcing and collaboration management for business-business and business-academia collaboration were picked and relevant codes developed. Following themes and categories were developed: hacking, crowdsourcing, value creation, community and culture, partner perception, interaction benefits, interaction problems and challenges, process design.

In the following the sampling criteria for both rounds of interviews should be outlined. Before doing so the use of purposive sampling should be disclosed, critically reviewed and explained. Purposive sampling was chosen because the nature of explorative study is not to generalize findings, but to explore phenomena and help to generate insights for future studies, which can be achieved most effectively by selective sampling. Still it has to be emphasized that choosing this sampling technique might cause vulnerability to errors, a low level of reliability and a high level of bias. Nevertheless it is reasonable due to the limited number of sources for useful data, because both the number of cases of such collaboration and the number of representative in the industry with knowledge or even awareness about biohacking is very low to the researchers first observations.

Perspective of Biohacking Community

All four interviewees (**Table 3**) were selected according to specific criteria. Most importantly they must not only be members of different communities, but rather be in a kind of respected position - e.g. founder. Therefore, this four individuals are experienced and influential enough to be considered as "representative" of their community. Another initial criteria were objectives to proof their personal abilities to create values for instance by founding companies or the creation of bigger projects.

Next to these common criteria the sampling of interviewees was intended to be diversified according to the expected or demonstrated susceptibility for interaction with the pharmaceutical industry based on prior activities or general behavior. Two key interviews were with two members of the biohacker community who were part in initiating and running such an interaction. There was one interviewee which was chosen because he was observed of being eager to collaborate on one of his projects, but he had not been able to establish such a collaboration. In contrast one interviewee and his community were picked for their strict views on monetarization of community efforts which seemed to be hard to make it fit with the business mindset of the pharmaceutical industry.

Table 3: Interviewees Biohacking Communities

Name of Interviewee	Abbreviation	Date	Duration	Community	Collaboration experience with industry	Profession
Martin Malthe Borch	**MMB**	13. June 2016	56 min	Co-founder of BiologiGaragen in Copenhagen, Denmark	yes	Management Consultant
Pieter van Boheemen	**PvB**	13. June 2016	57 min	Founder of Dutch DIYbio in Den Haag/ Amsterdam*, Netherlands	No, wish to collaborate on antibiotic project	Manager at Waag Society; Founder and CEO of Amplino
Olivier de Fresnoye	**OdF**	17. +23. June 2016	91 min 35 min	La Paillasse, Paris	Yes, as dedicated project manager	Freelancer**
Alexander Murer	**AM**	21.June 2016	78 min	Co-founder of Open BioLab Graz, Austria	No	Founder and CEO of Briefcase Biotec

* community originally was established in Den Haag and then moved to Amsterdam hosted by Waag Society, which employed Pieter van Boheemen as project manager

** according to answers in interview and LinkedIn profile, note eventual bias due to payment

Perspective of Industry Representative

The main criteria for choosing the three industry representatives was prior knowledge of the biohacking phenomena or even experience in collaboration with biohacking communities.

Table 4: Interviewees Biohacking Communities

Name of Interviewee	Abbreviation	Date	Duration	Organization	Collaboration experience with biohacking communities
Niclas Nilsson	**NN**	7. July 2016	90 min	Head of R&D Open Innovation, Leo Pharma, Denmark	no
Gernot Abel	**GA**	13. June 2016	100 min	Science Manager Novozymes, Denmark	yes
Isabelle Vitali and Jean-Frédéric Petit-Nivard	**IV**	8. July 2016	59 min	Innovation and Alliances Development Director; Innovation Manager; Roche France	yes

Two of the interviewees were the respective counterparts to the previous interviewed biohacking community representatives in their existing interactions. With this possibility of direct comparison of the answers the overlap in different issues about the interaction was intended to be accessed. The third interviewee was highly aware of the phenomena and is seeking for establishing such an interaction. All three of them are responsible for open innovation initiatives and managing collaborations in their companies. Concerning the interview with Gernot Able it must be mentioned that his company Novozymes is not a pharmaceutical company. If this influences the reliability of his statements will be discussed in detail in the critical review on this interaction.

3.4.3 Secondary Data

In order to obtain an advanced understanding especially about business-community interactions other secondary data sources were analyzed. This is in line with the explorative approach of this research. This includes both publicly available and disclosed internal information on both existing collaboration. As sources following material was examined and taken into consideration while analyzing the primary data sources: websites about the collaboration, press releases, result reviews, internal and external presentations. The overall goal of this broad approach is to be able to gain insights from this in-depth contextual analysis. Also the findings from qualitative interviews can be triangulated and therefore foster its overall validity.

4. Results & Discussion

4.1. Definition "Hacker" and Diversity in Motivations

In order to build a relationship between companies´ innovation / RD departments and the biohacker communities and to successfully collaborate on projects, it was one key proposition that it is essential to first of all understand who is engaging in such community and what to consider as a "hacking".

There was a problem right at the start: regarding the hacker culture and the discussion around that term there is the understatement that *"It is better to be described as a hacker by others than to describe oneself that way."*[131] This implies that there is a need to proof yourself to the community with action "hacks" to be called "hacker" first. So it would not be adequate to just go out and ask straightforward if someone is a hacker or not, gather their demographic background data and furthermore ask them what their motivations are. This would have led to false negative and false positive. People who could be considered as hackers - in traditional meaning and in line with the research definition - would not call themselves "hacker" and pretenders would have so. This problem is also manifested in the unclear definition of hacking and the historical development of the term with its typical computer association. Consequently, the approach chosen was to co-develop an definition with selected communities and their members. As starting point and based on general observation and first discussion with community members like the founder of the Dutch DIYbio community this definition was postulated:

"Interacting with matter and technology in a playful, creative, experimental and hands-on way" (research definition)

In the conducted questionnaire this definition was examined in comparison to the answers of the participants to an open request to define the word "hacking". In total 43 formulated definitions were received. These definitions (Appendix 7.1) were evaluated by first categorizing all words in objectives, adjectives or verbs. By doing so several words already appeared multiple times. As next step word groups were created based on similarity and meaning and to gather a sense of quantity. This led to the result that hacking was seen by the participants as creative, curiosity driven, hands-on, fast and efficient activity which is aimed on problem-solving and the understanding, optimization or modification of systems and technology.

At this point the current research definition seemed to tend in the right direction, but should be challenged further by the expert interviews in the biohacking community and industry. Therefore the interviewees were as well asked to give their definition on "hacking" and afterwards were confronted with the researcher´s definition. This yielded

[131] http://catb.org/~esr/jargon/html/H/hacker.html

to a variety of different definitions and point of views. One critical point of view about the word "hacking" is:

> *"a fashionable word for developing disruptive programs, disruptive solutions or disruptive innovation"*(IV l. 55-58).

Nevertheless, most of the interviewees link "hacking" to technology, but they did not limited it to computer or software. In their definitions there was a strong emphasis on the explorative nature of "hacking" by *"finding new ways"* (OdF l. 980), *"try to stretch the limit"* (PvB l. 49), *"in a way that was not necessarily intended"* (MMB l. 101). This curiosity seems to be driven by different intentions and motivations such as specific problem-solving as *"there is usually a problem trying to be solved"* (MMB l. 110), engaging in *"something that matters*" (GA l. 246), to *"tackle issues"* (OdF l. 981), for the *"intellectual challenge"* (PvB l. 52) or *"just do it for fun*" (PvB l. 51).

To prevent capturing just word phrases about motivations the participants were also asked why they personally got involved into "hacking" activities and to name motivational driving forces of people in their community. This also often revealed the personal story and reasons for starting a local community. One shared motivation of the interviewees of the biohacker community was to follow curiosity (MMB l. 144) which did not fit into the curriculum of university or was plan of the research agenda (AM l. 294ff) or to quote the interviewees on this issues:

> *"(..) the scientist and engineer themselves that are working in the biotech industry, but they also feel like they are restricted by the regime inside the university or the policy inside their companies."* (PvB. l 129)

Therefore this curiosity is not satisfied and ideas could not be pursuit. By not being able to perform experiment or research in the traditional settings they were driven to create access to a laboratory and equipment for themselves and others (PvB l. 93ff). But it was not only to get access to a laboratory, there was also a huge social aspect as motivational driver:

> *"And I just needed a place and a group were I could discuss these kind broader applications which weren´t really represented at the university." (MMB l. 151)*

All this mentioned aspects in the interviews demonstrate not only why somebody engages in such activities, but also how: creating local communities and the building of open lab spaces which both could serve as *"temple for creativity and fun"* (NN l. 180)

Next to interviews these findings are in line with both the participants observations at the open evenings of the Dutch DIYbiocommunity and with the results of the questionnaire. As the questionnaire was handed out on two designated beginner events its main purpose was to gather their initial motivation for people to attend such events.

Figure 1: Questionnaire result for motivation to attend beginner event

Figure 1 shows the result a of a multiple choice question, additional there was an open text question to describe the motivation. The result was that most people are highly interested in both theoretical and practical knowledge building and this fits the findings of the interviews:

(..) by being in the community you being kind of exposed and you need kind of defend your reflection and knowledge. Being this challenged you will learn from people from in the community, which can be quite rewarding to follow other people. (MMB l. 180)

The interest in seeking for *"inspiration"* and "*experience"* could be seen as traits of curiosity which is a big driving force. Both of these aspects seem to happen in an open, fun and creative way and are – besides the law (AM l. 1004) - free of constraints (MMB l. 178) and without restrictive hierarchy (AM l. 321, OdF l. 1283). This matches with the described characteristics in the hacker ethic and attitude. Some key aspects like freedom (AM l. 329, NN l. 932), sharing (NN l. 482, PvB l. 74) and learning were mentioned and were highly valued by the interviewees.

Especially the learning aspect of creating an atmosphere of free flow of knowledge and experience in order to stimulate both the independent and collective knowledge building was nicely described by this:

"Introduced to this kind of learning - this hacker ethos of learning – and that kind of more fluid or dynamic approach to knowledge building, learning and sharing." (MMB l. 158)

Furthermore, the interviewees emphasized a strong social aspect in attending community events. In the questionnaire this aspect was separated intentionally to being able to differentiate between "contact to interesting people" in terms of general networking and "contact to like-minded people". Although only four participants mentioned this aspect, it is seen as one essential component in this social construct of local communities due to participants observations and interview statements like this:

"And a lot of people like to be around like-minded people, so there is a big social aspect to it. They like technology, they like discussion about what technology can do and like the like-minded people in that community." (PvB l. 138)

Next to being part of a social construct, having fun in intellectual stimulation and serve their curiosity in undirected exploration, interviewees mentioned members getting involved in directed and serious ways to either being able to work together with others on projects they are passionate about and therefore can achieve self-realization (PvB, AM l. 370). Or even they have serious intentions like understanding and researching on diseases (AM l. 369, PvB l. 121) or engage in societal issues (MMB l. 147, PvB l. 123).

One interesting point of view about motivation, which already outlines what problems can be faced while in engaging with such communities and how valuable an social and cultural understanding of hacker communities from economical perspective is, was that "hacking" is a strict hobby activity in which you interact with science and technology in your free time and that should not be business oriented (AM l. 243). Although this opinion has to be considered as radical and other interviewees were more liberal about that by saying "*you don´t do this because you see a business need or a business opportunity. That can also come of course, but you do it because it is exciting and fun"* (NN l. 180), it still demonstrates how some parts of the community are motivated and how they will interpret their activities in consideration of the social norms which are collected under the term "hacker ethic" or "hacker culture". This behavioral or social construct can be seen as relevant part for identification and can be crucial for becoming part of the communities. How this cultural aspects affects collaboration or an engagement with the pharmaceutical industry will be discussed in depth in a later chapters. Anyhow, the understanding of "hacking" as social construct ranged from an outsider perspective of being very skeptical as that there *"is a sort of fantasy around hacker"*(IV l. 164)*,* to more insider perspectives as lifestyle and attitude (PvB l. 104), mindset (OdF l. 991; NN l. l79) or even up to being a sub-culture (PvB l. 45).

In confrontation with the research definition the lack of intention was criticized (PvB l. 58). And even after evaluation of all data the realization is that there is broad variety of intentions and motivations. Even the motivation of single members can be different to the motivation of the collective community. Consequently, it seems questionable if a definition with all different intentions is useful for business-community collaboration. What in fact is useful about this finding is that if there is variety of different motivations, there might be different incentives appealing to different people in this communities (OdF l. 847, 253).

4.2. Diversity in Profiles of Being a "hacker"

One goal of this exploratory study was to create a profile about "hackers" engaging in biohacking activities and being active in local communities which could be used for innovation manager to evaluate a fit and to build on a collaboration. To be critical about the findings this goal could not be accomplished in reliable and valid manner.

The reasons to draw this conclusion are that, first of all, the researcher interacted only with one community intensively over a period of four months and three other communities mainly through their community leader, so both the numbers of communities and also the numbers of encountered individuals hackers is far from being a representative sample size. Second of all, it was recognized during the research that each community is very specific in itself due to the lead of founding partners, the overall circumstances and the surrounding environment. So to give two examples for this finding: For the Dutch DIYbio community the "*majority in our lab are from the art and design backgrounds"* (PvB. l 156). The reason might be that it is hosted by and associated to the Waag Society, which is an independent media and technology lab with a strong design approach. But not only the Waag Society, also the leading figures in the community with Pieter van Boheemen and Lucas Evers are very design oriented and attract many other designer and art persons to their community. In contrast the Open BioLab Graz was founded in attachment to a traditional ICT hackerspace by Alexander Murer and fellow students of his molecular biology study course. So their community is till shaped by this fact (AM l. 412) and therefore has a focus on technology (AM l. 428).

In order to create a first profile which could be used for further research purposes both participant observations and a questionnaire were used to access simple demographic and background data. The weakness of this approach was that it highly depends on each specific community and if the method accesses the core community, occasional "drop-bys" or just visitors of singular events (MMB l. 203).

Mentionable about the observation of the community event was that the gender ratio in the open community events was roughly equal, which might be the case because of the art and design focus of the particular community. Furthermore, people mostly were in the age of 20 to 30, but not exclusively as there even have been young students or even pupils, but also some retired people present. Most of the participants were either currently students or have an university education. The interdisciplinarity of the community could be rated as high because the core community consists of a molecular biologist, a chemist, a biotechnologist, two electrical engineer, a software programmer, two designer and a social scientist. There were several nationalities present.

In the questionnaire (Appendix) there was a similar picture about the age with an average age of 32 years, 85 % of participants currently with higher education, 12 % even obtained a PhD. The information about profession with 23 % working in a software / IT sector need to be seen relation to the fact that the majority (34 out of 49) of data was collected at a biohacking beginner event at a community which is more affine to the digital startup ecosystem and its focus is mostly on digital health topics.

With all this research findings at hand it was still a very vague picture with almost no hard criteria besides motivation, intention which were described in the chapter before and a general interest in technology. Because of this the community leaders were asked in the interviews about typically characteristics. Their answers focused again more on intention and motivations, but not specific personal characteristics or certain backgrounds. There is one plain-spoken answer to the question which not only describes the specific research question, but also the open mindset of hackers in general:

"I don´t want to say any typical characteristics, it could be anything. (..)I don´t want to limit this group." (MMB l. 138)

Consequently, from the scientific point of view the collected research data is not representative enough to deduct any specific profiles. This issue could be faced in an in depth analysis as part of designated study on this phenomena in the future. Till then, a pragmatic approach on dealing with this lack of profiles in business-community interactions is needed. Paradoxically, it might be actually helpful for innovation manager not to think in predefined boxes and categories in such explorative interactions, but again *"not to limit this group"* (MMB l. 138) at the beginning and to create categories and profiles for themselves based on actual exploration, experiences and the specific innovation need. This approach seems reasonable as "hacking" is an activity, a "hacker" someone who engages in these activities and "hacker communities" are social constructs which are open to everyone and in which someone is recognized by action and categorized by his motivation rather than by background. So there might be no such thing as a typical hacker with clear profiles. If innovation manager acknowledge this difficult issue and act accordingly, it would signalize the hackers as interaction partners that they accept part of their basic cultural idea which is that:

"Hackers should be judged by their hacking, not criteria such as degrees, age, race, sex, or position" (hacker ethic)

4.3 Value Creation in Biohacking Communities

4.3.1 General Values

Value can have all kinds of facets. Anyhow, this thesis should focus on values which are important in a business context. Still it should be briefly mentioned that biohacking communities as social construct create a social value for its members like a sense of belonging based on shared technological interest and a place for self-realization.

This led to two things: it induces two important attributes - engagement and commitment which both there were confirmed to be present in the interviews (GA l. 471, NN l. 692). Secondly, through encountering in face-to-face meeting there is a creation of personal networks locally (MMB l. 306) and even globally (GA l. 315, PvB l. 280).

All these factors are important and need to be keep in mind, because they can be seen as fertile ground for many present or created values which will be discussed in the rest of this chapter. One industry representative acknowledges this effect by saying:

"(..)the power of such a community crowd will be really, really high compared to individuals in a company working separately pretty much. So the power is really strong. The social aspect is really productive as well. " (NN l. 486)

Additionally, even if the education of the public (NN l.694) and changing the perception by getting genetic related technologies *"out of this dark prison and show its importance"* (AM l. 565) are a generated values in hackerspaces, there is not an intermediate overlap with the value creation of the pharmaceutical industry (NN l.694).

Based on first observation there were several values suspected to be present or created in a biohacking community which are interesting from a business perspective. For the further evaluation it seemed applicable to differentiate between hard and soft values. As hard values it was expected to find objectives like projects, ventures and therefore inventions. In contrast soft values were suggested to be: ideas, fun, creativity, curiosity, interdisciplinarity, problem-solving and access to technology, skills and collective knowledge. Another important value for businesses was seen in the access to talented people. In interviews with both representatives from the biohacking community and the industry it was tried to access which of these values the interviewees were aware off and mentioned, but also which values could be deduced from their given answers.

4.3.2 Ideas and Creativity

First result was about two values which arguably go along "ideas" and "creativity". In a question to the representatives of biohacking community one agreed and two fully agreed that biohacking communities are a source of creativity and ideas in general (PvB l. 301, OdF l. 398, MMB l. 326). Also the representatives of the industry acknowledged that creativity is a present value in these communities. (JV l. 114, 165, NN l. 166, 226).

One hypothesis was that if a community is such a source of creativity, it could have an influence on its members. So the community representatives were been asked about the development of their members´ creativity over the time of affiliation. The answers showed mostly a positive development as that they are not only more creative in their specialized field ("*Sie sind auf jeden Fall in ihrem Fachbereich kreativer"* AM l. 594) but also in a general perspective (PvB 287, OdF l. 275). There was one concrete an example mentioned (PvB l. 293). So as reasons for the increased creativity the exchange or knowledge and ideas in their field of interest (AM l. 594), the confrontation and crosspollination with other ideas and fields of expertise (PvB l. 287, MMB l. 326), the collaboration on interdisciplinary projects, the absence of pressure (OdF l. 278), but also the empowerment to start being actually creative were mentioned:

Nicht nur theoretisch kreativ zu sein, sondern auch kreativ in der Praxis zu sein. Wege aufgezeigt zu bekommen, wie es funktionieren kann. Das Organisatorische, die Infrastruktur, das Finanzielle und natürlich wenn man auf der Universität sitzt und man sich denkt „man das würde ich gerne machen". Das ist immens schwierig, irgendwie türmen sich 100 Wände vor einem auf. Ich habe ja kein Geld, ich habe kein Labor. Das man den Leuten es einfach zeigt und daraus entwickelt sich dann einfach mehr Kreativität. (AM l. 598)

4.3.3 Access to Tools, Equipment and Technology

Next to empowerment this quote reveals two other, related reason for creativity: necessity (AM l. 611) and the lack of access to tools and equipment (PvB l. 93). As being said that necessity can the "mother of invention", it stimulates the creation of values. It forces biohackers to improvise and to overcome issues with a creative approach which requires to rethink and challenge the underlying processes (AM l. 616) and therefore can stimulate a deeper understanding. A pragmatic and trivial example of overcoming was given from a biohacker representative who needed a shaking incubator and simply put the shaker into the incubator. (AM l. 620) But more often hackers use their creativity and their diverse skill-set to design and create their own equipment from the scratch with the resources they have to hand and share it openly.

"We make open source designs of the devices like centrifuges or PCR machines and publish them online. And you really see people replicate that all over the world." (PvB l. 222)

T. Baden (2015) summarized in a review some of these projects about lab equipment[132], there repositories to list projects with instructions[133, 134, 135], there are first conferences hosted about this topic[136] and with BioCoder a designated journal which among other things publishes such do-it-yourself projects. All these channels are more and more also used by academic research groups who share their project designs (e.g. digital microfluidic DropBot[137], collaborate with biohackers and are able to reduce their costs for lab equipment.[138, 139] According to this recent study of Pearce (2016) this relatively minor development costs result in enormous return on investment for the scientific community.[140]

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[132] Cf. Baden (2015)
[133] http://collections.plos.org/open-source-toolkit-hardware
[134] http://hackteria.org/wiki/Main_Page
[135] http://biohackacademy.github.io/biofactory/
[136] https://home.cern/cern-people/updates/2016/03/gosh-roadmap-open-source-science-hardware
[137] http://microfluidics.utoronto.ca/
[138] Cf. Pearce (2012), p. 1303
[139] http://www.nature.com/news/open-hardware-pioneers-push-for-low-cost-lab-kit-1.19518
[140] Cf. Pearce (2016), p. 192

4.3.4 Problem-solving, Collaboration and Management Skills

So consequently, these projects are a value creation in itself, but it generates much more values than just the project objective. For instance, in project development you are faced with problems of known or unknown type on a regular basis, exercising to solve these problems therefore is a frequent task leading to new findings, input and experiences.
These aspects of solving a problem seem to stimulate as 89 % of the participants of the questionnaire people are tinkering, experimenting and working on projects even in their private time. But as nowadays in a knowledge society problem solving also is a huge part of professional life, it might be reasonable that people can benefit from the projects in their private life and vice versa. This hypothesis was tested in the questionnaire and the result is that two third of the participants have benefited at their working tasks from private projects. So this finding could imply that, if a few of these beginners would become engaged members working on projects, that also their company could benefit from their spare time projects and engagement in a biohacking community.

In order to accomplish projects there is a need for certain skills, so either the people need to learn them by themselves or start collaborating with someone with the right skill set. Either way working on projects in a biohacking community could improve someone's practical or collaboration skills. Furthermore, as in business collaborations and also projects both require certain managerial skills to be successful like being a leader (MMB l. 310), organize and motivate yourself and others (AM l. 576). For all of these skills the biohacking community enables to exercise and gain them (MMB l. 309). So engaging in projects is not only about learning new skills in your field expertise, but also learning new skills in a huge spectrum of disciplines.

4.3.5 Community projects

By trying to quantify a conversion rate between generated ideas and developed projects there seems to be a huge gap (AM l. 501). And this should not be understood negatively, because a hacker community seems to embrace that free and open flow of ideas and the intellectual stimulation of ideation. But even the ideas which start most of are shut down very fast due to underestimated need of equipment and especially the need time effort (AM l. 494). The projects are running through a *"natural selection process"* in which the success probability of a project depends highly on the motivation of the individual project initiator to *"keep pushing"* (PvB l. 232).

Next to hardware and tools there also have been projects about molecules and biology in the biohacking communities. Two mentioned projects in the interview were "BioStrike" (MMB l. 239 , PvB l. 345, AM l. 469) and "VeganCheese" (AM l. 473). The first was a collaborative research approach of several biohacking communities (i.e. Amsterdam, Berlin, Barcelona, Copenhagen and Prague) to source new antibiotics from mainly soil bacteria – in which the researcher was involved during his four month

as research intern. The second one is also a collaborative project of two biohacking communities (Counter Culture Labs and BioCurious both in California, US) in which more than 24 biohackers were working on engineering yeast by synthetic biology to become milk-protein factories.[141] The dynamic and the evolution behind this project is a showcase for many other projects, because in order to make their project happen they started to raise money publically using crowdfunding . Their initial goal of $ 15.000 was exceeded by 249% and they were able to raise $ 37.369.[142]

4.3.6 Entrepreneurship

If funding seems to be available for such projects, the step from turning a project into a business venture might be appealing. Indeed, several other projects turned into startups and raised money via crowdfunding (**Table 5**). As example the first "Open PCR" (AM l. 472) design project was started with little money in 2010, it is still running and a company was founded on top of this open-source design.[143] This company raised with Open qPCR another $ 202.701 in December 2014.[144] Speaking about crowdfunding it should be noted that both just mentioned biohackerspaces BioCurious and Counter Culture Labs themselves were successfully crowdfunded at their beginning.[145, 146] The downside of this approach should be also noted and can witnessed in the heated economical and scientific debates on the "Glowing Plants" project.[147, 148]

Table 5: Crowdfunded projects and companies with background in the biohacking community

Name	Raised by	Project	Amount Raised
Glowing Plant	Company	Genetic modification of plant to make it glow in the dark	484.013 $
Open qPCR	Company	Open-Source real-Time PCR thermocycler	202.701 $
Bento Lab	Company	Portable DNA analysis laboratory	152.415 £
OpenTrons	Company	Open-Source biology lab automation robot	126.694 $
The ODIN	Company	DIY Crispr Cas 9 Kits	71.496 $
BioCurious	Project	Bio-Hackerspace	35.319 $
Counter Culture Labs	Project	Bio-Hackerspace	33.170 $
Open Insulin	Project	open source protocol to produce insulin	16.656 $
Open PCR	Project	Open-Sour PCR thermocycler design	12.121 $

Sources*: Crowdfunding campaigns on websites kickstarter.com, Indiegogo.com, exerperiment.com*

[141] https://realvegancheese.org/
[142] https://www.indiegogo.com/projects/real-vegan-cheese#/
[143] http://openpcr.org/about
[144] https://www.kickstarter.com/projects/chaibio/open-qpcr-dna-diagnostics-for-everyone
[145] https://www.kickstarter.com/projects/1836537355/counter-culture-labs-your-biohacking-and-citizen-s
[146] https://www.kickstarter.com/projects/openscience/biocurious-a-hackerspace-for-biotech-the-community
[147] http://www.nature.com/news/glowing-plants-spark-debate-1.13131
[148] https://www.technologyreview.com/s/601884/why-kickstarters-glowing-plant-left-backers-in-the-dark/

But even without crowdfunding there are companies starting out of hacker communities. Most of the interviewee witnessed the formation of startups, one of them even could easily quantify as much ten startups from the communities he is associated with (OdF l. 354). Two concrete examples are the interviewees Pieter van Boheemen as founder of the malaria diagnostic device company Amplino[149] and Alexander Murer as founder of the microfluidic DNA synthesis device company Briefcase Biotec.[150] Both started their company from a community project, for both it started out of simple tinkering with technology together with others (AM l. 197, PvB l. 34). For both the project which turned out to be their company and the biohacking community was a joint development (PvB l. 242, 246, AM l. 36). The intrinsic drive to start a company was different though. On the one hand there was a founder with entrepreneurial experience who saw the business opportunity. On the other hand there was a case of what could be considered as accidental entrepreneurship[151, 152], because according to the interviewee Alexander Murer at the beginning there was no plan to create a commercial product (AM l. 194, 201). In fact their motivation and reasons to found a company, which meanwhile raised over $ 500.000 venture capital[153], were:

Wir wollten ursprünglich ein Open-Source Gerät bauen und hat sich eigentlich dadurch ergeben, dass wir gesagt haben: Okay wir brauchen 2000-3000 Euro Materialkosten um das Gerät zu bauen. Und so sind wir eigentlich zu diesem Inkubator und auf diese Startup-Schiene erst wirklich gekommen. Wo wir dann teilgenommen haben und sogar beträchtlich mehr bekommen haben.(AM l. 197)

Aldrich (1999) argues in his work about this kind of accidental entrepreneurship that *„truly innovative start-ups are often the result of creative experimentation with new ideas by outsiders to an industry“*.[154] Even if this thesis is not able to judge if the inventions of the companies out of the biohacking community are "truly innovative", the emphasis on creative experimentation by outsiders can be identified in biohacking communities by participant observations and also by the interviews:

"cause at the time I making also my lab at home and I was this with friends. And I started Amplino with two other guys and we started doing tinkering, doing different kind of lab devices. And that´s kind of how we started" (PvB l. 243)

In the follow-up of the interviews it was tried to validate and quantify this finding, so the accelerator IndieBio, which hosted the company of Alexander Murer, was asked to rate in their investment history how many startups have an origin somehow in the biohacking community. The director of the European IndieBio program Cathal Garvey,

[149] http://www.amplino.org/
[150] http://www.kilobaser.com/
[151] Cf. Shah (2007)
[152] Cf. Aldrich (1999)
[153] http://kilobaser.com/kilobaser/presskit/Presseaussendung_Briefcase_Biotec.pdf
[154] Cf. Aldrich (1999), p. 4

who once himself dropped out of his PhD program to start his own lab [155] and is well known in the biohacking community due to projects like the dremelfuge[156], elaborated that for 9 of 24 companies this was the case (Mail CG).

Regardless of accidental or intended, crowdfunded or venture capital backed entrepreneurship or just being community projects with no immediate business case the source of these objectives is related to that way of playful, creative, altruistic tinkering and experimentation in biohacking communities and should be seen as value in itself.

4.3.7 Access to Talents

An important value for the pharmaceutical in biohacking communities can be the people as potential employees. Access to talented people with diverse skill set and a creative and innovative mindset should be considered as possible value and it was mentioned by several interview partners from both perspectives (AM l. 888, GA l. 176, ‚OdF l. 1203). Or to put it straight: *"Yeah, hire those hackers and work with them."* (PvB l. 472)

In summary, there is a vibrant ecosystem of biohacking communities full of ideas, projects, ventures. All of it is fueled by passionate, committed people with a diverse skill set. The question is: How can the pharmaceutical industry benefit from these values? How suitable are the existing open innovation processes to internalize these values? Could hackers and the pharmaceutical industry start co-creating value in interactions? These questions should be the subject of the following chapters.

4.4 Crowdsourcing the Biohacking Community

At the start of this exploratory study there was the thought on what is produced on a larger scale in the biohacking community and should be accessible in general. Due to observations while attending regularly community events the researcher noticed that there were constantly ideas created by community members in a creative, fun and most importantly openly shared way. So it should be examined if these ideas and the ideation potential of the community could be harvested by the pharmaceutical industry. As popular method for this crowdsourcing was chosen.

Because of the idea that crowdsourcing is based on engaging on interesting and challenging problems in technological context, it could be presumed that this activities are interesting for the biohacking communities. Nevertheless, the researcher did not encountered one person who was speaking about a typical crowdsourcing challenge during his four month research in the community. To get a more representative picture the interviewees of biohacking communities were directly asked about crowdsourcing.

[155] https://eu.indiebio.co/mentors/cathal-garvey/
[156] https://github.com/cathalgarvey/dremelfuge

The intention of the questions were to evaluate general use in the community and if crowdsourcing is not used – what was assumed based on the observations – to find out why the community is not engaging in these crowdsourcing activities.

The interviews confirmed the first observation that biohacking communities are not participating in the current crowdsourcing efforts. Most of the interviewees of the biohacking community were aware of the existence of such platforms and understand the basic principle. It was acknowledged that it might *"be a way to innovate, but it is less creative"* (PvB l. 312). Most of them never engaged in these platforms, nor did their community members to their knowledge. One interviewee engaged for a certain time personally in such activities but stopped without naming a reason. (OdF l. 466).

Asking the interviewees about why there is no participation of the community members in such crowdsourcing activities, following problems and concerns were raised or were agreed on:

- no awareness of the crowdsourcing platforms (AM l. 701, PvB l. 329)
- bad balance between input and output (MMB l. 367)
- critical about value-sharing (AM l. 674)
- wrong incentives (OdF l. 484, OdF l. 478)
- wrong kind of interactions (OdF l. 427, PvB l. 319
- missing of the social aspect (PvB l. 307,330)

Especially the social aspects, missing interactions and wrong incentives are interesting findings, because these might be valuable insights not only for crowdsourcing, but also for collaboration design.

After accessing the point of view of the biohacking communities part of the innovation manager were asked about crowdsourcing. As time was limited in the interviews and the focus of research was by then more on collaboration, only two of the three innovation manager were asked either direct in the interview or via follow-up mail. Both were using crowdsourcing in variety of setups internally vs. externally and on different kind of projects and problems. (NN l. 359, GA Mail). The company-operated platform at Leo Pharma aims for solution providers in the traditional field like academic research groups and biotech companies, but is not oriented to capture individual solutions (NN l. 372). The reason is the need for being a legal institution in order to sign a contract about ownership and confidentiality (NN l. 393).

Being asked if crowdsourcing would be in general a good method to interact with hackers, both industry manager with a good knowledge about the phenomena agreed the method has potential as "*it is useful for building interaction and engagement, but cannot stand alone – face-to face is required to keep momentum and building further on*

passion and trust"(GA Mail). It was mentioned as a possible problem that it might be hard to keep the biohacking communities in direction (NN l. 419).

After that assessment one industry representative was confronted with the findings on the reasons why biohacking communities are not participating in crowdsourcing. The results were not surprising to the interviewee because there are different incentives involved (NN l. 428). He agreed on the interaction aspect and also argues that he sees the biohacking communities being drawn to bigger problems (NN l. 451):

The biohacking community in general as I see it, doesn´t work for cash rewards. Of course they don´t mind to get cash rewards, but the driving force is having fun and being creative. (NN l. 434)

Nonetheless, crowdsourcing targeting on biohacking communities was considered as interesting and as something which to be followed up in the future. (NN l. 398) Furthermore, the plan is to rethink the approach:

"so that would be the next step is to see one where the community or the ecosystem can create incentive, where outside partners work together and benefit from each other´s results in order to come up with a better solution. And that does not exist, not for the pharma industry." (NN l. 407)

Although this thesis as exploratory study does not claim to be representative and future research about crowdsourcing on biohacking communities is needed, the first impression is that crowdsourcing with cash reward way seems not to be very suitable for engaging with biohacking communities. The finding that according to the interviewees almost no one in the four researched communities is participating in crowdsourcing must be seen highly critical given their creativity, skill set and ideation potential. So by starting to analyze the problems in crowdsourcing about missing interaction and social aspects, it seems likely that the way to actually leverage the full potential of biohacking community is by going a step further in the innovation process than just trying to harvesting ideas. All this implies that the pharmaceutical industry should consider to start the interact with the biohacking communities.

4.5 Collaboration between Pharmaceutical Industry and Biohacking Communities

During the research two existing interactions were discovered, studied from both perspectives and critically analyzed. For this issue both the interviews and open and disclosed secondary data was used. The findings from that insights are supposed to help both innovation manager and research to access this kind of interaction and the phenomena of biohacking community in general. Next to examine the two existing interactions the insights of other interviewees, who were looking for such interaction but could not establish one yet, also revealed information on this issue.

Before exploring the interactions into depth it was been accessed if both sides actually want to interact. Therefore the interviewees of the biohacking communities were asked if it is desirable for hacker, hackerspaces and the communities to interact and actually work with the pharmaceutical industry in general? All four agreed in general (AM l. 757, PvB l. 384, OdF l. 631, MMB l. 421) as for example *"there is a good crosspollination of ideas and focus when you talk to individuals from these backgrounds."* (MMB l. 426). Each of them gave insights on like how those communities are ticking. For example about openness that implies a willingness to interact with almost everyone as long as it fits the idea of biohacking (AM l. 757), but still communities should think about not selling themselves out (AM l. 763). In an existing interaction there were concerns raised in the community, but the vast majority was pragmatic and took the possibility to work with specific technology (OdF l. 631).

By asking the interviewees about their general opinion towards the pharmaceutical industry all given statements can be put into relation and potential possible biases could be revealed. Some of them acknowledge that it is hard to speak about "the pharmaceutical industry" in general (OdF l. 599, MMB l. 416). Nevertheless the overall opinion towards the pharmaceutical industry was more like it was seen as *"double-bladed sword"* which is on the one side necessary (PvB l. 356), there is trust in the scientific principles (AM l. 738) and it is good that it exist (MMB l. 405). But on the other side it is considered as tough and as an environment with an attitude of *"money before everything"* (OdF. 602). Furthermore, they are considered as slow innovator because of their corporate structure and their old-fashioned and uncreative way of operating, although there is supposed to be a lot of investment involved (PvB l. 358). The community leader expressed that they do understand that some people of the communities have issues or just do not want to interact with the pharmaceutical industry due to its bad reputation (OdF l. 617) or appealing repulsive (PvB l. 361). Nevertheless, the interviewees themselves showed no real bias and were pragmatic about interactions.

Asking the industry representative the same questions if such a collaboration would be desirable for the biohacking communities, two of them raised concerns. One expected it to be "ambivalent" and the other self-reflected the perception of the pharmaceutical and the implication on such collaboration as following:

> *"I would hope so, probably right now they might not think so. Because the pharmaceutical industry as it works today is seen as a rigid, legal and contractual which it is. And again it will change a little bit, but then it does it will be an opportunity." (NN l. 333)*

So consequently, it seems there is a general willingness to interact on both sides which is already very interesting given their differences in organizational structure, intentions and also the gap in their cultures. This can be seen as one key finding of this thesis.

4.6 Review Interaction of Roche France and La Paillasse

4.6.1 Case description

The first case is about the interaction of the French branch of the Roche and a Paris based biohackerspace. The name for this interaction was Epidemium. On its websites it quotes to be *"an innovative approach to the epidemiology of cancer in an open science framework"*.[157] The community was challenged to help research in cancer epidemiology in an open, participative and interactive way based on using big data. This research initiative was designed to meet the French Cancer Plan 2014-2019 by "providing the means of innovative research", "sustaining health democracy" and "supporting public policy on data sharing".[158] The overall challenge was divided in four topics:

- Understanding cancer distribution in time and space
- Risks and protective factors in cancer
- Understanding Cancer from the medical literature
- Environmental changes and cancer

Asking the representatives of both sides in the interview for a short description they both emphasized the focus being on open big data (OdF l. 679, IV l. 212). Analyzing the website it has to be acknowledged that there are typical attitudes present which appeal to hackers as the goal was to *"break down barriers of medical research"* and that science is performed more efficiently in an open and collaborative approach. Also these four aspects were mentioned and valued[159]:

- openness
- collaboration
- transdisciplinary
- independency

If this representation fits with reality, was tried to accessed by analyzing the interviews and secondary data. The results will be highlighted in the following chapters which analyze the partners, motivations and benefits, initiation and design, experience, result and learnings. At the end the interaction should be reviewed critically and classified to an innovation method such as crowdsourcing or collaboration.

4.6.2 Partners

Roche is a pharmaceutical and diagnostic company with over 90.000 employees worldwide and spent 9.3 billion CHF for their R&D efforts last year. Their therapeutic

[157] http://review.epidemium.cc/
[158] http://review.epidemium.cc/
[159] http://wiki.epidemium.cc/wiki/Dimensions_%26_Valeurs

focus is on oncology (IV l. 21) and according to their annual report of 2015 Roche is market leader in oncology, biotech and in-vitro diagnostics. Roche states that *"external innovation is crucial to our strategy"* and that they are managing over 200 partnerships worldwide. In 2015 alone Roche started 45 research and technology collaborations. In its innovation approach Roche *"fostered the scientific diversity and creativity to develop value*" or as Severin Schwan the CEO of Roche puts it: *"diversity drives innovation"*.[160]

La Paillasse is a biohackerspace and a community laboratory for biotechnology in Paris. La paillasse describes itself as *"interdisciplinary laboratory network with no age discrimination, diploma or income, the technical, legal and ethics necessary to the implementation of collaborative projects and open source."*[161] On a crowdsourcing campaign its purpose is described as *"a genuine space of freedom and counter-culture for explorers and curious minds"* like designers, scientists, artists, makers, entrepreneurs, engineers and citizens.[162] La Paillasse was inspired by weekly meeting on synthetic biology and was initiated by T. Landrain the founder of La Paillasse in 2010. La Paillasse developed from a 30 square meter laboratory at a squat in a Parisian suburb in 2011 to becoming the biggest community laboratory in Europe with a 750 square meters in the city center of France.[163, 164] It is supported financially by the city of Paris, the regional government and the company SynBiota. But there have been other companies who are listed as partners who donated laboratory equipment.[165]

4.6.3 Motivations and individual benefits

As the published motivations of the collaboration program were seen as *"breaking down barriers of medical research"*[166] and to help the research in cancer epidemiology, it was of interest to examine which were the individual motivations to collaborate besides the higher purpose. Answering this issue is strongly correlated with the benefits both sides were expecting and at the end realized by collaborating.

The representative of Roche explained that her intention to engage in this with the biohacking community was to *"go beyond the peer"* (IV l. 22) and she noted that open innovation means for her to develop something which at the end is available for the scientific community (IV l. 40). Furthermore, in order to *"complete their work for the patient"* Roche is trying work with diverse stakeholder in a collaborative and multidisciplinary approach and for them *"La Paillasse was the best choice to do that"* (IV l. 247). For her an important fact to really engage in this interaction was her

[160] Cf. Annual Report Roche 2015
[161] http://lapaillasse.org/manifesto/
[162] https://www.kisskissbankbank.com/de/projects/la-paillasse
[163] http://lapaillasse.org/manifesto/
[164] http://www.wired.co.uk/article/parisian-biohackers
[165] http://lapaillasse.org/amis-et-partenaires/
[166] http://wiki.epidemium.cc/wiki/Dimensions_%26_Valeurs

counterpart as it is a *"question of involved persons"* (IV l. 258) and that they quickly developed a common understanding in their first meetings (IV l. 249). Based on all these facts the innovation manager saw from the beginning that *"there is a big complementarity between La Paillasse and Roche"* (IV l. 267). Being asked about the benefits her response was that "*for the company it was a great opportunity*." (IV l. 406) as the project can be seen proof of principle for the new approach. So she learnt valuable lessons from this first attempt (IV l. 388) which she can build on in the future. She knowingly accepted the risk of this project from the beginning and did not look for a specific return of investment (IV l. 382), but she is expecting a return of investment with future collaborations (IV l. 385). Concerning the focus on big data in the program Roche is benefiting *"from the a better understanding of what we can do with open big data"* and "*how to improve the analysis"* (IV l. 410). She also agreed that employees became more open-minded to work together with different people (IV l. 418).

The representative of the biohacking community La Paillasse revealed in the interview a lot of the mindset and intrinsic motivation both of himself and the hacking community:

"Try, just try. It was just like an exploration. Let´s move for it and see what happens. We had no idea if it would be a success or a failure. But finally it worked. It was a bet." (OdF l. 739)

By running such a project the biohacking community pursuits its desire for exploration and experimentation. Next to that the interviewee admitted his interest of working with communities as method to accomplish something (OdF l. 60). So his intrinsic motivation might be also described by the quote:

"Try to show with a prove of concept, that those communities can bring knowledge, ideas, creative ideas." (OdF l. 1202).

Not only the interviewee´s motivation can be described as "*trying to develop a collaborative intelligence*" (OdF l. 52), but also the founder is quoted on the website:

"In the era of collective intelligence and decentralized, there is no monopoly on great ideas" (T. Landrain)[167]

So the collaboration can be see an opportunity to prove their beliefs to others and the gain of reputation for something which could be considered as a "hack". Also this interaction could have served aspects like working on a higher and altruistic purpose.

Next to intrinsic motivation it has to be noted that there was also a 200.000 Euro payment from Roche to La Paillasse which both partners are transparent about. Furthermore, the interviewee disclosed that if there are partners and funding involved, he gets paid for his project management work (OdF l. 140). He emphasis that by this he

[167] http://wiki.epidemium.cc/wiki/Initiateurs

tries to make both his and the work of the community sustainable (OdF l. 147). Also he noted that all his projects start out as ideas and he works free of charge (OdF l. 150). In the opinion of the researcher based on his statements (OdF l. 74), his track record of community related work (OdF l. 55) and his others on-going projects (OdF l. 201) he is showing a kind of entrepreneurial motivation, but it also indicates that the interviewee is motivated by social impact and not primarily by money. Still it has to be outlined and disclosed for further understanding and will be discussed critically in a later chapter.

As concrete benefits for the community the interviewee mentioned that such a interaction and the underlying projects were opportunities and possibilities for community members to satisfy their interest in technology in either known or new fields (OdF l. 833). Furthermore, he highlighted the intellectual stimulation (OdF l. 828) and how participants gained new perspectives and inspiration while working on the challenge (OdF l. 840). He explained that the easy access to health professionals, skills, resources and tools lead to optimal conditions for experimentation which was very appealing for many participants (OdF l. 843, 846).

Asking both sides for an assessment of the benefits of the respective of their counterpart, the industry partner particular emphasized that the community learnt a lot (IV l. 397) and that both are willing to develop future programs like that (IV l. 401). In contrast the biohacking counterpart describes very detailed the benefits for the industry:

From my point of view the key benefits are: showing all the partners and employee there are also ways to innovate and to approach work, then: interest of sharing commons, sharing knowledge, sharing discovery, sharing everything. Well not everything should be shared, but more. I guess it is something I heard from them. But then: It is also a new way for the research, people and specialist to think outside the box and understand something, learn something, try something new and then open their minds to innovate outside but also inside the company. I would say that. And then: there will be a lot to re-use. All the work the community did, because it is open source and they can develop it and improve it if they want. (OdF l. 866)

But next to all these benefits he also pointed out that the industry was eager to learn something from the biohacking community which is the ability to *"move fast, with a lot of people and only little money"* (OdF l. 733).

4.6.4 Initiation and Design

Interestingly the collaboration started through an individual employee of Roche who is close to La Paillasse and recommended that both parties should meet (OdF l. 704). Both interviewees mentioned that this first meeting was essential (IV l. 248, OdF l. 723):

"We met and it happens. It is a little easy to say that, but it is pretty much what happens." (OdF l. 728)

So after the initial meeting in March 2015 they went together through a *"preparation phase"* of five to six months with meetings once or twice a week to explore the possibilities of the collaboration together, co-designed the program step-by-step and scoped the challenge. Followed by that both partners reached out jointly to attract other partners for the collaboration (OdF l. 752, IV l. 292). Both a scientific and ethic committee were recruited (IV l. 229). La Paillasse gave several talks to promote the program (OdF l. 750). Roche announced a designated project manager which responsibility it was to setup and implement this interaction. He was in charge setting up an internal data database team to create the technical platform (IV l. 347). Also Roche and La Paillasse worked closely together on setting and developing the legal framework between each other and for the project in which the biggest concern was the safe use of health data (IV l. 350). The data set consists of 50.000 data points from clinical studies about 33 different types of cancer and of four billion data points from cancer patients (IV l. 215) and it was authorized by the French Informatics and Freedom Commission (IV l. 233). In total Roche invested 250.000 Euro in this project (IV l. 361). The actual Challenge4Cancer was time limited and went from November 2015 till May 2016. The three best projects have been awarded in an event with a price money in total 9000 Euro.

4.6.5 Tasks

The tasks during the collaboration according to the project manager were to build the structure for the documentation, interact with the teams and organize the events (JF l. 288). Most tasks were carried out together (OdF l. 701). Another task mentioned was to plan and design the follow-up to capture the generated value and insights from the challenge (IV l. 428). Also the winning team was offered support and mentoring if they want to continue and organize themselves as startup (IV l. 433).

The documentation is an open and interactive wiki-based platform where both the organization and the team members could share and present information.[168] Next to the detailed and well documented projects and amongst other there was one interesting section about the rules of the collaboration with in total twelve paragraphs. It explains the setup, the process and responsibilities.

In total there have been about 20 events (OdF l. 534). There was one kick-off event and one price ceremony at the end. Most of the events were regular meetups every one or two weeks. At these meetups neither Roche nor La Paillasse gave the presentations, instead they invited scientists or physicians to speak about their research or for example data science companies to give introduction to their open source tools (OdF l. 668).

[168] http://wiki.epidemium.cc/wiki/Accueil

4.6.6 Experience

Being asked about the collaboration experience both sides are speaking positively about the collaboration (OdF l.689):

" It was a great experience. It is great experience. It will be a great experience, it is going to be continued" (IV l. 265)

Both sides highlighted they were both happy and lucky with their counterpart. The industry perspective highly outlined the working attitude and professionalism of the biohacking community counterpart. They showed to be highly communicative and efficient in their working approach. The program manager described it like this:

"(..) they are well organized, they have good tools and this allows us to be quite reactive and to be able to in 24 hours or 48 hours to produce exceptional amount of work." (IV l. 297)

The industry representative recognized that the biohacking community in comparison to the industry is using different tools (IV l. 181) and processes (IV l. 183). Also she was astonished that sometimes they were *"more organized than ourselves"* (IV l. 184). Also being asked about the experience the industry interviewee is highlighting *"the big complementarity between La Paillasse and Roche"* (IV l. 267).

On the other side the biohacking counterpart outlined that during the collaboration they were working closely not only with the innovation department, but also with a variety of departments for example legal, medical, clinical or communication (OdF l. 694). Also they valued getting into touch with a lot of different people from inside the pharmaceutical company in general (OdF l. 696).

4.6.7 Results and Lessons learned

Both sides rate the collaboration as success (IV l. 376, OdF l. 763) and describe themselves as being happy (OdF l. 760) or being satisfied (IV l. 370). Interestingly both immediately express that there is room for improvement (OdF l. 764):

"I was really satisfied. I think we have a big room of improvement. But we can say now: it works." (IV l. 370)

They both have ambition to improve issues like participation of the community in terms of attracting more physicians (IV l. 320), go further with the project or even the objectives could go further (OdF l. 764). But both seemed patient and want to keep pushing step-by-step in the future with new collaborative programs (OdF l. 1130, IV l. 266, 435). For example, although it could be imaginable to do something ambitious like a collaborative drug discovery unit, it still is *"not the objective we wanted to do and what we want to do in the future in 2017"* (IV l. 476). Nevertheless, it seems for both

sides the most important result of the program was the proof that *"it is possible for the pharma industry to work with collaborative community"* (IV l. 371, OdF l. 1005).

Concerning concrete results in terms of tangible outcome and projects there is published a first overview on the programs review website.[169] So during the six-month challenge the community grew up to 678 people of which they account 459 as active members and 330 are registered participants. There have been in total over 1000 attendees to regular the community event in the 18 listed events. On the virtual wiki platform there have been 3600 contributions by in total 114 accounts. Initially there have been 15 projects with in total 75 projects members of which 8 projects and 63 participants made it to the final presentation day. The winning project was called "Baseline" which tried to develop and validate an epidemiological model based on aggregated data and discover new risk factors using this model.[170]

Next to the interviewee of the biohacking community (OdF l. 793) also the scientific and ethic committee seemed to be impressed by the quality of work (Odf l. 761). He stresses out to see all of this results under the consideration that it was achieved *"aside of their personal and professional life. And during six months only."* (OdF l. 803). Furthermore he points out the unconventional approach of some of the projects that induced a "*wow that exists*" when speaking about the projects with some epidemiology researchers (OdF l. 810).

4.6.8 Critical review and classification

Even if both the setup and the results look very promising and this case might be a showcase for such interaction between a pharmaceutical company and a biohacking community, the researcher does not want to jump into conclusion. The need for a cautious and critical evaluation of the case should be emphasized. This is necessary to reveal possible biases by both the researcher and the interviewees. In order to reflect his findings the researcher first wants to discuss reasons for a possible confirmation bias and research bias. In the following the four defined shared values of this case should be reviewed critically. At the end all factors should be considered to conclude if this case represents a collaboration based on the research definition.

Biases

From the researcher´s perspective it has to be disclosed that the evaluation of the interaction is only based on the interviews as primary source and available information on the internet as secondary source. The amount of interviews is not representative. The researcher did not take part in events or observe the actual events of this case, nor did he interview participants or members of the community. This would exceed the focus of

[169] http://review.epidemium.cc/
[170] http://wiki.epidemium.cc/wiki/Baseline#Goals

this exploratory study and the scope of this thesis. Consequently, without further investigation and a validation the researcher recommends to remain critical about the findings. Also a "researcher bias" is possible due to the perception of the phenomena and his experience in the biohacking community might influence the way of asking questions, guiding the interview, setting focus and evaluating the statements.

From the perspective of both case representatives a reason for a possible confirmation bias is that they both committed time and effort. Furthermore, Roche invested 250.000 Euro, which can be seen as a decent sum for a project which was admitted to be risky and it might simply not work (IV l. 384). Roche was transparent about this in the interview and towards journalists (IV l. 360). This transparency is missing – to the best knowledge of the researcher – on the websites of Epidemium. Roche is labeled as main partner, but the investment is not communicated clearly. It is questionable how an absolute transparency of this investment would affect the biohacking community and the perception of this collaboration. Next to that the biohacking community is benefiting form a payment of 200.000 Euro[171] and the interviewee disclosed that he is getting paid by partners on such projects (OdF l. 141, 147).

Next to an financial interest another reason for La Paillasse and Roche to show a confirmation bias might be an interest in gaining reputation by their peers or competitors for engaging in such activities. Also the research setup might be responsible for introducing a bias, because both representative agreed on not to anonymize their statements and knew that single quotes will be shared not only with their counterpart, but also later on with the general public. This might be a reason for them not speak up free an openly as there were no raised concerns or critical statements. Also there might other hidden agendas imaginable which cannot be ruled out like for example talent sourcing or employer branding on the one side and the attraction of other industry partners in the future on the other side.

Independency

This financial transaction has to be seen critical because it might affect either directly or indirectly one critical condition which was claimed as value of the program: independency – especially the one of the biohacking community. Because if such a payment is used to pay the salary for individuals (OdF l. 149) or potentially for the space itself, their perception of the partnership might be influenced and their financial independency might be questioned. Especially if there are future projects or the continuation of this program is on the line. With the aspect of sustainability the biohacking interviewee mentioned a fair point of such activities and based on his track-record of projects which can be categorized more due to their social impact than to their potential as business case, his motive seems to be not primarily money.

[171] http://www.industrie-techno.com/open-innovation-roche-s-associe-au-biohackerspace-la-paillasse.39105

As this represents a critical issue both sides were asked in the follow-up of the interview about the contractual details. This was done because a contract can be considered as huge limitation of the independency from the point of view of other biohacking community in particular the Novozyme – Biologigaragen case. La Paillasse disclosed in the follow-up that there was a contract signed. About the details both parties agreed confidentiality, still the main frame was admitted to that both engage in providing resources to manage the program successfully and deliver together the main outcome (OdF Mail). Being asked how the money was used he disclosed:

"All the budget was sent to La Paillasse to manage the overall project, this include events, resources we paid to allow participants to use it (servers farm, big data tools, spaces, etc.), travels to meet people from the ecosystem and paying freelance like designer, web dev, etc. to develop the needed tools and salary for the program staff. To sum up, the budget was used to set up the program, raised the community and provide all participant the best support in terms of expertise, tools, spaces, interactions, etc. to bring the best from the crowd to address the Challenge." (OdF Mail)

Unfortunately, to the date of the submission of this thesis Roche did not answered to this follow-up. Considering the effort to organize such a format and event, money seems necessary, still the self-declared independency at least in financial and legislative terms can be questioned. Nonetheless, the existence of La Paillasse does not depend on the support and good will of Roche as they get other financial support. Therefore can be considered semi-autonomous.

Openness

Evaluating the openness of this case it should be differentiated between how open this collaboration is for partners and how open are the results shared with the public. In both aspects the case can be seen as very open.

There was no restriction or requirements like previous knowledge for participants in the community. All information concerning the challenge and the necessary data are open access and are very well documented. The well-structured documentation and for example the specific starter kit helps all actual participants and outsiders to take part or benefit from the data. The overall impression is very welcoming and helpful. In their frequently asked question section they deal with a variety of cases of how to participate and highly encourages prospective participants to join the program. Also other companies joined as partner, but notably not another pharmaceutical company.

In terms of results the projects are very well documented in the project either on the project wiki or the source-code repositories GitHub. If this documentation is enough for reproducibility cannot be judged by the researcher. Still the organization delivers both a technical setup and encouragement to document as good as possible. The presentation and poster of the project inform very well on the what and how of the projects.

According to the set of rules of the program the participants are the owner of the intellectual property, but there is an obligation to publish contributions under a license of their choice respecting the eligibility of the Open Source Initiative. [172] This is in line with the claim of being open source / science.

Transdisciplinary

As this was one of the reason for Roche to engage in this project this aspect seems to be covered. Transdisciplinary can be confirmed by the evaluation of the initial 15 projects which cover 11 key competencies and the interviews. Both representatives noted the diversity of people who engaged in projects or are just present in the biohackerspace.

Collaboration and Classification

The purpose of this paragraph should not start a semantic driven discussion about collaboration, but it should critical review the setup of the case to validate its character and therefore prevent to draw wrong conclusions for future research. By doing so it might be argued that this case is not a collaboration but a kind of crowdsourcing instead. The fact that there was a challenge with price money presented and worked on by a crowd are arguments for that classification. In this point of view La Paillasse could be considered as crowdsourcing intermediate in a local setting or as event organization facilitator. La Paillasse could even be accused that they outsell their community which in other biohacking communities would be a strict no-go (AM l. 764). Although the challenge and the collaboration could be disaggregate from another, so that there was a collaboration in setting up a crowdsourcing campaign. The representative of La Paillasse while just being asked about his experience seemed to feel the need to highlight the character of a collaboration and argued as following:

"It was not like only a partnership where one gives money and one gives space and community. It was really collaboration and we set up the program all together. And we made to coordinate it all together." (OdF l. 700)

It cannot be dismissed that La Paillasse was part of the organizational team. So the critical question about this issue is who is "we" in this statement: Was it the whole community or every voluntary, or was it only a selected circle of which some even might getting paid for doing it. It is legitimate to pay for service in a business relationship, but it is highly questionable if a hackerspaces should be seen as business entity. This concern is based on the other interviews (MMB, NN, GA) and observations. Nevertheless paying money induces a set of professionalism and help to overcome the problems, because of which many other industry representatives hesitate to engage with biohacking community: lack of professionalism, long-term commitment and organizational structure. Being asked if the results would have been possible without this professional attitude, they admitted that probably would not be the case (IV l. 205).

[172] http://wiki.epidemium.cc/wiki/Règlement

On the other side money helps to make a community sustainable (OdF l. 147) and also individuals should be allowed to make a living from their effort and time. This is legitimate, but it should remain under critically review as a community should not become a business case or asset. There is a risk of selling out the community by accepting money with strings attached (AM l. 765). In the interest of all involved partners this issue should always be considered as it poses a threat to the community spirit which is one source of many of interesting values this interaction want to tap into in the first place. This is a finding which should be taken into consideration both by the industry and biohacking communities for future interactions in-between them. This should not imply by any means a strict zero-dollar policy, but rather encourage a pragmatic approach dealing with money. It should be handled mindful and transparent. As there have been no interviews and observations with participants this aspects cannot be ruled out, but the fact that the winning project is referring about this program as a six-month hackathon indicates that there might be a different perception of the program in the community[173]. Besides the money aspect it is critical to assess what were other benefits and based on the used definition of collaboration how mutual these benefits were for all involved parties. Also these questions are justified by the concerns of other biohacking communities who emphasized that in case of crowdsourcing often a lot of people work and only very few get paid (AM l. 674) and that there is discrepancy between input and output (MMB l. 367). So the community benefited were discussed in the previous chapter. Without a doubt, these aspects can be seen as very valuable from the biohacking community point of view and are in line with the interviews. On the other side Roche had access to diverse skills, experience, creativity and commitment by the participants to invest valuable spare time and effort into the projects. Also all the results are open source and therefore equally accessible and useful - at least theoretically – for all participants and the scientific community. That is one key difference to crowdsourcing because there the solution are not disclosed. Although just labeling crowdsourcing campaign as open source does not make it a collaboration. But overall the degree of mutuality in terms of benefits can be seen positively in this case.

Also in terms of governance and organization both partner with designated project teams appear mostly to be equal in their task and rights. Next to organizational work La Paillasse highlighted that *"people from the pharmaceutical company came pretty often to our meetups, some get involved in our projects, getting involved visiting the community, they came to be contributor on the wiki"* (OdF l. 697). So there was an involvement and interest by people from Roche. So there were interactions between both sides. Next to Roche people interacting with the community also the teams interacted and cooperated with each other despite the price money (OdF l. 259). All these aspects can be seen as arguments for a classification as collaboration.

[173] http://wiki.epidemium.cc/wiki/Baseline

Concerning the part of the definition on *"the issue that brought them together"* there seems to be no doubt for the researcher that both parties have the true intention to contribute in the fight on cancer. What has to been seen critically is the aspect on "shared norms". Theoretically, the cultural gap is huge between a pharmaceutical company and a biohacking community. One represents openness and the other is built on patents and secrecy. It seems challenging to bridge both contrary parties due to this differences. It could be argued that in order to start finding potential overlaps one of the first steps is to acknowledge the others identity, culture and differences. Although both sides agree that they were hooked right from the start, the researcher remains skeptical if the industry partner really acknowledged the culture and identity of the biohacking community. Also the representatives might have assimilated themselves in the talks to either sell themselves or be pragmatic to make such a project work. This point of view is based on statements by the industry representative. Being asked about her idea about hacking she described hacking as "*fashionable*" (IV l. 55) which she does not like and is not important to her (IV l. 62). Questioned about the implication of the term hacker in the general public she even speaks about "*a sort of fantasy around hacker*" (IV l. 163). Although this might not be representative for all involved people from Roche - like the actual project manager who was present at the interview and had the chance to add comments in a follow-up email - it shows that the interest might not be primarily in the community itself as partner, but it might be more seen as an asset:

> *"To me what is not important is if La Paillasse is hacker or not-hacker. What it is important to me is that La Paillasse is doing something different, with a lot of different people, with a lot of different expertise. And this is key. The name of hacker is not something important to me."* (IV l. 78)

In chapter 2.3.3 it was discussed how important a cultural fit and the perception is for the success of a collaboration. It seems to be one thing, if there is clash of cultures which can be overcome and comprises can be made. But it seems questionable for a representative of the pharmaceutical industry, who is interested in a long, trustworthy and productive partnership with a biohacking community, to show such a low appreciation of the cultural understanding of ethics and values of the community. Even if it seems to currently to work well, people in biohacking communities *"are not the dumbest"* (AM l. 884) and eventually find out. Even if the terms "hacking" and "hacker" are admittedly fuzzy, representatives should value their counterparts culture because it is the source of the value they initially want to internalize. So instead of speaking about *"fantasy"*, representatives should take their cultural identity serious and be transparent about their own intentions. So the aspect of "shared norms" has to be seen highly questionable.

In summary and based on the current evaluated information which are not representative, there are questionable points and aspects which cannot be ruled out. This case still fits the research definition of Thomson et al. for a collaboration. But the concern should be raised that this case should not be seen as typical case for a collaboration of a pharmaceutical and biohacking community – at least until further research was conducted.

4.7 Review Collaboration of Novozymes and Biologigaragen

4.7.1 Case description

The second case is about the collaboration of the Danish biotechnology company Novozymes and the Copenhagen based biohackerspace Biologigaragen. There is a project they are working on together called "Baessy".

The goal of this open source research project is to develop cheap, robust, standardized and simple assay tools to monitor biological process. The tools should be useful for industrial and academic laboratories across the world, but also for DIY- and homebrew communities.

As first milestone it was declared to build gas phase sensors to measure bioethanol during fermentation. The focus of the projects was divided in three topics: [174]

- Open source assay development
- Biodesign for the everyday life
- Open source laboratory tools & equipment

4.7.2 Partners

Novozymes is not a pharmaceutical company, but as biotechnology company. So their focus is life science and they interact with biological matter very closely. The consequences of this choice will be discussed in a later chapter. Novozyme has around 6400 employees worldwide and it spent 14 % of their revenue in R&D last year. Its focus is in enzyme production and their market is B2B in which they are market leader with market share of 48 %. [175] Since January 2015 Novozymes as part of their innovation strategy introduced one strategy called *"Partnering for Impact"* which *"enabled us to rethink relationships and business models and think more in terms of partnerships."* (CEO Nielsen)[176]

[174] http://biologigaragen.org/baessy
[175] http://report2015.novozymes.com/
[176] http://report2015.novozymes.com/

Biologigaragen is a biohackerspace and a community laboratory in Copenhagen. Biologigaragen describe itself as "a physical space containing a laboratory as well as an association for people with an interest in practicing biology."[177] As their purpose Biologigaragen declares "*to foster a culture of citizen science, and build a community laboratory for people to meet, play, do projects and share their ideas.*" [178]
Biologigaragen started out in 2010 and is associated to a technical broader hackerspace called "Labitat". Biologigaragen is a members run and is organized non-hierarchical. There are two organizational elements present: First of all, the general assembly which is held monthly and open to all members. It is considered as the "highest authority of the association". Next to that, there is a an elected board which is responsible for administration. There are no restriction in becoming a member but a certain process for which a monthly meeting or the board has to accept the perspective members. Additional there is an annual fee of 150 DKK (20 Euro). Not being a member does not exclude people from coming to the events and participate in lab work as guest. Biologigaragen is benefiting financially by sharing their facilities with a general hackerspace and also it is supported by donations.

4.7.3 Motivations and individual benefits

Both agreed that the overall motivation was to explore what is feasible and beneficial for both by tinkering with open source hardware for both the industry partner and the biohacking community (GA l. 361,365, MMB l. 442)

The responsible science manager at Novozymes Gernot Abel sees the potential in open innovation in general as opening up and actually getting into a dialog (GA l. 38), but also about inviting outside people and skill-set which Novozymes is lacking and where it can be improved (GA l. 76). He was especially interested in their technical skill-set in micro processing and programming. He described that bluntly as a level of skill-set which is not present in Novozymes and therefore identified the biohacking community as complimentary partner for his wish to improve and change many aspects of the lab work at Novozymes for example by automation (GA l. 381). He describes himself as someone who is highly affine to such technological tinkering (GA l. 376) and expressed his fascination for many projects from global community. He articulate his wish to create an interface to absorb not only that kind of knowledge and tools present in the biohacking community into Novozymes, but also the creativity and craziness that is not typically be seen in a company (GA l. 157). He wants to embrace the prototyping possibilities to create what he calls "haptic innovation" (GA l. 164, 185):

> *"It is not only about discussing innovation or what kind of tools could we use, it is crowdfunding, crowdsourcing, but it is making it haptic."* (GA l. 164)

[177] http://biologigaragen.org/about
[178] http://biologigaragen.org/about

Being asked about the benefits for the company interacting with a biohacking community in general he noted that there is potential to *"kind of disrupt the innovation process"* (GA l. 301). He argues that even next to the interaction itself, by just mimicking internally their different mindset and methods to approach problems it can influence the innovation process of the company (GA l. 301, 562). The actual interaction is helping him and the whole innovation department not only to copy methods like in his example a hackathon, but to "make it authentic" (GA l. 565). Also it seems that adopting communication (e.g. use of Twitter (GA l. 494)) and sharing habits which are present in biohacking communities, help innovation leader in companies to make the innovation process more tangible and present for the rest of the company next to the standard monthly innovation newsletter (GA l. 504). The company also seems to benefit from the two characteristics of the biohacking community: First of all, that they are not product oriented, but more process oriented (GA l. 318). Secondly, that they highly value the sharing of knowledge and the mutual education on the process (GA l. 138). Furthermore, he emphasizes their potential as source of inspiration (GA l. 316) and ideas (GA l. 302). He values and showed to be impressed by their network locally and globally (GA l. 315) which was shared with him by being connected and introduced to many people (GA l. 437). he described the network as very different and which would not to be visual for the company otherwise (GA l. 151). He is speaking of an increased connectivity (GA l. 558). There was even one case in which through the mailing list this network was even helpful to attract a possible new customer. He emphasized that the network and this activity is a "door opener" from which both sides can benefit (GA l. 613). Also this activity and the communication about it (GA l. 553) helped to change the perception of customers and partners as they are *"puzzled"* about this approach by Novozymes (GA l. 583) which he refers to as *"paradoxical intervention"* (GA l. 582):

"You might call it is an innovation breaker, it is not an ice breaker. It is an innovation breaker." (GA l. 575)

On the other side the biohacking community part hoped mainly for *"a crosspollination of ideas"* (MMB l. 426) while talking to the industry representatives. It seems that it could generate a mixture of theoretical knowledge and playful tinkering by the biohacking community with the actual practical experience and problems of the pharmaceutical industry. In general the biohacking representative made the impression that for him this interaction was for the sake of curiosity and that benefits would happen naturally for example by exchange of insights which would be *"fruitful for the internal discussion of the community"* (MMB l. 561). These different insights and experiences (MMB l. 596) would be exchanged by the representative *"just being there"* (MMB l. 566). The interviewee of the community was well aware of the IP relevant issues in such an approach, but outlines that there is so much besides that which could be interesting for the community (MMB l. 567).

Being asked to describe the benefits for its counterpart the industry describes that there have been donations of equipment (GA l. 197) and Novozymes also brought needed technical and biological for the particular. For all the project material Novozymes spent about 1350 Euro in total (GA l. 543). Besides this project he signals a strong openness to help other biohacking communities as well. This not necessarily include financial or material support, but for example advice and knowledge on projects or problems (GA l. 203). Another non-tangible benefit the biohacking community is supposed to get is credibility which is connected with the brand of Novozymes, which for example should help to apply for founding. He emphasized that he is doing this as well with other hacker community projects or ventures and that for him it is only a tweet on Twitter, but a valuable popularity and credibility push for the projects (GA l. 631).

4.7.4 Initiation and Design

The initiative factor was a PhD student associated with Novozymes, who together with individuals from Novozymes approached the Biologigaragen (MMB l. 338). It has to be noted that the first approach failed. The actual interaction started out with informal bi-weekly meeting of two individuals of both sides. These two were reflecting how the approach using open source hardware which is present in the biohacking community could benefit the "*everyday life as an assay scientist*" in a company (MMB l. 441). So they agreed on building a first prototype in their bi-weekly session every Thursday for a few hours. This agreement was informally and to no point there was a contract.
They made the project publically and open for everyone who is interested to join in. They jointly organized a workshop on this topic for school children to "see how easy this was to be understood" (MMB l. 444) and that "the best and biggest engagement is in the education sector" (GA l. 478). The coordination was equally shared by the two individuals of both sides. An overview of the coordination and also the overview on documentation is a publically available shared Google document. In this document there are descriptions of work packages, tasks and responsibility, so every interested person can freely attach to them. The communication is done mainly by the mailing list. There is no designated project manager at Novozymes as it was a side project of the responsible science manager who was allowed to spent every two weeks half a day at Biologigaragen working on the project. But he also invested his private time to work on this project (GA l. 541). In financial terms there was no direct payments involved based on the project from Novozymes to Biologigaragen, still they covered the costs around 1350 Euro for necessary material (GA l. 543).

The project is currently on hold as the availability of the responsible person in biohacking community changed due to a new job as management consultant (GA l. 692). The industry representative is still supporting the biohacking community as best as possible in order to "keep them in the landscape" and possible do workshops in the future (GA l. 698).

4.7.5 Tasks

As one important task trust building was mentioned (GA l. 483, 414). It was outlined that trust was not necessarily to be built between the company and the community as entities right from the beginning, it rather should start through individuals spending time together either by regularly meetings or just employees engaging in their private or working time in the biohacking community in order to *"slightly get to know each other and slightly build trust from an individual to individual."*(MMB l. 465). Both sides seem to have found their necessary level of trust - without a contract. The industry representative highlighted that trust is not only crucial in-between organizations, but also internally in the company. According to him it was not only his effort as project coordinator, but he worked closely together with the innovation department (GA l. 491) and emphasized trust was important for his activity (GA l. 469, 504):

"I have been working together with the innovation management people like Frank Hatzack and Christian Tillegreen and they have been kind of the corner stone to make this a success. If I would have been doing this alone, yes it would been interesting from the technical side, but generating the inside on how this innovation work here, how do you run it, how do you communicate it." (GA l. 489)

Next to trust it was seen as important to build a project governance structure (GA l. 469) and talk about expectations regularly to avoid different perceptions and disappointment of the participants (GA l. 432). This is needed to preserve the engagement in the community, which was seen as big challenge. Therefore both representative together with other community members had constant discussions on how to create engagement (GA l. 470). This engagement was seen particular important as the objective of the challenge contains biological experiments which need continuous work. Interestingly they realized that the highest engagement was achieved by engaging in education. Therefore they jointly created and ran a workshop for pupils on their project objective and invited school classes to the biohackerspace (GA l. 478).

4.7.6 Experience

The overall experience for both was positive. Especially the industry representatives was open and enthusiastic about his experience and described his overall experience:

"So we can make it tangible, haptic and authentic. It is not just damn dirty talking that we want to make innovation, but we actually do it." (GA l. 565)

The interaction seemed to be based on open dialogue and very close interaction in this regularly meetings. Both were able to share their views openly (GA l. 415), reflect them (MMB l. 441) and it was no issue to argue with opinions or even criticize each other for instance as using "corporate language" (GA l. 417). There was an openness for giving and receiving advices (GA l. 416). But they did not seem to assimilate completely because according to industry representative they accepted their differences:

"But realizing okay, yes for sure there are some flavors that makes me different. We have different philosophies. Accepting these philosophies." (GA l. 419)

Also he agreed that there is a possible "clash of cultures" between biohacking communities and the industry (GA l. 341, 683) and furthermore he acknowledged that "*hacking is an identity of the community somehow"* (GA l. 261).

He also reflected that *"it has been challenging and not a walk in the park"* (l. 591) as there might have been single cases of wrong expectations in the community about the interaction which caused disappointment, frustrations or even aggressive behavior (GA l. 431). For this reason, he emphasized the ability of dealing with feelings (GA l. 436) and soft skills in general (GA l. 422). But even if this seemed to be present as the two coordinators *"had a very good going along and knew what we had in each other"*, there still appeared friction in the project execution (GA l. 458). But interestingly according to him this was also essential for the experience and the outcome because:

"Innovation is about friction. If it doesn´t hurt, if it doesn´t burn, if it doesn´t do something it is not innovation." (GA l. 589)

4.7.7 Results and Lessons learned

The tangible result of this project was the development of a prototype (GA l. 550). Although this seems to be not very much at first, this prototype was shown several innovation and science conferences and the involved people were invited to give talks about the project. So it seemed to influence the peer and public perception of innovation and at Novozymes (GA l. 552) and increased the connectivity of the innovation department (GA l. 558). They were enabled to take different conversations with people as result of this interaction which is seen as "door opener" even to customers (GA l. 613). Furthermore, the industry representative emphasized the variety of other non-tangible and not by key performance indices (KPI) measurable results (GA l. 588).

One of this non-tangible and not measurable results which affects mostly him as innovation manager is that the insights and experiences of this interaction *"had completely changed my view on things"* (GA l. 392) and consequently he decided to become a member of the biohacking community himself (GA l. 690). So the result for him was to gain access to a network which might be unconventional, but interesting for the matters of the company (e.g. microfluidic systems and lab automation (GA l. 189)). He was able to obtain insights in new fields he had "*no clue*" about before like synthetic biology (GA l. 392). But also his initial intention to learn practical skills on micro processing seemed to be satisfied given the project requirements of building and programming a sensor. They seem to be inspired by the prototyping idea and the do it yourself mentality which is present in the biohacking communities. For example after this interaction they seem to rethink processes and are more critical about decisions in

terms of just spending a huge amount on lab equipment. As an practical example for a change of mindset in the RD department the innovation manager disclosed in the follow-up an internal presentation. In this presentation they were discussing the approach of instead of buying one specific, high end tool for the lab for 500.000 DKK to rethink the process and built something pragmatic and cheap for 500 DKK.

Next to results there have been many learnings during and because of this interaction. The industry representative summarized them as following:

"Well the lessons are trust opens doors, be prepared for surprises, positive and negative and the third one – lessons learnt – communication is key and perception is key." (GA l. 650)

Trust was already mentioned as critical aspect in the task chapter and is highly related to communication. The whole setup of this interaction was not something planned in advance or has been captured in a roadmap, it was designed on the fly. This finding is difficult to deal with as it is hard to apply on other communities. So consequently the third key lesson of being prepared for surprises seems to be reasonable. At its beginning there was such surprise for the industry which almost led to no further interaction and maybe results in the last referred key lessons: perception. Because it proofed not to be helpful to apply traditional business-to-business mindset while interacting with a biohacking community. Both the sides reported this experience (GA l. 410, MMB l. 474). As being confronted with a legal document the community simply refused to sign it. This insights reveal that a typical business agreement or contract with terms and demands can be seen as threat to the freedom and independency for the member of the biohacking community. In their understanding the community does not see itself as a legal entity and embraces freedom and indepedency. This was seen as classic misunderstanding and misperception by the industry about their identity (MMB l. 480). Furthermore, the representative stated that it would limit the interaction itself (MMB l. 479). Novozymes overcame this problem according to the biohacking community representative by *"sending down the people who knew what they could tell and what they couldn´t tell us. So it really was based on the individuals and not that Biologigaragen signs a kind of contract."* (MMB l. 481). Still the representative were able to reduced IP risk by ruling out certain critical fields in the interaction from the beginning in which such problems could occur (GA l. 370). Still after months of interaction the representative of the biohacking community prefers to speak about a collaboration between individuals of Novozymes and Biologigaragen (MMB l. 436).

For being able to deal with such an interaction the science manager described necessary employees as people who are not afraid of non-conform actions (GA l. 517) and someone who likes to work outside his comfort zone (GA l. 668) and can cope with uncertainty as both the outcome and the process is not predictable (GA l. 527).

Being asked what their counterpart learnt during the interaction the industry part outlined that the representative got a better understanding of project management as it is done in the industry (GA l. 653) and on the other side the industry got inspired by the approach the tools and knowledge. And consequently Novozymes are supposed to look *"more into open electronics and newer open-source hardware that can be suiteable in a lab context "* (MMB l. 447).

4.7.8 Critical review and classification

With all this excitement of the industry representative it seems necessary for increasing the objectivity and reliability of his insights to critical review the case and discuss possible biases. This review is done analog to the first case of Roche and La Paillase.

It has to be discussed and disclosed that Novozymes is not a pharmaceutical company. This might have consequences for the implications and findings about the interaction, still as being a biotechnology company and with its objective about biological organisms and lab equipment it could have been done also by a pharmaceutical company to improve their RD processes. So it seemed valid to analyze this interaction.

To achieve internal validity both cases were researched with the same approach which is as discussed in the first case prone to the biases. Still it aimed on making the cases more comparable to each other. Unfortunately due to different setups and dimension the comparability in several aspects seems not to reliable enough to draw conclusions

<u>Biases</u>
As mentioned both invested money and time can lead to a confirmation bias. With only 1350 Euro invested money should be seen as negligible. Also nobody´s salary is depending on the outcome of the interaction. Also time might be not a compelling reason, because with only 2 days a month of his working hours spent at the biohacking community it might seems not enough to falsely justify the interaction. Far more reasonable seems to be the idealistic value for the representative who speaks very enthusiastic and passionate about the biohacking community. He might be affected by his perception and his personal involvement in Biologigaragen himself. As science manager his highest priority is not to initiate collaboration or build open innovation programs, still to obtain reputation in innovation matters by peers or position himself as collaboration partner for other biohacking communities cannot be ruled out completely, but in comparison to his idealistic value seems also negligible. So it should be remain caution to jump into conclusion only based on his perspective due to the possibility of a confirmation bias. Also, his experience is not necessarily representative for all biohacking communities. Still the reliability of this observation and opinions can be rated as high, because he has experience with interacting with several biohacking communities (GA l. 49, 365) and did this for about three years (GA l. 48, 391). Also

other encountered or interviewed representatives from different companies saw many of the potentials and benefits he describes in his statements as well to be present in the biohacking communities (e.g. Interview NN).

On the other side the representative of the biohacking community can be considered as neutral without real reasons to be biased. It could be argued that reputation related with this interaction helped the community which he is the co-founder of and also himself in his career. But for instance he withstood the temptation as there was a contract with official terms because it would hurt the integrity of the community. Also when referring about the interaction being mostly between him and his counterpart of Novozymes he seems not to do this to snatch the reputation, but more out of idealistic beliefs and the valuation of the freedom and independency of the community. This attitude, his mindful and neutral way of answering is stringent throughout the interview and seems trustworthy. Still a bias or a personal affection cannot be ruled out completely.

Collaboration and Classification

Concerning the definition on collaboration this interaction can be classified as collaboration as it fits all necessary criteria. Both partners can be rated as autonomous, even if there was a donation of about 13400 Euro[179] and lab equipment this is not substantial for the existence of Biologigaragen. This donation was transparently published on the website of Biologigaragen. There was no contract present so the process was informal by jointly discussing terms, rules, structures and process. They set up an objective of the collaboration. The interaction can be rated as mutually beneficial as the immediate results were publically available. Still the impact of this interaction seems to be more on the side of the industry as it affected the perception of innovation processes and its openness of single individuals. This particular way of approaching problems was also "developing" shared norms. Still Novozymes had to learn it the hard way and the interaction almost failed because of the wrong initial perception of their counterpart. Once there seemed to be cultural fit through the assigned project coordinators on both sides the interaction seemed to be engaging and productive.

This case of interaction is a good showcase how important the perception of the biohacking community for the success of a collaboration is. Also, it shows how you can achieve with little money a lot of tangible and especially non-tangible results. The stated impact on the innovation processes should be emphasized once again. The project itself seemed to secondary for this process, but it was important to create engagement and catalyze exchange of habits, knowledge, ideas and inspiration. So it might be a showcase that such collaboration showed not be designed primarily outcome-oriented, but process oriented, as this might far more valuable. This also showed to be a good method to deal with otherwise occurring

[179] http://biologigaragen.org/2013/282

5. Conclusion

Concerning the process and the objective of this exploratory study about biohacking communities and their interactions with the pharmaceutical industry the researcher shares the lesson described by an industry representative about his interactions:

"(..) it is travel you might get addicted to, so that is a lesson learnt." (GA l. 653)

In order to strive to answer the role of hackers in the open innovation processes of the pharmaceutical industry the first step was to make the word hacking tangible and also better understandable for innovation studies. This yielded to a research definition which should be seen as temporary and has to be sharpen in future. Important in this context is that hacking should no longer viewed only from an ICT perspective, nor as criminal related activity. Hacking is about embracing curiosity, sharing and education and dealing with technology in a creative, experimental and hands-on way.
The consequent task to develop specific profiles of hackers was unsuccessful as the collected data is not representative enough to deduct any reliable profiles. There might be common characteristics, but it seems that there is no such thing as a typical hacker or hacking community. Still the thesis illuminated a variety of different motivations. These are valuable insights as they could be used by innovation manager for finding overlaps and then to create and incentivize interactions. The study revealed a variety of appealing reasons to consider biohacking communities as innovation partner. These values appear in form of creativity, ideas, all kind of technological projects, startups or as talent pools.

It showed that innovation manager, who although not having any profiles or cases to follow, were able to successfully established such interactions. Typical innovation and management methods seems not to be very appropriate. So the key of this endeavor seems to accept and embrace the explorative character of such interaction – especially on a personal level of the innovation manager. As all encountered biohacking communities showed a general willingness to engage with the pharmaceutical industry – not without having biases, but for the sake of interacting with interesting technology, skilled and experienced people in the industry and working on a higher purpose – innovation manager can simply start engaging with such communities on an interpersonal level. There seems to be no big risk in terms of IP issues or investment as such interactions seems to be designable appropriately. Interaction should be designed in an open dialogue and innovation manager should not insist on contracts as such communities are not business entities and it might threaten the interaction itself. The interaction should be based on trust and more seen as informal.

In order to be prepared and fully leverage the potential of such interaction this exploratory study comes to the conclusion that future research is needed – especially given such statements by industry representatives:
"(..) we are going to do this, it is a question of how and when, not if." (NN l. 224)

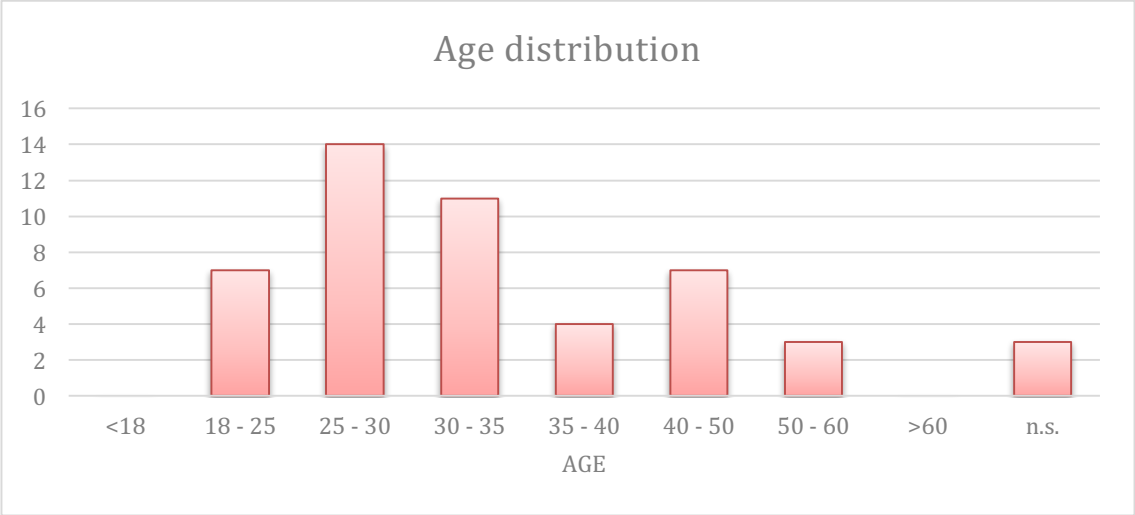
6. Appendix

6.1 Questionnaire

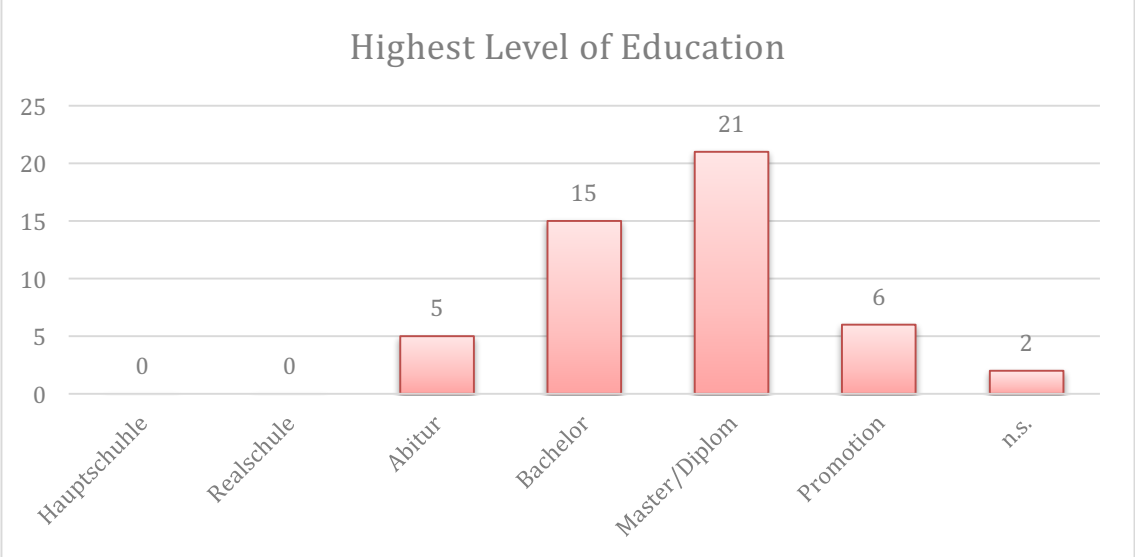
6.1.1 Results

Gender
Total: 48 / 100 %
Male: 33 / 69 %
Female: 15 / 31 %

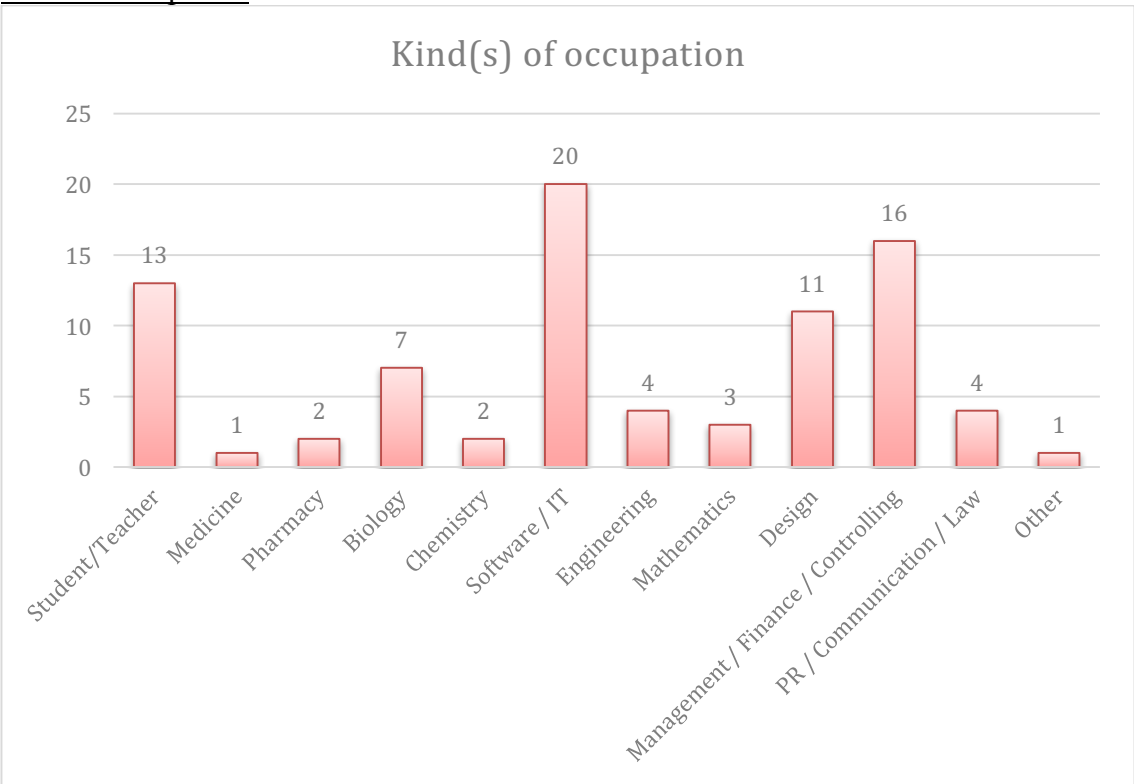
Age
Average age: 32,93 years



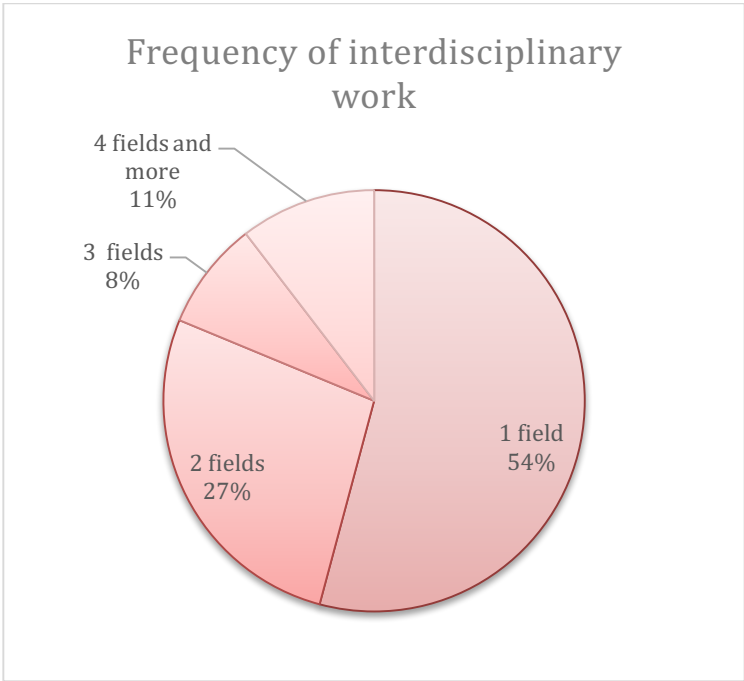
Highest Level of Education



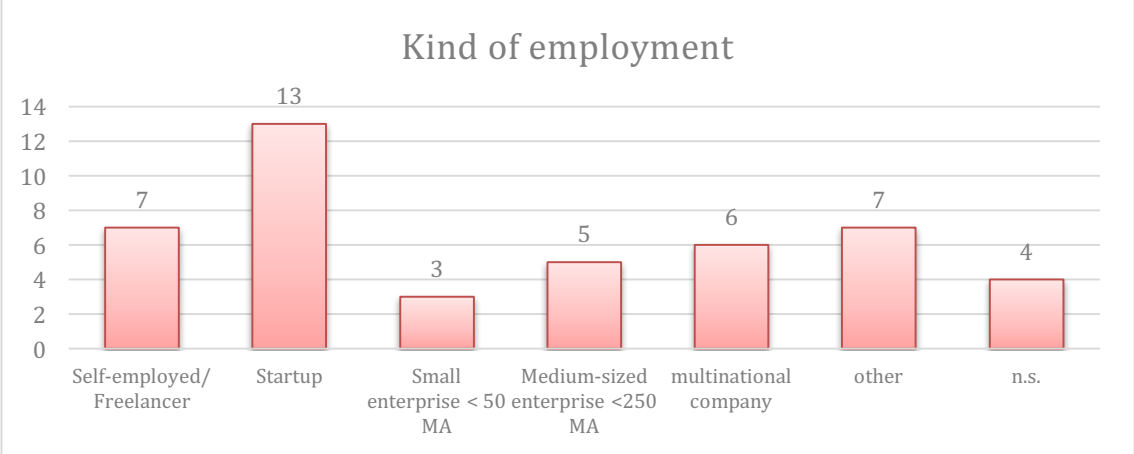
Kind of occupation



Average number of fields of occupation: 1,71 fields of occupation



Kind of employment



Q: What is your motivation to participate in this event today?

#	Motivation	#	Motivation
1	interest in science and technology	**17**	curiosity, Interest in CCR delta32 (0,1,2 copies)
2	to explore the exciting field of genetics and its potential for the future	**18**	new topic
3	learning, knowledge	**19**	Taking part in the biohackacademy, there is a general interest
4	I want to know what is possible with today's technology	**20**	learn
5	expand horizon; learn about gene coding	**21**	curiosity related to my bio course; interest in scientific projects, interest in artistic work
6	I am working for a marketing department of a biotech startup. In order to better understand my job and tasks I joined this event. Furthermore the topic is of my interest besides my professional occupation	**22**	making a documentary
7	new field of interest; state of the research	**23**	I would like to understand better how humans can influence & engineer biological systems to fit their need or to understand the world better. I am interest in science, engineering & technology and this is a great opportunity to understand how bio engineering is done
8	Smart Data, Privacy Policies (Governance), Digi Health (Product + Marketing)	**24**	Professional: general field of digital production and design; Private: to give a creative twist to my (.not readable..) Failed attempts
9	Founder of Hacking Health Berlin (Meetup-group)	**25**	interest in tissue stuff etc.
10	become a gene scientist, learn more about biohacking	**26**	make my own organism / journalism
11	curiosity	**27**	learn
12	curiosity	**28**	learn about GMO in DIY context
13	Crispr	**29**	Bio-Hacking Introduction
14	high interest in topic and possible professional reorientation	**30**	curiosity
15	Crispr/Cas 9 and synthetic biology	**31**	personal interest
16	private		

Q: Which Nature is your interest in this event?
Total: 48 / 100 %

private: 22 / 46 %
business: 2 / 4 %
both: 24 / 50 %

Q: What do you expect to take home from this event?

Q: How would you estimate your knowledge in biosciences?
Total: 45 / 100%

n.s.: 2 / 4 %
no previous: 16 / 36 %
basic: 17 / 38 %
intermediate: 4 / 9 %
competent: 6 / 13 %

Q: Is this your first "biohacking" event?
Total: 49 / 100%

n.s.: 1 / 2 %
yes: 35 / 71 %
no: 13 / 27 %

Q: Have you know about "biohacking" before this event?
Total: 49 / 100%

yes: 39 / 80 %
no: 10 / 20 %

Q: How did you find out about this event?
Total 46 / 100 %

By an invitation in the Meetup group 19 / 41 %
By friends 16 / 35 %
More by coincidence based on general interest in technology 7 / 15 %
Active research about "biohacking" 4 / 9 %

Q: How is your attitude towards “hacking” in general?

Total	49 / 100%
Postive	21 / 43 %
Rather positive	16 / 33 %
Neutral	10 / 20 %
Rather negative	0 / 0 %
Negative	1 / 2 %
N.s	1/ 2 %

Q: Is problem-solving a large part of your occupation?

Total:	49 / 100%
yes:	37 / 75 %
no:	5 / 10 %
not sure:	5 / 10 %
n.s.:	2 / 5 %

Q: Do you engage in technology and science outside your professional occupation?

Total:	47 / 100%
yes:	47 / 100 %

Q: If so, rarely, often or regular?

Total:	26 / 100 %
rarely:	8 / 31 %
often:	6 / 23 %
regular:	12 / 46 %

Q: Do you have private scientific / technology-based projects and/or ideas you are currently working on or planning to work on in your leisure time?

Total:	46 / 100%
yes:	41 / 89 %
no:	5 / 11 %

Q: Did your professional problem-solving tasks ever benefitted from your private projects?

Total:	37 / 100%
yes:	31 / 84 %
no:	6 / 16 %

Q: What is “hacking” according to you? Please try a definition or description:

#	Definition	#	Definition
1	creative application of technology (definition by CCC)	**23**	remodeling, redefining, adjusting existing systems, platforms etc.
2	Modifying or tampering with a system against the rules laid out by the system designers	**24**	curiosity
3	take matters into one's own hands. Grassroots	**25**	modifying systems, habits, technologies; asking questions and trying to answer them in a creative way
4	to take responsibility for your own body and to something about it	**26**	making changes in a system
5	curiosity	**27**	modification
6	crossing boarders	**28**	non-business nor academia related "playing" / changing / a... With certain things
7	Taking a system and modifying it to do more than intended and more than was thought possible	**29**	It is on an individual level, a challenge to produce tangible results from a system that you learn about through a lot of self-teaching and experimentation. On a collective basis it is a way of people trying to take specific parts of world systems into their own hands to recreate or restructure them somehow
8	find fast, practice oriented solution	**30**	transform the functioning of a process or a machine with a DIY solution
9	optimization; trying to get a deep understand of something and then change it completely with technology	**31**	tinkering, adopting & transforming existing stuff to meet your needs
10	fast solving of a problem, often without taking all boundary conditions into account	**32**	in the bio-sense using different kind of biological processes such as cell culture to produce particular effect
11	unconventional methods	**33**	it is a stupid word, be more specific
12	to cross boarders in order to push development forwards	**34**	make do things, something they were not intended by design
13	find the most efficient ways to solve a problem. These ways can be untraditional	**35**	empowered to do research independently, collect, understand, build things
14	to optimize	**36**	Understand something and change it to the advantage for a lot of people
15	change and optimize	**37**	take creative - not always legal - means in order to use stuff, information or practices in a different way than expected
16	people who research out of curiosity in order to challenge themselves	**38**	to discover of possibilities in special areas
17	innovation	**39**	to decode and solve problems
18	overcome constraints	**40**	obtain of information
19	solving problems in creative way	**41**	to analyze and test software, hardware and processes
20	find new ways in a playful way	**42**	IT, Code
21	creative and novel approaches to overcome problems, which are better than the "standard"	**43**	finding solutions around established systems

Verbs		
Most frequent mention: optimize (5), understand (5), modify (4), change (4), solve problem (4)		
Group	**Frequency of mention**	**Single words and frequency**
Expression of practical intention	18	optimize (5), to modify (4), change (4), adopt (1), transform (1), restructure (1), remodel (1), recreate (1)
Expression of problem solving	9	solve problem (4), overcome problem (1), find solution (1), find way (1), overcome constraints (1)
Expression of physical activities	7	make (2), produce (2), build (2), take apart (1)
Expression of practical knowledge creation	6	tinker (1), experiment (1), test (1), discover (1), analyze (1), research (1)
Expression about knowledge	6	understand (5), learn (1),
Adjectives		
Most frequent mention: creative (4), curios (3), hands-on (2)		
Group	**Frequency of mention**	**Single words and frequency**
Expression of creativity	7	creative (4), untraditional (1), unconventional (1), different (1)
Expression of ways how to approach problem	7	fast (2), playful (1), efficient (1), practice oriented (1), tangible (1), empowered (1)
Curiosity	5	curios (3), hands-on (2)
Others	3	novel (1), illegal (1), collective (1), individual (1)
Objectives		
Most frequent mention: systems (6), technology (3), process (2), boarders (2)		
Expression of objective of interest	15	systems (6), technology (2), hardware (2), software (2), information (2), machine (1)
Expression of process orientation	5	process (2), practices (1), method (1), approach (1)
Expression of rebellious intent	4	boarders (2), rules (1), constraints (1)
Expression of outcome	5	innovation (1), development (1), advantage (1), effect (1), result (1)

6.1.2. Example Questionnaire

Scientific questionnaire about „Biohacking“	 Student: Christian Schulz Supervisor: Jan-André Pramann, Institute of Business Administration at the Department of Chemistry and Pharmacy
Name Event	Place, Date

Dear participants,
dear Biohacker,

This questionnaire (1 ½ pages, 5 min. handling time) is part of my data collection for my master thesis in innovation management at the University of Münster, Germany. As part of my studies in business chemistry my research interest is "biohacking". I am interested in the people, their backgrounds and their individual motivations. All information is handled confidentially and is only used for scientific purposes. For further enquiry or interest in the scientific evaluation feel free to contact me under: c_schu86@uni-muenster.de

Thank you very much for you participation and your support of my master thesis.

Best scientific regards

Christian Schulz

General personal information

Gender:
□ female □ male

Age: _____ □ no comment

Highest level of education:
□ High school / GED □ Graduate
□ Undergraduate □ Bachelor Degree
□ Master Degree / Diploma □ PhD
- if academic studies, which field of study:

_____

Kind(s) of occupation: – *Check as many as appropriate*
□ Student / pupil / lecturer □ Medicine
□ Pharmacy □ Biology
□ Chemistry □ Software / IT
□ Engineering □ Mathematic
□ Design □ Management / finance / controlling
□ PR / communication / law □ Sonstiges:
_____

Kind of employment:
□ Self-employed / freelancer □ Startup □ small entreprise < 50
□ medium-sized entreprise <250 □ multinational company □ other:_____

Kind of industry: _____ □ no comment

Questions about the event:

What is your motivation to participate in this event today?

Which nature is your interest in this event?

□ private □ business □ both

What do you expect to take home from this event? – *Check max. 3 items*

□ Inspiriation □ Knowledge □ Skills □ Experience □ Fun

□ Contact to like-minded people □ Contact to interesting people

□ other:_____

How would you estimate your knowledge in biosciences?

□ no previous □ basic □ intermediate □ competent

Is this your first event about "biohacking"?

□ yes □ no

Have you known about "biohacking" before this event?

□ yes □ no

How did you find out about this event?

□ by an invitation in the Meetup group	□ by friends	□ more by coincidence based on general interest in technology	□ active research about "Biohacking"

Question about „hacking":

How is your attitude towards "hacking" in general?

□ negative	□ rather negative	□ neutral	□ rather positive	□ positive

What is "hacking" according to you? Please try a definition or description:

Question about your relation and usage of technologies and science

Is problem-solving a large part of your occupation?

□ yes □ no □ neutral

Do you engage in technology and science outside of your professional occupation?

□ yes □ no *if yes*: □ rarley □ often □ regular

Do you have private scientific / technology-based projects and/or ideas you are currently working on or planning to work on in your leisure time?

□ yes □ no *if not, why?*: _____

Did your professional problem-solving tasks ever benefitted from your private projects?

□ yes □ no □ not sure

Thank you very much for your participation and now please enjoy the event!

6.2 Interviews

Interviewees Biohacking Communities

Name of Interviewee	Abbreviation	Date	Duration	Community	Collaboration experience with industry	Profession
Martin Malthe Borch	**MMB**	13. June 2016	56 min	Co-founder of BiologiGaragen in Copenhagen, Denmark	yes	Management Consultant
Pieter van Boheemen	**PvB**	13. June 2016	57 min	Founder of Dutch DIYbio in Den Haag/ Amsterdam*, Netherlands	No, wish to collaborate on antibiotic project	Manager at Waag Society; Founder and CEO of Amplino
Olivier de Fresnoye	**OdF**	17. +23. June 2016	91 min 35 min	La Paillasse, Paris	Yes, as dedicated project manager	Freelancer**
Alexander Murer	**AM**	21.June 2016	78 min	Co-founder of Open BioLab Graz, Austria	No	Founder and CEO of Briefcase Biotec

* community originally was established in Den Haag and then moved to Amsterdam hosted by Waag Society, which employed Pieter van Boheemen as project manager

** according to answers in interview and LinkedIn profile, note eventual bias due to payment

Interviewees Industry Representatives

Name of Interviewee	Abbreviation	Date	Duration	Organization	Collaboration experience with biohacking communities
Niclas Nilsson	**NN**	7. July 2016	90 min	Head of R&D Open Innovation, Leo Pharma, Denmark	no
Gernot Abel	**GA**	13. June 2016	100 min	Science Manager Novozymes, Denmark	yes
Isabelle Vitali and Jean-Frédéric Petit-Nivard	**IV**	8. July 2016	59 min	Innovation and Alliances Development Director; Innovation Manager; Roche France	yes

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