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# Utilization And Valuation Of Open User Communities in High Technology Companies

Master's thesis in Master of Management - Strategy and business development

Supervisor: Arild Aspelund

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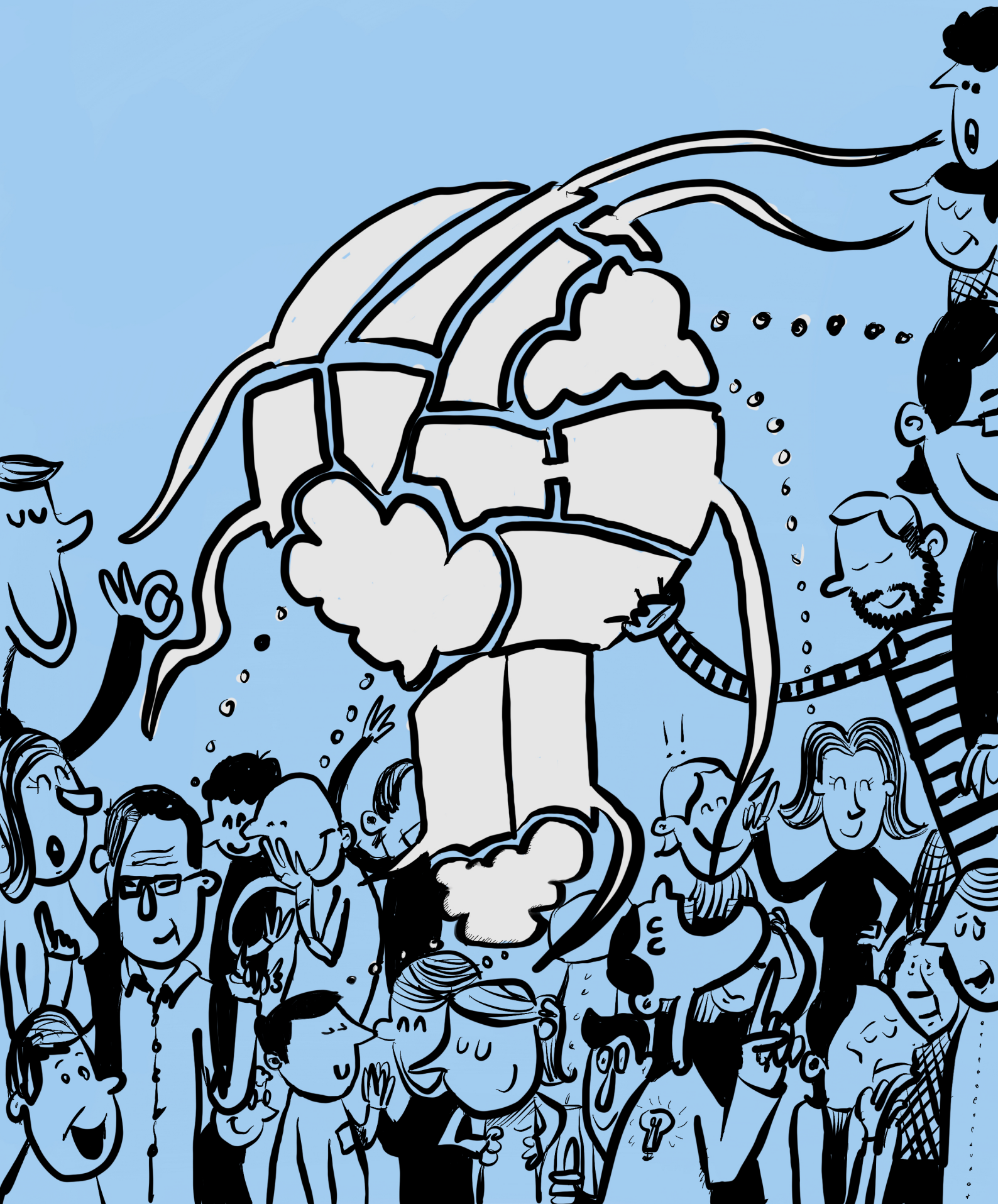
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## **Problem Description**

**Candidate names:** Frode Halvorsen, Jo Uthus

**Thesis Title:** A model for valuation of open user communities in high technology companies

**Problem description:** AVRfreaks is an online user community of more than 300,000 unpaid, highly skilled engineers raising technical issues and offering solutions through discussion forums and project websites for free for the AVR microcontroller, designed by Atmel Corporation.

Atmel executives have to make decisions on investments, why should they invest in AVRfreaks? What is the return?. This question has been raised by Atmel management in its strategy and budgeting process in the past 15 years without receiving any tangible answer.

Companies like Atmel must be able to understand how they create and utilize a community to resolve the return on investment question and we are going to discuss this issue through two research questions: How to create and utilize a community and How to value a community.

The main purpose of this study is to: Set our industry experience with AVRFreaks and Atmel into an academic context and explain how community can be utilized outside of this context  
Design a model for the valuation of an open community  
Apply the valuation model to the use case of AVRfreaks

**Supervisor:** Arild Aspelund

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## Abstract

The context of this study is the AVRfreaks community and Atmel Corporation and we explain how to utilize a community and create a model for calculating the value of a community through two research questions:

The practical problem: How to utilize a community?

The theoretical problem: How to value a community?

High-technology products are debated, criticized and publicly supported by highly skilled, experienced and educated engineers in Internet forums. The engineers form communities with similar interests and compete in having the highest amount of posts and likes from their peers as their only compensation. Meanwhile, in the boardroom, executives ask themselves how they can utilize communities and struggle to understand the return of investment in a community.

This study examines existing theories and literature in network theory and community valuation to show how to utilize a community. This study presents a clarification of the community typology in the Introduction and the approach in the study is a generic model for valuation, applied to the functional areas of support and R&D at Atmel. The empirical studies correlate the data from AVRfreaks with Atmels internal data to calibrate the model and provide a valuation of the community.

The result of the study finds an annual valuation of AVRfreaks to Atmel to be multi-million dollars in the form of reduced customer support-cost and wider market reach. We find that the application of the model in other industries beyond microcontrollers is possible but further research is required with more calibration to avoid sacrificing precision in the valuation.

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## **Preface**

This thesis concludes the Master of Management studies and degree in the MOL program at the Norwegian University of Technology and Science (NTNU).

Throughout the work on this study, we have received great support from our supervisor Dr Arild Aspelund as well as the professors, internal and external lecturers of the MOL program. The selfless contributions and support of Dr. Oyvind Strom in reviewing our work was also outstanding. Thank you! All of you have carefully guided us through the maze of academic rigour and enlightened our industrialized, practically-oriented minds.

Without even reading it, Ståle Gerhardsen turned this thesis into an awesome drawing.

Our wives (Siri Uthus and Christina Vinje) possess uncanny super powers allowing us to neglect wife, family, kids, home and friends while finishing this work. We are forever grateful!

Jo Uthus

Frode Halvorsen

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# Introduction

## **Background and purpose of the Study**

The Internet brought power back to the consumers from the mighty corporations, transferring power from the boardroom to the customers. Customer reviews on Amazon is the dominant decision factor when you buy a consumer product online and not the carefully crafted billboard messages of a marketing department. Companies able to take advantage of this change and create communities of loyal, dedicated brand advocates of customers and users will outperform their competitors. What kind of resources are hidden within communities of hundreds of thousands of customers and users of your products? What kind of knowledge and expertise is accumulated within this group and how could you as company utilize and put a price tag on this user expertise, which is often open and free.

The AVRfreaks community count more than 300,000 highly skilled engineers. They share ideas, resolve technical questions from strangers and contribute high-value research and design in the open-source domain for the AVR microcontroller products. All of this happens online without any monetary compensation.

Atmel Corporation is the vendor of AVR and a \$1 Billion USD public company and in the boardroom, Atmels CEO and executives ask themselves: What is AVRfreaks and what is the return of investment in this community of volunteers? Are we investing in pirates or supporting fans of our products?.

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Finding a definition of community offers many alternatives, although Merriam-Websters (2017) definition brings most clarity in our context: a group of people who have the same interests, religion, race. Communities exist as networks of people, using websites with specific forum software to discuss, argue and share their opinions on common topics. Engineering communities typically also have virtual project repositories where community members can share their projects showcasing their skills, solve specific problems or ask for help.

Atmel's AVR product is a microcontroller which customers use to design electronic products worldwide for numerous industries. End products are often smart phones, consumer electronics, white goods as well as industrial automation and lighting products. The design process for Atmel customers is tedious and involves multiple engineer disciplines, including software and printed circuit board design. The documentation of the microcontrollers often span 1,000+ pages of datasheets and customers often spend 12-18 months designing and qualifying their products for mass-market release. Atmel offers design assistance through a systematic support process, involving a direct connection to the customer through email or phone.

Companies like Atmel Corporation, who operates with a business-to-business customer-engagement model often shrug at the existence of a community surrounding their products. The company revenues are created through the business process of selling and buying a product limited by regulatory requirements, contracts, master purchase agreements and long-term relationships. Single quantities of the product sell at \$1US Dollar, although the customer profile is dominated by customers who buy 100,000 units and more. The idea of having an online community of people for your product, with no monetary incentive is far-fetched and hard to value in this context.

Research in the infancy of the commercial Internet already saw valuation of communities as important (Armstrong & Hagel, 1996) and the purpose of this study is to explain and discuss how a company can utilize a community of volunteers and provide a model to calculate a value of the community that can be applied to the balance sheet as an immaterial value or justify investments in a business case. The study applies the model to the AVRfreaks community and Atmel.

This study propose two research questions:

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1. The practical problem, How to utilize a user community?
  2. The theoretical problem, How to value a user community?

### **Question 1: How to utilize a user community**

This is the practical problem. Most people today benefit from online communities without realizing they benefit from the volunteer work of its members. Your question to Google about configuration problems of your cell-phone can very likely be answered by a member of an online community on a website where you have never registered nor posted any questions previously. It is also likely that the community contributions take place without monetary compensation to those offering their knowledge. Open user-driven communities exist for thousands of products and services online, offering access to information, research, comments and product ratings in a transparent online micro-universe. Although practitioners' guides exist for creating communities, limited contextual research exist to understand how to utilize a user community by a company. This study will specifically address how to utilize a community in the context of the AVRfreaks community and the vendor of the AVR product; Atmel Corporation.

### **Question 2: How to value a community**

This is the theoretical problem. Research exist to describe the taxonomy, analyze the user dynamics and understand networks with communities, but limited research exist on the valuation of the community effort and output in the areas of research & development and customer support of high technology products. In this research, we develop a model for the valuation of open user communities and apply it to existing communities in multi-billion dollar companies in the high technology industry, including the AVRfreaks community and Atmel Corporation.

### **Contribution of this study**

This study brings significance to management and executives, limited to high-technology product companies with an existing or new online community. To establish a business case for

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investing in a community, executives must understand the value it can bring as well as the risks and potential it offers. Being able to calculate a monetary valuation would bring such business cases to conclusions more easily.

This research also adds context to existing valuation research, in particular the research performed by Wenger et.al. Wenger wrote in 2000: We believe that commercial success in the online arena will belong to those businesses that organize electronic communities to meet multiple social and commercial needs. By creating strong online communities, businesses will be able to build customer loyalty to a degree that today's marketers can only dream of and, in turn, generate strong economic returns. Prior research is focused on generic application of communities for marketing and brand value while this study is complementary and adds valuation of technical product support and research & development.

## **Outline of chapters**

The rest of this study is split into 5 chapters, all supporting various parts of the 2 research questions: 1) How to utilize a community and 2) How to value a community.

**Chapter 1** Theory is a literature review of research in network and community theory, typologies investigating behavioural patterns for sustaining and growing user communities and concerns primarily research question 1: How to utilize a community.

**Chapter 2** Methodology outlines how data was collected for the study, discussing the validity of data as well as various limitations in scope and focus required to design a model for valuation. This chapter is focused on research question 2: How to value a community.

**Chapter 3** Introduction of case studies presents Atmel Corporation and the AVRfreaks community.

**Chapter 4** Empirical Data is primarily focused on research question 2: How to value a community and is directly linked to internal data for supporting customers and certain areas of R&D at Atmel in addition to the public statistics for the AVRfreaks forum and project pages.

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**Chapter 5** Discussion is split in two sub-chapters, one for discussion of each research question.

The discussing of research question 2) How to value a community also concludes with the design of a model for the valuation as well as the calibration of this model. The models valuation of AVRfreaks as a multi-million dollar community is outlined in this chapter.

**Chapter 6** Conclusion is a short chapter with concluding remarks, suggestion for further research and our anecdotal observations on and criticism of the results. uch AVRfreaks is worth, provide a valuation in dollars that in our opinion should be added to the company balance sheet as an asset with a specific immaterial value.

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# Theory

Our literature review consists of two main parts; network theory and community theory. Basic network theory is required to understand the internal life in a community, how it grows and evolve.

The typology of an open user community is important as there are multiple definitions as well as presentations of and theories applicable to both the user behaviour and the network effects of the behaviour. Why are some nodes in a network more attractive to connect to than others? What is the typical growth rate and the life cycles of a community?

The theory reviewed and discussed is relevant to answer the two research questions:

- The practical problem: How to utilize a user community?
- The theoretical problem: How to value a user community?

## **Existing research and literature**

Online communities are a relatively new phenomena, so most of the existing research related to online communities originate in the last twenty years. Network theory is a wider and more generic topic than online communities and we will see that nodes in networks related to online communities are distributed and grow different in the more classical network theory.

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A literature search was commenced primarily using available databases from NTNU, including the bibsys search-engines and <http://www.jstor.com> in addition to generally available material from <http://scholar.google.com> and other public search engines.

Researchers von Hippel (1999), Walden (2000), Loewenfeld (2006), Franklin (2014) and Wiegandt (2009) offer research on online communities in the areas of community lifecycles, social interaction in online communities and community member typologies that offer a framework for answering research question 1) how to utilize a community.

Research by Geoffrey Moore and Yochai Benkler was studied but not included as we found the theories would offer limited additional validation of our answers to the research question as their theories were either borderline to the question or already covered by the chosen researchers.

Robert Metcalfe's (Metcalfe, 2013) initial studies on Ethernet IP-networks create a simple valuation model for networks, further extended by Odlyzko, Reed, Wenger, Trayner & de Laat extend this area of research beyond data-networks and into human interaction and communities with valuation cycles. The contributions of Barabasi (2002) extended existing research to add to the understanding of how individuals in networks, sub-networks and communities operate and contribute.

In the chosen research we expect to find sufficient theory to create a model for the valuation of the community based on the empirical data found from the use-case.

## **1.1 Network Theories**

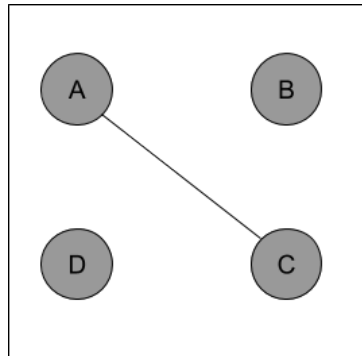
Understanding how communities work requires a fundamental understanding of how networks are constructed. The physical, social or digital network will consist of nodes and edges. In a community, the node is a user and an edge is the communication between two users. In this chapter we will give a short introduction to network theory and how this will affect the behaviour in communities.

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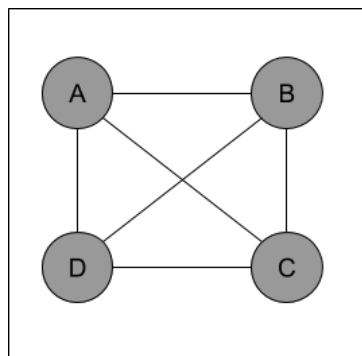
## Network theories

The interconnect of the nodes is critical in the modelling of the network, as illustrated below with 4 nodes and 1 connection between node A and C. In this example node A and C are of degree 1 ( $K_1$ ), while node B and D are degree 0 ( $K_0$ )



**Figure 1.1:** 4 nodes and 1 connection between A and C

Extending this example with connections between all 4 nodes illustrates the basic valuation models first defined by Robert Metcalfe in the 1980s where A,B,C,D are all inter-connected. In this example all nodes are of degree 3 ( $K_3$ )



**Figure 1.2:** 4 nodes where all are connected

Wenger et al. (Wenger, Trayner & de Laat, 2011) define a network as a set of relationships, personal interactions and connections among participants who have personal reasons to connect. A network is viewed as a set of nodes and links where participants interact for learning, information sharing, build helpful linkages, create knowledge and joint problem solving. Wenger mention that there might be both pure networks and communities. An example could be a personal network, which rarely is a community as people in the network are not likely to have much in common except being connected to the same person.

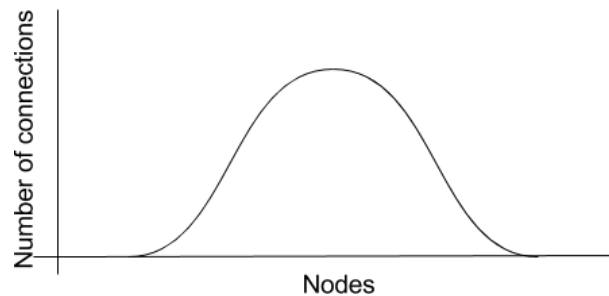
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According to Wenger et al (2011), network growth and the increased noise within the network is problematic as nodes in a network don't have any commitment to the network itself. Human beings in a community are empathetic with a sense of responsibility to the network. The network will require maintenance of connections and the ability to distinguish between useful information and noise.

## Nodes and connections

Until the late nineties, research on connections between nodes in a network were based on the random network theory, which will create a Erds-Rnyi network. This theory will give the nodes a poisson distribution of connections. (Barabasi, 2016)



**Figure 1.3:** Poisson distribution of connections

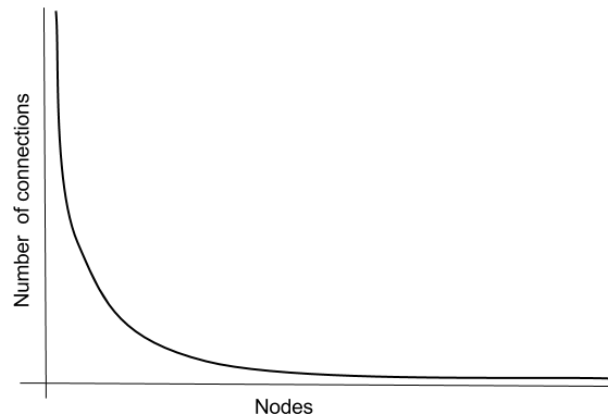
The random network theory does not apply well to growing and evolving networks including online communities because the number of nodes in a random network are set before the connections are distributed. An online community or a social network will grow and evolve over time so the number of nodes and connections will change over time.

In a study of web documents made by Albert Barabasi (1999), connections made between documents on the web gives another type of distribution. The degree distribution of these documents created a scale free network. A scale-free network is a network whose degree distribution follows a power law. (Barabasi 2016)

The power law distribution in a scale-free network indicate that a few nodes have a high number of connections while the majority of nodes only have a few connections. This is also a graph you will find in most online communities represented by postings per user. Even Wikipedia have the same ratio for users on the website: 1% of the users create content, 9% edit content,

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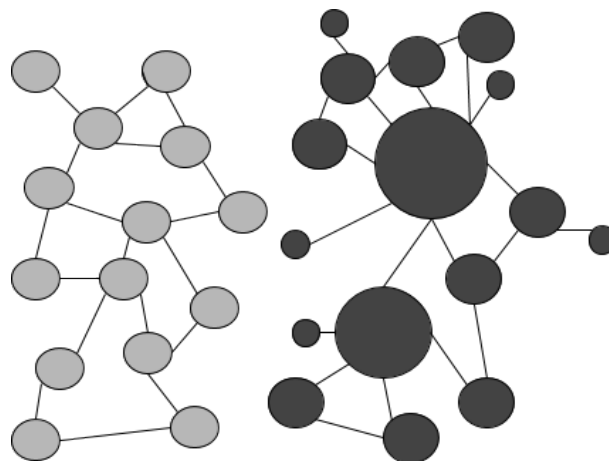




**Figure 1.4:** Power law distribution in a scale-free network

while the last 90% of the users only consume content.

The key difference between a random and a scale-free networks is the way nodes are connected following a Poisson or power-law distribution. Most nodes in a random network have comparable number of connections which prevents the creation of hubs. Hubs are nodes with the highest number of connections in a scale-free network. The more nodes a scale-free network has, the larger are its hubs. In contrast, the largest node in a random network will grow logarithmically or slower than the growth of the network itself (Barabasi, 2016). The last statement is contradictory with the description of a random network as a non-growing network



**Figure 1.5:** Left - Random network Right - Scale-free network

As we see in the model on the next page, there are no nodes in the random network to the left, that are considerable more connected the other. All nodes are within degree 1 - 3 ( $K_1 - K_3$ )

In the scale free network to the right, there are a few nodes that are heavily connected ( $K_9$ ) with

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other nodes, and some nodes that only have one connection ( $K_1$ ). Those well connected nodes are the ones we find to the far left in the power law distribution graph, and the many nodes with few connections are represented in the tail of the graph (Barabasi, 2016).

## **Reciprocity and interactions in a network**

Previous research has found that individuals provide knowledge in online communities because they want to interact with similar individuals to exchange knowledge (Kenkanhalli, et al (2005).

An important element in knowledge sharing and social exchange is reciprocity, because people keep score, assign meaning to exchanges and change their subsequent interactions based on a reciprocity balance (Faraj and Johnson 2011). Research shows that individuals who provide help strongly expect that their help would be returned (Fulk et al 2004, in Faraj and Johnson 2011).

## **Preferential Attachment**

The preferential attachment phenomenon has increasingly been recognized as an important reason for the typical power law distribution of users in communities (Baum and Mckalvey, 2006). The theory explains that network newcomers (or new network nodes) choose to attach to nodes with the most resources. Preferential attachment is a probabilistic mechanism where a new node is free to connect to any node in the network. The node can both be a hub or have a single link. Preferential attachment implies that if a new node has a choice between a degree-two and a degree-four node, it is twice as likely that it connects to the degree-four node (Barabasi, 2016)

The Barabasi-Albert model indicates that there are two simple mechanisms, growth and preferential attachments that are responsible for the power-law distribution in scale-free networks. (Barabasi, 2016)

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## Network Robustness

A scale-free network is less prone to failure. The reason is that the failure or removal is much more likely to be a node of a low connection degree than a hub and there are orders of magnitude more low-degree connected nodes than high-degree ones. A network can withstand the removal of several low degree nodes and it will not change much of the network structure.

If a hub fails or in some way is removed the network structure will change, important connections within the network is removed, and if several hubs are removed, the network can cluster. Only if a certain network-specific threshold is reached, the network can collapse..A scale-free network is much more robust than a random generated network when it comes to random failure and removal of nodes. A coordinated, strategic attack on hubs can result in fragmentation or collapse of the network. (Barabasi, 2016)

## Network diversity

There are some key network parameters that can affect the value of the community. Apart from obvious ones such as size, network diversity is a parameter that can increase or decrease the value created by the community. Studies show that while homogeneous groups give a confident feel to their members, heterogeneous groups generally perform better (Phillips, 2016)

An important aspect in communities and network is the weak ties that connect people that usually would not been connected. ” ... *Weak ties are barely socially involved with each other and represent a low-density network of acquaintances In general weak ties grant people access to information and resources they will not find in their own circle of friends*” (Granovetter in Wiegandt 2009, p 9). Granovetter implies that the potential value created in a network increase as the number of weak links increase, related to information and idea generations.

NASA teams that presided over the Apollo mission were actually more diverse than the MMT(ed:mission management team). NASA employees today are far more likely to have come to the agency directly out of graduate school, which means they are also far less likely to have divergent opinions. (Surowiecki, 2004, p. 183)

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Diversity helps because it actually adds perspective that would otherwise be absent and because it takes away, or at least weakens, some of the destructive characteristics of group decision making (Surowiecki, 2004, p. 183)

We can relate to this in online community forums discussing hobbyist electronics where everyone has the same interest, skills and abilities to create a blinking LED. The homogenous forum would strive to enhance the single blinking LED, whilst a diverse community could easily turn the blinking LED into a christmas-tree decoration or an underwater ROV, creating more total value.

## **Network growth laws**

Another important aspect of networks and communities is how they grow and at what rate new connections are made within the network. The original laws were defined by Robert Metcalfe with studies of packet-switching network protocols in the 1980s. Metcalfe explained the model by a much paraphrased example of the ability to call people on a phone: Two telephones can make only one connection, five can make 10 connections, and twelve can make 66 connections.

Metcalfe turned this principle into an algorithm:

$$O = n(n-1)$$

The value (O) is calculated with the nodes (or number of phones) as factor n. In a discussion forum, this means that 5 users have 20 connections and doubling the amount of users to 10 gives a total of 90 connections, or a growth factor of 4.5.

In online discussion forums, Metcalfe's model is particularly applicable as a user (node) in the network will have unrestricted access to other users within the same network. Metcalfe's hypothesis and model explains that the cost of a network grows linearly (adding nodes) while the value is proportional to the square of the number of users due to the limitless connectivity between all the nodes.

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## Limitations in growth laws

Robert Metcalfe discovered in further studies weaknesses in the initially published model and described in a note (Metcalfe, 2006): *"As I wrote a decade ago, Metcalfe's Law is a vision thing. It is applicable mostly to smaller networks approaching "critical mass". And it is undone numerically by the difficulty in quantifying concepts like "connected" and "value"."*

Metcalfe's law is a vision for network growth and the model does not accurately take into account activity levels of the nodes. As we will get into communities in chapter 4.3, we will learn that communities will consist of nodes with very limited activity, also known as lurkers.

Odlyzko et al. challenged Metcalfe's law (IEEE, 2006) and argued that not all connections are of equal value and network growth and value follows a logarithmic function.

$$O = n * \log(n).$$

The direct impact of this is that the value of a network of 5 users growing to 10 does not quadruple as with Metcalfe's Law, but has a much slower growth rate. In this case, the calculation is  $10 * \log(10) / 5 * \log(5) = 2.8$  vs Metcalfe's growth factor of 4.5.

The criticism of Metcalfe's law can be understood as the value calculated is the actual number of connections between all nodes in the network. And practically in a discussion forum the interactions between users does not allow for an unrestricted bandwidth to globally and timely interact with every user in the network.

Reed (2001) also argues that the value of a network lies in the creation of subnetworks and that subnetworks grow exponentially with the number of nodes. This is particularly interesting to social media platforms or online community forums where subgroups are created within walled gardens which can not automatically interconnect.

Although challenges to the original Metcalfe Law exist, Reed, Odlyzko and others make it clear that size in network matters to its significance and valuation.

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## 1.2 Community Theories

We apply a very generic definition of communities throughout this research as a group of people who have the same interests, religion, race (Merriam Webster,2016). The communities exist as networks or within larger networks as sub-networks.

It is also important to distinguish a community from a social network, such as Facebook. Facebook is a social network, and communities can operate within this social network in the form of fan pages, groups etc. Since there are several limitations to the forms of groups and pages related to data storage, ownership of the content and so on, communities within social networks are not a part of our thesis. Communities as described in this chapter need to operate more freely, with more possibilities for creating sub-groups, data storage and data filtering, and in a different structure than facebook and other social media sites provide, this would typically be in forum software such as AVRfreaks are built on.

### **Typology and classification of online communities**

Franklin et al. (2014) classify online communities with five requirements:

1. A sufficient number of members is required for the community to function
2. Active engagement within the community
3. Communication between the members on the site
4. A common interest, concern or question that forms the focus of the interaction between members
5. A collection of practices or protocols that govern behavior within the community.

Despite different forms of communities, this classification seems to meet most types and forms that will be handled by this paper.

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Von Loewenfeld (2006, in Wiegandt, 2009) classifies a brand community as a community who share a common interest, and where the community's focus is on both values (both commercial and noncommercial) and needs. In contrast a religious community share common nonphysical characteristics and have a value focus.

Mainelli, 2012; Harris et al. 2002, (in Walden (2000)) classify online communities by four purposes, relating to the owner of the community. An online community which is used to generate, modify or present ideas, is have the purpose to thought leadership. Here the company, the community owner, can get input, feedback and ideas from the community. It is important that the company not only take, but also gives back to the community some way.

A community that seeks to address the system or operation of an organization, either by a passive form to maintain best practice or an active form of mobilizing members to make change, is a built on the purpose operations for the owner. A community's purpose could be service, then the main member activity is to offer feedback on products or services, and by that seeks to improve, develop or maintain the delivery of a service. There are communities where the core function is to create new, stronger and deeper relationships between the members. In this communities building relationships is the solely purpose.

For our case, AVRFreaks, the main purposes of the community are thought leadership and service, even though some might seek such forums solely to build relationships with other, that is not the main purpose for the community.

## **Peer trust in communities**

In our research on utilization and valuation of communities, it is important to understand that you are more likely to trust a person you consider a peer compared to a biased message from a vendor of a brand and product.

In his research, Von Loewenfeld (2006 in Wiegandt (2009)) made an observation that recommendations between peers in communities also leads to the acquisition of new customers for brands, increasing the importance of the community hubs in a network. Algesheimer et.al (Wiegandt, 2009) also shows that not only can a brand community generate new customers, but it will also

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convert customers into ambassadors for the brand as the social value of the product, in other words, the possibility to interact with other like-minded individuals are often more important for brand community members than the product itself (Wiegandt, 2009).

This is particularly important in our research as the influence of persons we classify as hubs (ie: moderators) in an online community is instrumental for health and growth of the community.

## **The impact of the online community**

Wenger et al. (2011) define a community as a learning partnership among people who share and use each other's knowledge as a learning resource. They learn from each other about a particular subject, and join forces for understanding and addressing challenges they face, both as individuals and collectively. The participants of a community have in some way a shared identity around a topic, subject or a set of challenges.

*Social network of continuous interacting individuals, who influences each other within a specified timeframe and develop a sense of belonging. Thereby the social interaction between members is subject to well-understood focus, such as a common goal, a shared identity, a common possession, or common interests (Algesheimer, 2004, in Wiegandt, 2009)*

Shirke (2008) use Howard forums as an example of an online forum, where participants have a common interest and join forces for understanding and building knowledge around a particular subject, in this case mobile phones.

*The information produced is so good that engineers at mobile phone companies will sometimes refer customers to it when they have a particularly complex question. Despite the fact that Howard Forums is not an official part of any mobile company, the quality of the technical information there is outstanding, a product of the community's passion for (or obsession) with phones. (Shirke, 2008, p. 229)*

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Wenger et al. (2011) also mention that communities could develop in a negative way; The community can become hostage to its own history, its established ways of doing things and the participants of the community, When that happens, the community becomes closed and starts to focus inward to itself, build boundaries and blinders to new possibilities.

A common denominator in all these definitions is that a community builds on relationships between people who have a common goal or interest, whether it is microcontrollers, cats or mountain biking.

## **The lead user concept**

Lead users are users whose present needs will be the general need in a future marketplace (von Hippel in Wiegandt, 2009). These users are familiar with conditions that will be relevant in the future, and therefore may serve as a forecasting laboratory for firms.

Von Hippel (in Wiegandt, 2009) describe lead users as those who display two characteristics:

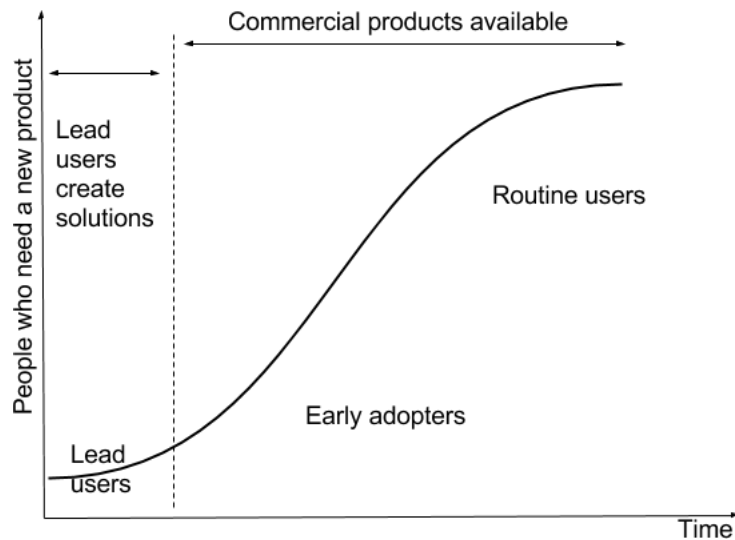
- They face needs that will be general in a marketplace, but face them months or years before the bulk of that marketplace encounters them
- They expect to benefit significantly by obtaining a solution to those needs.

The first characteristic describes the user's capability to innovate, and implies two aspects:

1. There are users who are ahead of the market
2. users who realize needs before others are better prepared to develop ideas for future products.

The second lead user characteristic, which describes the motivation for innovation, refers to the fact that these users expect a high level of satisfaction by developing solutions to their own needs.

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**Figure 1.6:** Lead user Curve (von Hippel 1999, in Wiegandt, 2009)

Von Hippel (1986, in Wiegandt, 2009) suggest a methodology for best integration of these lead users into the product development process, with this four step integration process:

1. Identify an important market or technical trend
2. Identify lead users who lead that trend in terms
  - (a) Experience
  - (b) Intensity of need
3. Analyse lead user need data
4. Project lead user data onto general market of interest

Dean Camera, a 25 year old engineer started his engineering career on the AVRfreaks forum at the age of 14, before going to college. He quickly became an asset in the community and show all the characteristics of a lead user. Not only is he selfless in his quest to support other community members, he also has the technical skills to innovate and share his innovation with the community. Most notably, he designed a software component that has become the defacto standard reference implementation for AVR microcontrollers. His project *LUF*A (a Universal Serial Bus software-stack) is a reference implementation outside of the community and has served as a source of inspiration for Atmels own design of similar software components.

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## Value cycles

In relation to research question two, valuation of a user community, understanding the different value cycles in a network is relevant. Wenger et al (2011) describes a system where value is created in cycles by communities and networks:

### **Cycle 1 - Immediate Value: Activities and interactions**

The most basic form of creating value in a network/community considers the activities and interactions themselves.

- For communities this includes activities such as helping other community members, making a conversation online, provide a good tip and so on.
- For networking this cycle means meeting someone, getting an address or a phone number, connecting, passing a piece of information or giving input.

Activities and interactions can produce value in and of themselves; You can get an answer to a question, get help solving a problem. Collective reflection and feedback can trigger out-of-the-box thinking and new perspectives. Community members can cooperate and make better solutions by combining knowledge and experience.

### **Cycle 2 - Potential Value: Knowledge Capital**

Not all value created by a community or a network could be realized right away. Some activities and interactions can produce knowledge capital which will accumulate over time and create best value over time. This potential value could even be useful even if it is never realized; one can learn from other members experience what to do or not to do in a given situation.

This knowledge capital can take different forms:

Personal Assets (human capital)

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This can be a useful skill, a key piece of information, a new perspective and so on. It can also be new ideas to address a class of problems. The personal value of members of a community or network could also be inspiration, caring, confidence and status.

#### Relationships and connections (social capital)

If we consider knowledge as a collective good that is distributed and accessible throughout a community or a network, then social relations and connections are a form of knowledge capital. The ability to ask questions and get information because one knows who to trust can be as valuable as personal information or commitment. A members reputation is another social achievement that could become a knowledge resource.

#### Resources (tangible capital)

As a member in a community or a network you will get access to certain resources, such as information, documents, tools, procedures and other resources created or gathered by the community.

#### Collective intangible assets (reputational capital)

This type of assets consists of the reputation of the community or network, the status of the profession or the recognition of the strategic relevance of the communities domain.

#### Transformed ability to learn (learning capital)

By participating in a facilitated network or a community could represent a valuable way of learning and building skills that could be transferred into experience to use in other contexts and situations.

### **Cycle 3 - Applied Value: Changes in practice**

Applying the potential value that lies in knowledge capital, means that it needs to be adapted and applied into a specific situation. This could be reusing a lesson plan, a piece of code, implementing an idea and so on. Adapting and applying knowledge capital in different contexts can lead to changes, innovations in action, practice, systems etc.

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## **Cycle 4 - Realized Value: Performance Improvement**

New practices or tools are not enough, even when applied. One needs to have a look at the improvement in performance after these new ideas were applied. It is not enough to assume that there have been an positive change of improvement when people or organizations change their practice, it is important to study the effect on stakeholders, including those who applied the new practice.

## **Cycle 5 - Reframing Value: Redefining success**

The last cycle of value creation is achieved when social learning causes a reconsideration of the criteria by which success is defined, by reframing strategies, goals and values. It can also lead to nye metrics for performance, move success metrics from an individual definition to a collective definition.

## **Complex relations among cycles**

Wenger et al (2011) points out that even though there are causal relations between the different cycles, it is important to not understand this as a linear process with distinct phases or a simple causal chain. Different aspects of the value cycle are likely to be important to different stakeholders. Facilitators of a community might be most interested in cycle 1 and 2, while members might care about cycle 3 and 5. Managers might be most interested in the performance measured in cycle 4.

## **Control structure**

To answer our first research question; how to utilize a community, we need to understand some of the seminal research by Walden (2000) on control of communities by a firm. Walden outlined five different propositions on how and what kind of control a firm should apply to its community.

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1. Communities with the main purpose to provide credible information about the focal firm, should be community control.
  2. Communities who are purely about the firm's product, should be no control structure
  3. Communities with the purpose to provide trust/information should be self control.
  4. Communities who provide product support, should have self-control.
  5. Communities who influence future products should be firm controlled.

In four out of five proposals, Walden concludes that self-control or community-control is the best form of control structure. The only case when control should be firm is when the community is about influence in future products, due to the sensitive information and data handled in such as community. Trust is a critical element in all online communities, and it is directly concerned with relationships, communication and mis-communication,. Trust underpins the possibility of all other benefits of an online community (Franklin et al, 2014). Franklin et al (2014) have listed four varieties of trust, and claims a community will fail if it loses its members trust in any of these four forms.

1. Technical - The community trust that the technical side of the community is appropriate and reliable in terms of function and usability.
2. Governance - The community trust that their personal details and other information is not going to be misused by the owner of the community.
3. Administrative - The community trust that the administrative side of the community is run effective and swift.
4. Community - Members trust in the other members of the community as worthwhile people to connect with through the community.

The findings of Walden and Franklin provides a firm understanding of types of control and how trust impacts the utilization of the community.

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## Community structure in Scale-free networks

The scale-free networks consists of nodes with different degrees of connections that coexist in the same network (see page 24), and by that some nodes become hubs with a high number of connections, while other nodes got fewer connections. (Barabasi, 2016) In an online community these nodes are community members, and some members got a lot of connections and interactions with other members, while other members got few connections and do little or non interaction with other member, which are the lurkers.

Another characteristic of community structure in social scale-free networks, is the degree correlations, which means that nodes of a degree  $x$  are more likely to connect to other nodes with the same degree. A well connected member in a community typically connect and interact with other well connected members. (Barabasi, 2016) It is important to take notice that a connection between two members can a) be reciprocal where both members interact with each other, or b) it can be one-way, where one member interact with another eg. in form of sharing posts, likes, following etc. An example could be famous people on Twitter which have many followers, but do not follow the same people.

Each member have a incoming degree ( $K^{in}$ ), incoming connections, and outgoing degree ( $K^{out}$ ), the number of outgoing connections to other members. A node's, member's, total degree of connections is:  $K_i = K_i^{in} + K_i^{out}$ . In the Twitter example a famous person would have a lot of incoming connections, but do not have the same amount of outgoing connections. The same would be within communities, highly connected community users could have a lot of followers within that community, but do not follow the same users. This means that a well connected member can have many ingoing connections from lesser connected members without the need to have an outgoing connection to them.

### 1.3 Summary

An online community as a network behaves different and more dynamic than you can predict with traditional network theories; new members add themselves to the network, new connec-

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tions are made, either by newcomers or by existing members. There are also differences in the contribution of members. A few members contribute and get the most connections in the network, while most members contribute and connect less. This is why such scale free networks consists of hubs and can be plotted by a power law distribution.

Brand communities are communities where members shares a common interest for a brand or a product, and where value and needs are the common focus for the community. A community consists of different types of members, from the passive types such as tourists and lurkers, to the more devoted members, the insiders, who are well connected with other members and contribute in large scale into the community.

A community goes through different life cycles as it evolves, from the critical mass cycle where there are enough members and activities to generate any real value, to the peak marginal value where there needs to be taken action if the community should be able to continue to grow and generate value.

The value creation in a community also goes through different cycles; from the immediate value given to a member when it gets help from another community member, to the more persistent value where the criteria which success is defined are reconsidered and where ideas and influences from the community have been implemented and resulted in performance improvement for stakeholders.

Finally, to be able to answer research question 1: How to utilize a community, we have understood the importance of the degree of control and autonomy in the community in addition to the trust between community and firm that can easily disrupt or strengthen how a firm is able to utilize and monetize from a community.

This field of study combines the soft values created when people with weak or even non-ties meet and share knowledge and the hard numbers where we calculate the monetized value created by the same community. The theories brought up in this chapter are relevant and necessary to understand both research questions; what is the internal structures of a community - network theory and how is knowledge and value created and transferred through different cycles which allows and understanding of how valuation of a community.

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## Use cases

### 2.1 Atmel Corporation

Atmel Corporation (Atmel) is headquartered in San Jose, California (Silicon Valley) and employs about 5,000 people with satellite R&D, Sales and Support functions world-wide. Atmel is a publicly listed company on Nasdaq with ticker symbol ATML and from its gross revenues of approximately \$1 Billion USD, more than 70% was generated from Microcontroller products, including the AVR product-line.

As is similar to most vendors in the semiconductor market, Atmel use a business-to-business transaction model for customer engagement. This is an important fact, as our study is specifically targeting communities of interest with Atmels products and communities or community members do not have a defined engagement model for Atmel. Atmels customer-base spans all major industries and markets, including: industrial, automotive, consumer, communications, computing and others. To its more than 30.000 customers world-wide, Atmels vision and marketing message is focused on simplicity in engineering / design, ultra-low power consumption, security and connectivity. Atmels fact-sheet explains:

*"We are bringing the digital lifestyle to you and making life easier at home, at the office, on the road, or at school. Whether its communicating with your smart-phone or wearable device, reducing energy and water consumption in your home,*

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*or browsing on your computer, we are not only changing the way the world interacts with you, but how you interact with the world.” (Atmel factsheet,2016)*

Atmels product-portfolio spans more than 20,000 products and its customers use Atmel products to design an inconceivable number of products. Examples of end-products include thermostats, smart energy meters for domestic use, wearable devices on your wrist to measure your fitness, a smartphone or mobile device that you take everywhere and anywhere, car accessories or control systems, HVAC (Heating Ventilation Air Conditioning) units in offices or factory floor manufacturing equipment.

The AVR product-line originated from Atmels Norway office in Trondheim and has become a substantial success in the market since its launch in 1997 with a strong 2nd place in its segment in 2016. Atmel Norways R&D office employs about 150 people (2016).

During this study, Atmel Corporation was acquired by Microchip Technologies in April 2016. Although this has had an impact on the organizational structure of Atmel, it has not changed the validity nor the relevance of the study. In Microchips annual customer conference, the company CEO Steve Sanghi publicly stated that Microchip will continue to invest in the AVR product-line and its strong customer-base and community (Sanghi Keynote, 2017).

## **2.2 AVRFreaks community**

In 2001 the AVRFreaks website was established by Atmel Corporation without any apparent relationship with Atmel. The website held multiple functions including bulletin-board / forum software and a project repository. This allowed users of the website to discuss the AVR product and upload software and source-code to share with other members. Initially 2 full-time Application Engineers from Atmel were assigned as managers; to moderate, engage in and evolve the forum content. They also implemented new features in the website.

Atmel’s motivation for establishing the AVRFreaks community was to create brand advocates and product champions. As part of the Management team, we allocated funding in the yearly strategic business plans and utilized AVRFreaks in marketing for branding and implicitly to

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support customers of the AVR product line. The AVR support group frequently referenced postings on the AVRfreaks forums whenever this was available, subjectively we find the content in the forums to have a very high technical value due to the competency of the key persons answering questions on a daily basis.

In November 2016 there are 300,000 registered users with a total of 1.27 Million postings in 150,000 topics. More than 200 new users register each day and maintain between 60-200 new topics daily posted on the forums.

By intentionally giving the AVRfreaks website an image of a community managed web-server, the anti-authoritarian, open-source developers were offered a playground that did not exist at the time.

The community had participants and contributors from Atmel that acted as independent persons in the forums offering expert technical insight. They did not hide their employment with Atmel upon confrontation but appeared as individuals in discussions. The moderators were recruited externally to ensure self-governance and independence from the company was ensured. A simple reward system was implemented for users, based on their number of postings.

The AVRfreaks community is available on <http://www.avrfreaks.net>

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## Methodology

The intention of this chapter is to present how our choice in design and methodology is sufficient for answering the research questions and which options we had and how our choices affected the validity and reliability of the answers. The research questions are:

**Question 1:** How to utilize a community?

**Question 2:** How to value a community?

The research approach is threefold: A thorough literature review is conducted and presented, design of a model applied to our case study, followed by a discussion and analysis of the results.

### 3.1 Design of the valuation model

In this study, we chose to answer the research question *how to value a community* by designing a model. The parameters of the model were chosen by mapping Atmel's business process for support, knowledge base and applications R&D to a system function.

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## Methodology for choosing parameters of the model

We examined the input and output of 3 business process parameters for Atmel; Product Support, Knowledge Base and Applications R&D. The business processes were thoroughly documented in Atmel's ISO9001 QA system.

Atmel Process	Input	Output
Product support	Question by e-mail or web-entry from customer	Response by e-mail to customer with solution from Atmel Support team
Knowledge Base	Question posted to Atmel's online questions and answer database by customer	Response from search-engine with a blank or suggested answer to question
Applications Research and development	Requirements from customers and marketing to demonstrate the use of AVR microcontrollers	Files available on the Atmel website in the form of PDF documents categorized by: Application Note, Reference Design, Software example

**Table 3.1:** Atmel's ISO9001 process for support

A mapping of the Atmel processes into a model function and finding a similar community function was done by examining the output of the business process to the activity particularly in the discussion forums and the project repositories on the AVRfreaks website. We also compared the IT-systems used by Atmel and AVRfreaks to be able to collect data for the valuation.

Model Function	Company System	AVRfreaks System
Product support	Salesforce ServiceCloud	AVR discussion Forum
Knowledge Base	Salesforce ServiceCloud	AVR discussion Forum
Applications R&D	Website CMS system	AVRFreaks Projects

**Table 3.2:** Mapping of company and community functs

The mapping between Atmel and AVRFreaks functions is further mapped to theories on valuation, primarily covered by Wengers value-cycle research discussed in the theory-chapter and further elaborated in our discussion chapter. Mapping the valuation theory also explains when in the timeline the valuation occurs:

**Cycle 1** offers immediate valuation. For AVRfreaks, this is the real-time or near real-time discussions in the forums offering response to and resolution of technical questions asked by the community members.

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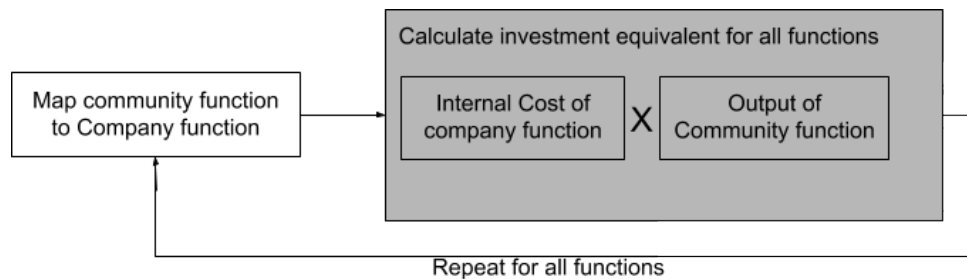
Atmel Function	Community Function	Valuation Theory
Technical Support	Discussion Forums	Wenger cycle 1
Application Notes, Reference Designs, Knowledge Base	AVRFreaks discussion forums and projects	Wenger cycle 2

**Table 3.3:** Combined mapping of function and theory

**Cycle 2** offers accumulated, potential value as it is both a knowledge base for future use or projects that offer value primarily available through search-engines for existing and new community members.

## The Community Valuation Model

To calculate an immaterial monetary value in a community, we design a simple model. The model use the mapping of a community function to an equivalent company function and calculates the equivalent internal investment required to create the same output as the community generates.



**Figure 3.1:** Community Valuation Model

The figure 3.1 also serves as a process description to guide the reader through the model. The steps required in the process is:

- 1. Map community function to company function** This study first use the community use-case function and find a similar business process with the company use-case. Our case-study applies a tangible deliverable from the community, like source-code components, application note documents or responses to a question (ie: discussion) as the data is publicly available and measurable. The business function is documented as a process through the ISO9001 quality system and mapped to the output of the community

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**2. Calculate investment equivalent for all functions** The valuation model calculates the investment required to produce a similar output as the community does by using internal resources in the company. internal cost and *output of community function* are known variables in the model.

**3. Repeat for all functions** The investment calculation is repeated for all mapped functions in step 1 and summarized as the total valuation.

The community valuation model can then be applied to the use-cases and the investment summarized for all mapped functions will create a total valuation of a community to any given company.

## **3.2 Removing variation in the model by limiting context and scope**

To reduce the variation in the model, we have chosen to limit the context to the high technology / semiconductor industry using the company Atmel and use-case AVRfreaks. The valuation is further limited to the scope of technical product support and specific areas of research & development in application development.

Based on prior research in the field of networks and communities the amount of variations would limit our ability to provide a monetized value of AVRfreaks unless we limit the context (Franklin, 2014). Although we do limit the variations in our model, it is worthwhile to point out that there are similarities beyond the semiconductor industry for companies designing products and offering product support to a broad customer base, where this research could be applied.

## **3.3 Research validity and weakness in the methodology**

Validating the output of the model pose a few challenges as Atmel is a publicly traded company with limited public data on efficiency and cost of the relevant parameters and functions in the

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model. This makes the validation of the model harder in public research, although we have to the extent possible been able to use data subsets from Atmel in the Empirical Data chapter.

The primary weakness of the model is the lack of relationship between community effort and product revenue. As our model is based on calculating the company's cost of an equivalent community function one can argue that the model does not offer a valuation but rather a cost-model where the community can replicate functions of the firm thus lowering a company's internal investment in Support and R&D as opposed to value created.

We argue that calculating a cost-equivalent of a community function offers value and observe that companies exist today where entire R&D and Support functions are managed in a brand-specific community. The CEO of 3D Robotics, Chris Andersson specifically writes about his anecdotal experiences with this approach (Andersson, 2012) as well as CEO David Lang of OpenROV (Lang & Demarest, 2013) where the entire product development is community-sourced and the entire product revenue is created by products designed through a community effort.

## **How was data collected**

The AVRfreaks website contains data from both the user forums and the project page. Special administrator privileges were required for the user-centric data and the project pages have public data available that we added to the Empirical Data chapter.

For internal data at Atmel, we have access to Atmel's internal database for support (salesforce.com service-cloud) and KPI tracking. Atmel employee surveys used the online tool [www.surveymonkey.com](http://www.surveymonkey.com) with analysis and presentation using Microsoft Excel. All data is presented separately in the Empirical Data chapter.

## **Theoretical framework**

Our literature review consists of two main parts; network theory and community theory. Basic network theory is explained in order to understand the internal life in a community, how it grows

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and evolves. The work of Barabasi is examined for the community dynamics while Metcalfe and later other researchers like Reed, Odlyzko, et.al use an algorithmic approach to value a network. Research by Wenger is also instrumental to provide a theoretical framework for the valuation of a community in a network and communities.

## **Delimitations**

One of the authors of this study has been involved in the AVRfreaks community and employed at Atmel with organizational responsibility for the technical product support and certain R&D areas. The detailed knowledge and select criteria for choosing support and R&D for the valuation model design was therefore controlled, although we do not see this as a delimiting factor but rather strengthens the discussion of the use-case and the application of the theory.

## **Limitations**

Access to financial data in a public company like Atmel Corporation is limited to SEC filings to NASDAQ. This was a limiting factor as revenue numbers specific to the AVR product-line is not shared publicly. If this data would have been available, the valuation model would be even more precise.

During the course of this study, Atmel Corporation was acquired by Microchip Technologies Inc (April 2016). This does not change the boundary conditions of the use case, nor the study and we are referring to the company Atmel for consistency purposes throughout this study.

## **Assumptions**

We assume that the agent-principal theory / transaction-cost modelling is understood as the basis of any online transaction. This assumption holds particularly true for the valuation model.

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# Empirical Data

In this chapter the empirical data will verify the validity of the outlined theories with data from the use-cases. In addition, the chapter will support the answers in the following discussion-chapter on our two research questions:

1. How to utilize a community
2. How to value a community

As outlined in the guidelines for the MOL Program at NTNU where this study is done, an emphasis is put on relating the theoretical framework to a use-case, Where applicable, the analysis and discussion of the data is presented in the Discussion chapter.

## **4.1 AVRFreaks community data**

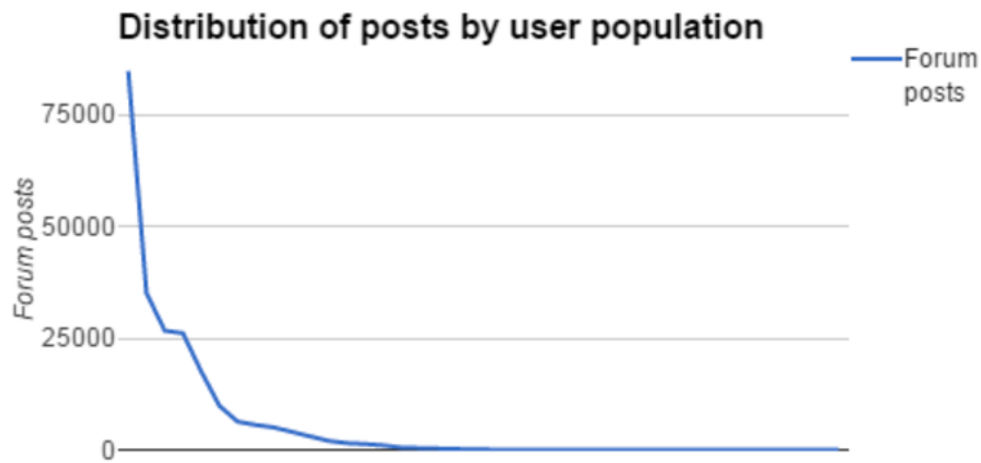
To be able to answer research question 2: How to value a community, we need data from AVRFreaks to simulate the model and discuss the results. This simulation is done in the discussion chapter, while we present the data here. The data collection methodology is explained in the Methodology chapter.

The data in table 4.1 is used for the model simulation in the Discussion chapter on page 57. The

<b>Community Name</b>	<b>AVRFreaks</b>
Brand	AVR
Firm Name	Atmel
Data collection Date	2016-12-12
<b>Community Variables</b>	
Community members	305,000
(net) User net growth rate (yearly)	73,000
Forum postings, total	1,159,293
Forum threads	152,000
Forum posts, yearly average	38,325
Total number of R&D projects	2,064
New "projects" (yearly)	200

**Table 4.1:** Data from AVRfreaks forum

distribution of posts by user-graph in the figure maps all users on the x-axis and their respective total amount of posts on the Y-axis, sorted by amount of posts.



**Figure 4.1:** Forum posts on y-axis, user# on x-axis.

We asked the community moderators to nominate candidates for honorable mention of the AVR-freaks community forums and we have listed them anonymously in the table below with their total amount of postings and the relative % of the total volume. More than 18% of the total volume of posts are created by 9 people in the community and in the Barabasi network these persons are considered hubs in the network around which communities form. Our findings support the Barabasi network theory.

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<b>Alias</b>	<b>Forum posts</b>	<b>% of total</b>
A	84687	7.29%
B	35049	3.02%
C	26648	2.29%
D	26058	2.24%
E	17553	1.51%
F	9853	0.85%
G	6310	0.54%
H	5567	0.48%
I	5007	0.43%

**Table 4.2:** 9 top contributors (anonymized) and their total number of forum posts

## 4.2 Atmel Corporation Data

This study presents the data from Atmel Corporation used in the simulation of the valuation model, which is discussed as part of research question 2) How to value a community.

The data is internal data used for budgeting new projects. Due to the variation of complexity in the R&D projects and similar variation in support case complexity and duration, median budgetary numbers are used. In the case of Atmel, a typical application note is a 6 man-week effort, whilst a reference design is a median of 18 weeks. The skills required vary, but typically range from hardware, software, documentation and application-specific competency. Generic Software Library functions require a median of 2 man-weeks effort (one SCRUM sprint for the development team) while part-specific libraries require a median of 1.5 man-weeks (All Atmel internal data). The methodology of data acquisition is explained in the separate Methodology Chapter.

<b>Atmel Variables - Support</b>	<b>AVR Support</b>
Median support cases / engineer (yearly)	500
Median Number of Knowledge base Articles / engineer / (yearly)	2000
<b>Atmel variables - R&amp;D</b>	
Median effort in man-weeks for application note	6
Median effort in man-weeks for part-specific software	1.5
Median effort in man-weeks for reference design	18
Median effort in man-weeks for generic software	2

**Table 4.3:** Input data from Atmel

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## AVRfreaks R&D Project categorization

AVRfreaks website and community offers its members to upload content into the Projects section of the website. In the table below, we have collected data on this section and compared the community function to an equivalent Atmel-function.

The table also includes a calculation of equivalent internal effort required to create the content found in the community website in the form of man-weeks. The calculation is based on the input-variables in the chapter above Atmel Input Data.

This data is required and used in the Discussion chapter to build the valuation model used to answer research question 2) How to value a community.

Category	# of projects	Atmel function	Estimated internal cost in man-weeks effort
Complete source-code	804	Application Note	4,824 man-weeks
Complete code with hardware design files	948	Reference Design	17,064 man-weeks
Generic library functions	168	ASF source-code	336 man-weeks
Part-specific libraries	84	ASF source-code	126 man-weeks
<b>Total</b>			<b>23,350 man-weeks</b>

**Table 4.4:** Toplevel categorization of avrfreaks.net projects

## Other costing parameters

Data from Payscale (2016) is used as an input parameter for dollar-value-calculation in the model based on US annual average cost of R&D Engineer. The data found here is not representative to the semiconductor industry and is the largest contributor to variation in the data-model, as highlighted in the Discussion chapter.

The cost-strategy of Atmel and peers in the industry is to combine a mix of high, medium and low-cost countries for research & development and support of products. Our experience is a 50/50% mix of low-cost vs medium plus high-cost regions are used, although this will vary given the context of the company. Atmel employs Engineers in Silicon Valley (the most expensive), throughout Europe in Norway, Germany, France and in India and China in a mix favourable to

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the medium-cost median. As we see in table 4.5 on page 55, we have a factor 1:4 from low to high-cost countries that introduce variation in the model, which also requires adaption for new use-cases.

<b>Region</b>	<b>Base salary</b>	<b>Factor</b>
High-cost (California/US)	\$100,000	x4
Medium-cost (Europe + rest of US)	\$71,000	x3
Low-cost (India)	\$24,000	x1

**Table 4.5:** Base salary median data for electrical engineer from payscale (2016)

## **Scale-free network structure in AVRfreaks**

Research question 1) *How to utilize a community* is less data-driven, but we offer data analysis to correlate the data we collect from the AVRfreaks community with the theory in our recommendation and discussion of the research question.

Barabasi scale-free networks create communities around hubs. In the data from AVRfreaks we find that the number of posts pr user follows a power-law distribution which Barabasi explains is a resulting behaviour of a scale-free network. (Barabasi, 2000) and we find that AVRfreaks behaves like a scale-free network.

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## Discussion

In this chapter we discuss our literature findings and empirical data from the case studies to provide answers to the two research questions:

1. The practical problem: How to utilize a community
2. The theoretical problem: How to value a community

Based on our findings, a community can create value in many ways, including but not limited to:

- Technical Product Support
- Application Notes, Reference Designs and Knowledge Base

The structure in this chapter is focused first on discussing the practical problem of establishing or growing a community for a company before we address the theoretical problem of valuation of a community effort. We discuss the mechanisms of achieving the value and then quantify the value using the data collected from both AVRfreaks and Atmel. We also present a model based on our quantified valuation and calibrate it with the use-case to increase the validity.

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## 5.1 Research question 1: How to utilize a community

Chris Andersson makes a statement in his book *Makers* (2015): *Chose the better community over the better technology, because the future is in the long-tail and the long-tail belongs to the community.*

We do not discuss this statement, but find it relevant to Atmel and AVRfreaks for support. Atmel operates with a traditional business-to-business (B2B) transaction model where customers are supported based on their company ranking and status. The AVRfreaks community offers a supplement to this model by indiscriminately offering highly competent, open support to everyone. It is therefore relevant to look at theories on community behaviour (Barabasi) and control of communities (Wenger) in our discussion on utilization of a community and how it applies to AVRfreaks.

Barabasi's preferential attachment model explains in network science how users (nodes) connect more easily to other power-users. Power-users in AVRfreaks are users with a high activity level and large number of posts in the forums. The underlying reason for making this relationship and connection is to utilize the competency and network resources (ie: other users who also support power-users) in order to solve specific technical problems using the AVR microcontroller. As such, newcomers to AVR can with very limited resources save cost on research and development if they use the AVRfreaks community and attach to the users with the most free and open resources and connections, ie: the moderators of the forums.

The long-tail market, the part of the market that consists of a large number of very small customers, is accessible to Atmel through the AVRfreaks community. This is an attractive market due to the profit margins these customers bring. In the semiconductor industry a factor of x2 can be achieved, making AVRfreaks very relevant to Atmel. This is very relevant as the cost of product support to tens of thousands of individuals without a community would not scale. The AVRfreaks community therefore represent a value for Atmel by handling support for this market, and by that keeping potential future large-scale customers loyal to the products that Atmel represent. This is an important aspect to bring into market strategy considered that research company Gartner predicted that: *"By 2017, 50 Percent of Internet of Things Solutions Will Originate in Startups That Are Less Than Three Years Old"* (Gartner, 2014). Our assump-

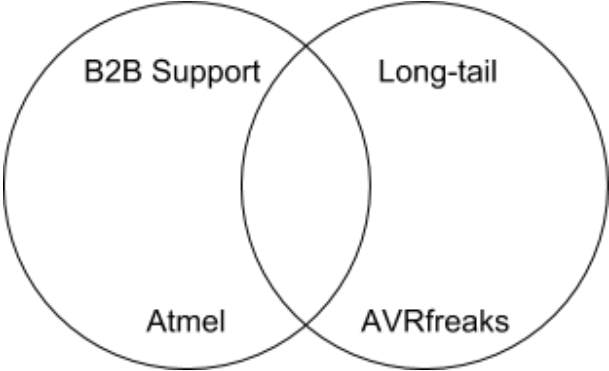
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tion is that the startups will initially find their way to through long-tail market which is served by the AVRfreaks community.

### **Managing a fragmented customer-base with a community**

To Atmel, the AVRfreaks community is a means to manage the very large and fragmented long-tail of its user- and customer-base. Atmels business-to-business (B2B) transaction model for selling millions of microcontrollers is very different to the transaction models for selling single quantities of microcontrollers and AVRfreaks solves this and supplements Atmel’s traditional B2B support model.



**Figure 5.1:** Atmel support models

The long-tail of customers is extensively discussed in the past decade (Anderson, 2012) and companies able to serve the traditional customer base with a B2B support-model as well as a establishing long-tail support model are able to extend market reach and increase profits.

Applying the research by Walden, et.al (2000) on control of communities to the use-case of AVRfreaks shows a strong correlation between the theory and how Atmel has allowed AVRfreaks to autonomously operate. The result is a strong growth of the community as well as and independence from Atmel which has maintained the trust of the community by new community members as well as customers and users of AVR. As community size is a direct factor to the valuation of the community (Odzlyk, 2006), the growth of a community is key.

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## **Why the user community is important for support**

For branding, marketing and sales of products, peer-level trust is orders of magnitude higher than trusting the vendor as it is unbiased and objective.

Community discussion forums can be considered generally available information through on-line search-engines. This is in contrast to the traditional support mechanism offered in a B2B transaction where 1:1 communication is established between customer and vendor in a closed database. To manage the 1:1 support function, firms establish self-help systems where questions and answers are available in a knowledge base, accessible without interacting with the vendor. This is beneficial to reduce the transaction cost of support, which in turn allows the firm to scale the number of customers to engage as well as allowing customers to spend less time resolving issues if the information is already available. In support systems and models, this is referred to as *case deflection*, where a query or question from user is resolved before any human interaction takes place.

An online community discussion forum offer a similar function of case deflection where search-engines make questions and answers available to everyone, not limited to market vertical, customer priority group or limited to the long-tail. When comparing the technical questions raised in support forums and the questions raised in the traditional support model, the questions are the comparable. This means that resolution to a technical question raised in the community forum is also relevant to the traditional B2B customer.

## **Management and control of a community**

When Atmel initially established AVRFreaks, the intention was to build a self-sustained community of independent users. To achieve this, Atmel involved only initially to support new users to become key hubs in the network that would later become autonomous in the user-driven community.

Numerous discussions took place in Atmel to engage stronger into the communities directly and the choice was made to let the community drive itself without Atmel involvement. In discus-

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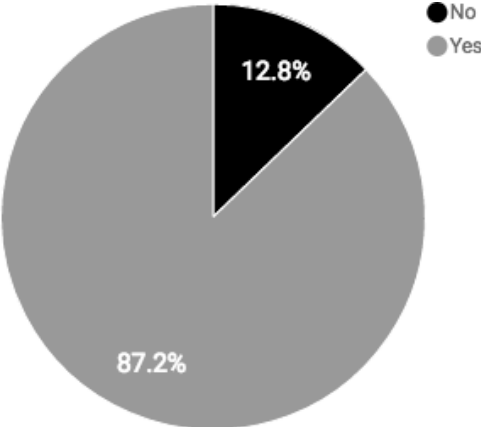
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sions with the community moderators, they were concerned that the experienced Atmel engineers would shy away the significant community members and again resulting in a diminishing community.

In the context of our study we consider the purpose of AVRfreaks as a community to be:

- Product support and information to users
- Giving credible information about the products to users and potential buyers

Walden (2000) states that the best control structures for such communities are community control and self control. Atmel implemented this approach by giving AVRfreaks an autonomous and open-source structure with little or no company control. This is also confirmed when we study community involvement and control by employees at Atmel. From the Atmel internal survey about employee relationship to the community (N = 39) we find that while 87.2% of the asked employees have a community member profile, only 15.4% of these profiles are showing that the members are working for Atmel.

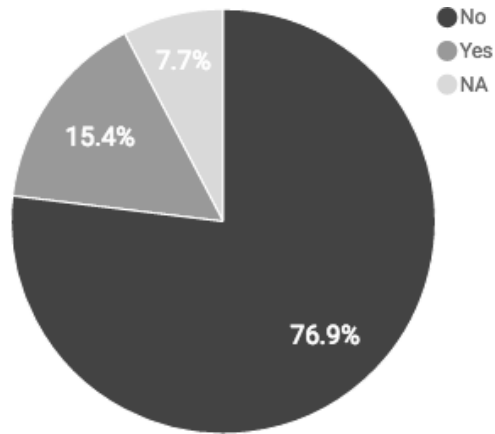


**Figure 5.2:** % of asked Atmel employees with AVRfreaks profile

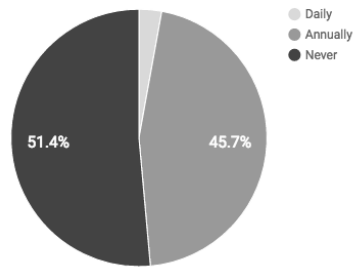
Only one employee visits the community on a daily basis, while an increasing number have more sporadic use of the community, from weekly (3), monthly (7), quarterly (9), yearly (8) and never (11). The distribution is even more diverse when asked who write, only one writes daily (2,85%), while 16 (45,71%) writes on a yearly basis and 18 (51,42%) never writes.

The observations we have from AVRfreaks on utilization and control of the community follows the theoretical framework of community control mechanisms proposed by Walden, where At-

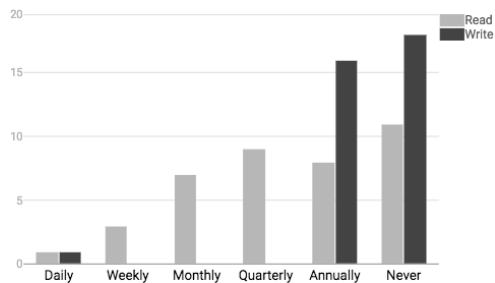
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**Figure 5.3:** Are your profile showing that you work at Atmel?



**Figure 5.4:** How often do you visit AVRfreaks?



**Figure 5.5:** How often do you read/write on AVRfreaks?

mel does not interfere with or engage with the community but rather have employees volunteer their contribution as individuals not showcasing their Atmel employment.

We categorize the AVRfreaks community as a brand community with scale-free network structure based on the characteristics of the community. The most important asset of such a community are the moderators, which are hubs in the network. Scale-free networks are solid, although removal of the hubs can result in dramatic failure of the community. The community owner, in this case Atmel must ensure that moderators are established and supported to prevent fragmen-

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tation and a weaker community.

An observation on AVRfreaks is the consciousness from Atmel on community involvement and control. We see a strong correlation between the theory on community control and how Atmels behaviour have created an autonomous community which is orders of magnitude larger compared to peers in the microcontroller market.

## **Recommendation to utilize or create a community**

Based on our industry experience with Atmel and AVRfreaks, the findings in literature and the correlation of the theory with our use-case, this study offer recommendations for establishing or supporting a community.

### 1. Create a scale-free network

Barabasi scale-free networks are robust! In the community, the hubs are key to support the robustness and the community will require strong moderators that will in turn will create strong followers, based on the reciprocity principles. Expect to see sub-communities form inside this network which further support the robustness.

### 2. Create an autonomous control-structure

Waldens theories (2000) on community-based control of the community is supported by the observations in the AVRfreaks usecase. This requires a trust by the company in the output the community can provide through its autonomy. It does limit the direct involvement from the company but does not limit its support of the moderators. It is key to allow community members discuss all aspects of your products, good and bad.

### 3. Openness

Keep the discussions and sharing of knowledge open, searchable by global search-engines (Google, et.al). The content generated in the community has two significant advantages over corporate-generated content:

Trust in the community from your customers is very highly regarded compared to trust in the company (Von Loewenfeld, 2006) and exposing community moderators (hubs) turn

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them and other community members into ambassadors for your products. Don't be afraid of discussions about your products, it is feedback from fans and supporters that only wants to see the products improve. Use that opportunity to improve your products.

#### 4. Moderate by standards

Set high expectations and elite standards in the forums. Moderators will support and not limit the value of the community, in turn creating more valuable output and increase attraction of new community members. The lead users will expect high standards and if this is provided attract more users. Von Hippel (2005) and Walden (2000) explains these concepts translated into an online community. For the company, it is important to strengthen the community quality and support the moderators to create a robust community

Once the community is established and content or output is generated by community members a valuation of the community should be done to understand the levels of investment required. This will be covered in the next chapter.

## **5.2 Research question 2: How to value a community**

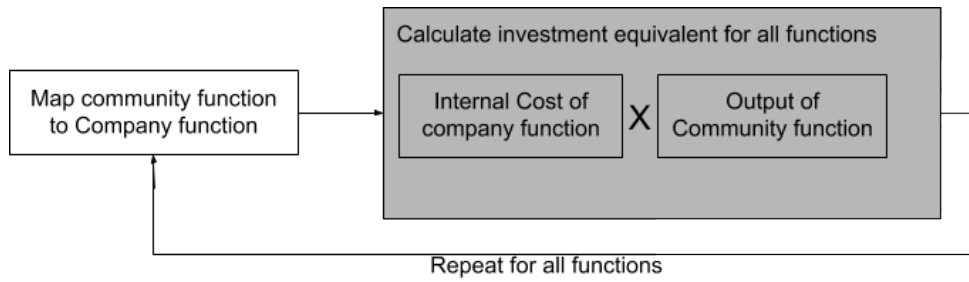
Our goal for this study and the research questions is to create a model to calculate monetary value of a community. Monetary value can be added as an intangible asset in the company balance sheet, thus turning the value of a community into an officially reported asset to the company. In our study, we have also researched competitors in the semiconductor industry (ST, Freescale, NXP) without finding any specific mention of communities as an asset in their balance sheets. These findings are non-conclusive though as immaterial assets of a company is rarely specified in public filings.

To calculate an immaterial monetary value in a community, we apply the model explained in the methodology chapter (see figure 3.1 on page 47) for the case study of AVRfreaks and Atmel. The model is repeated here for readability.

The model maps a community function to an equivalent company function and calculates the equivalent internal investment required to create the same output as the community generates. In

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**Figure 5.6:** Model to generate valuation of community

the Methodology chapter, we applied a mapping of Atmels business process to the AVRfreaks model of operation, as outlined in the table below. In the same table, we have also mapped valuation cycles from Wenger (2011).

The value cycles define stages of value in networks, where an increasing potential valuation for the company is offered as you extract value past the initial stages of the cycles. Community members and the company will have an immediate return in the first cycle where activities and interactions are made, while skills and knowledge is transferred to the network. The higher value of the network is extracted by the company in the later cycles, where customer value (and company profits) is created based on the internalization of skills and knowledge found through the discussion forums and project pages.

<b>Atmel Function</b>	<b>Community Function</b>	<b>Valuation Theory</b>
Technical Support	Discussion Forums	Wenger Cycle-1 (page 35)
Application Notes, Reference Designs, Knowledge Base	AVRfreaks discussion forums and projects	Wenger Cycle-2 (page 35)

**Table 5.1:** Mapping of Atmel and Community functions with the Wenger valuation theory

Wengers Cycle 1 is the **immediate value** of a community; discussing and helping community members, which is reflected in the discussion forums in the community mapped to Atmels product support.

Wengers Cycle 2 is the **knowledge capital** a community can generate through accumulated effort, social and human capital or tangible tools or knowledge. This is represented in the community accumulated discussions in the AVRfreaks forums and the AVRfreaks projects section. For Atmel, this is directly mapped to application notes, reference designs and knowledge base of Atmel.

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Now, with our classification and mapping of functions, we will present our findings throughout the rest of this chapter by outlining the cost of Atmel's functional areas and equate that to the community output of the similar function which will generate a cost-based model for valuation.

### 5.3 Total valuation of AVRfreaks

Using the model and calculation of the data presented in the empirical data chapter, we find the valuation of AVRfreaks to Atmel presented as an investment case in the table 5.2.

As we are focusing on the year 2016, we are applying a valuation of two components of the community: First is the immediate value (referred to as Wenger's value-cycle 1) where the value is generated constantly through the discussion forums, mapped to the support function of the company. Second is the accumulated value of the entire community output, represented by the discussion forums as a knowledge base and the projects-section mapped to application notes, software and reference designs.

Atmel Function	Community Function	Investment value	Return
Technical Support	Discussion Forums	USD \$ 1.9 Million	Immediate
Knowledge Base Application Notes Reference Designs Knowledge Base	Discussion forums AVRfreaks projects	USD \$0.28 Million USD \$7 Million	Accumulated
Total valuation		USD\$9,18 Million	

**Table 5.2:** Summary of AVRfreaks community valuation for calendar-year 2016

The variation in this model is explained in the empirical data chapter on investment value based on base salary medians of a **medium-cost** region. The public information about Atmel does not offer any split in the mix of regions and we see that the total valuation of the community could range from USD\$2,5 Million to USD\$12,2 Million depending on the location of the engineers.

In an investment business case, the accumulated value will take time to create and in particular the AVRfreaks project section is a tedious effort requiring substantial effort over time to create with talented, experienced and dedicated community members. The total revenues of the AVR product-line is not disclosed publicly, although the AVRfreaks community valuation is com-

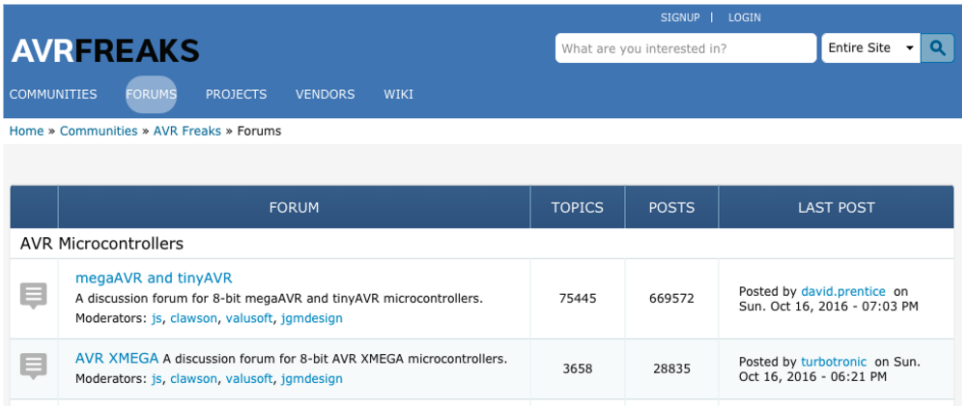
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parable in significance to the cost of operations for the applications engineering team, which handles similar company functions. As internal cost is allocated in a company balance sheet (in the case of Atmel as part of R&D cost) a discussion on classifying the value of the community as an intangible asset, as it can neither be seen nor touched but brings value to the company.

## Calculation of the support value

Communities offer an immediate value through the activity in the discussion forums. The discussions are similar to technical support questions posted directly to Atmel by customers through the incident management system. The discussion forum software on the AVRfreaks website offers an open, transparent resolution of technical questions.



The screenshot shows the AVRfreaks website interface. At the top, there is a navigation bar with 'AVRFREAKS' logo, 'SIGNUP | LOGIN', a search bar with the text 'What are you interested in?', and a dropdown menu for 'Entire Site'. Below the navigation bar, there are links for 'COMMUNITIES', 'FORUMS', 'PROJECTS', 'VENDORS', and 'WIKI'. The breadcrumb trail reads 'Home » Communities » AVR Freaks » Forums'. The main content area displays a table of forum statistics for 'AVR Microcontrollers'.

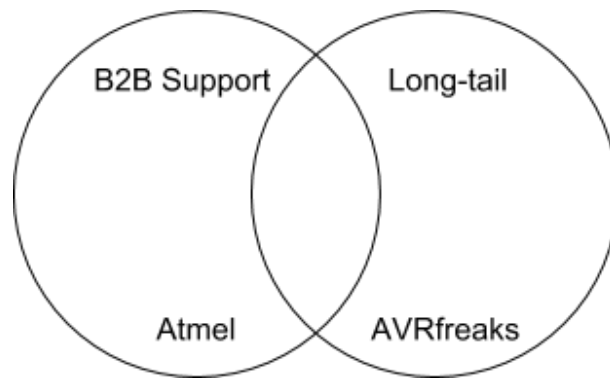
	FORUM	TOPICS	POSTS	LAST POST
	<b>AVR Microcontrollers</b>			
	<a href="#">megaAVR and tinyAVR</a> A discussion forum for 8-bit megaAVR and tinyAVR microcontrollers. Moderators: <a href="#">js</a> , <a href="#">clawson</a> , <a href="#">valusoft</a> , <a href="#">jgmdesign</a>	75445	669572	Posted by <a href="#">david.prentice</a> on Sun. Oct 16, 2016 - 07:03 PM
	<a href="#">AVR XMEGA</a> A discussion forum for 8-bit AVR XMEGA microcontrollers. Moderators: <a href="#">js</a> , <a href="#">clawson</a> , <a href="#">valusoft</a> , <a href="#">jgmdesign</a>	3658	28835	Posted by <a href="#">turbotronic</a> on Sun. Oct 16, 2016 - 06:21 PM

**Figure 5.7:** Screenshot of avrfreaks.net showing 75.000 topics with a total of 669.000 posts for one of Atmels 8-bit microcontroller products

Support is a resolution of a technical issue required to finish a product design and for the company, this will create revenue and thus direct value. For Atmel with a business-to-business customer engagement model, a 1-to-1 model for support is applied where users call, email or contact a specific individual assigned to support customers.

The community in the case of AVRfreaks openly supports requests in a forum, which carry similar behaviour as Atmels B2B support except the communication is open to everyone. The proposition is that a community offers immediate value in discussion forums for the long-tail that falls outside of Atmels traditional B2B support and as a side-effect also extends Atmels market-reach into the long-tail of the customer distribution.

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**Figure 5.8:** Traditional support combined with community support

The details and data are found in the empirical data chapter, which we use for our calculations. The total number of postings for the year is based on a 150 daily post average, resulting in 54,000 total posts yearly. It does not make rational sense to calculate a support value from the total 119.000 posts total for all technical forums on AVRfreaks, as the real value is the immediate output created in the discussions so our calculation is for a yearly (2016 runrates) valuation. Our studies show that 1 of 4 posts are new questions in the technical forums, which is comparable to a support question.

The data shows  $54,000/4 = 13,500$  new questions raised on the forum yearly. The internal capacity of Atmel engineers of 500 cases per support engineer per year this is equivalent to 27 full-time engineering positions if this support function would have followed Atmels traditional support-model.

Using the Payscale (2016) salary data for US employees this gives an immediate valuation AVRfreaks at \$1,9 Million USD for 2016.

This customer base is not served by Atmel traditionally and will most likely represent additional revenue in new markets to the company. The public P&L statements of the company does not break down customer revenue by market to further analyze this in our model.

## **Calculation of knowledge-base value**

Communities offer an archive of conversations accumulated throughout the lifetime of the community and accessible to search engines. This brings value to any user of the product, regardless

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of market segment and customer profile and therefore this community function is mapped to Atmels Support Knowledge Base function. The internal, company-offered knowledge base is maintained manually by application engineers of Atmel.

The total number of topics is 151,000 in the entire avrfreaks database. A topic equates to a question / answer pair in the Atmel knowledge base, although we should assume that a factoring of (K) to the number of topics must be applied to validate postings as appropriate knowledge base articles. The model-calculations does not take any factoring into account as there are no mechanisms for peer-rating or review in place today.

<b>Subforum</b>	<b>Posts</b>
tinyAVR and megaAVR	75.500
XMEGA	3.700
UC3	7.800
Tools	33000
<b>Total</b>	<b>119.000</b>

**Table 5.3:** Summary of discussion forums

The cost of generating 119,000 knowledge base articles internally and manually at Atmel is (based on data collection presented in the empirical data chapter is: 119,000 / 2,000 articles per engineer per year = **59.5 engineering years** turning the valuation of this entire knowledge-base is USD\$4,2 Million over the lifespan of the community and its content-database.

Normalized over the lifetime of the community (15 years) this is equivalent to 4 Atmel engineers full-time each year. Using payscale (2016) data to calculate this yearly valuation for 2016 the value is USD\$285,000 USD

We would argue that the openness and peer-trust found in the community brings a higher value to the entire forum database compared to Atmels knowledge base, as the knowledge base is carefully curated by Atmels engineers while the forum is open and transparent offering ie: Google search-engines to curate the findings based on user-queries from its search-engine. This allows for a semi-automated presentation of the forum discussions as a knowledge base.

The valuation of this knowledge base is also with a high degree of uncertainty, as it would not be expected that this source of information should be curated manually by engineers, but rather made available through automated data analysis software (Artificial Intelligence or similar).

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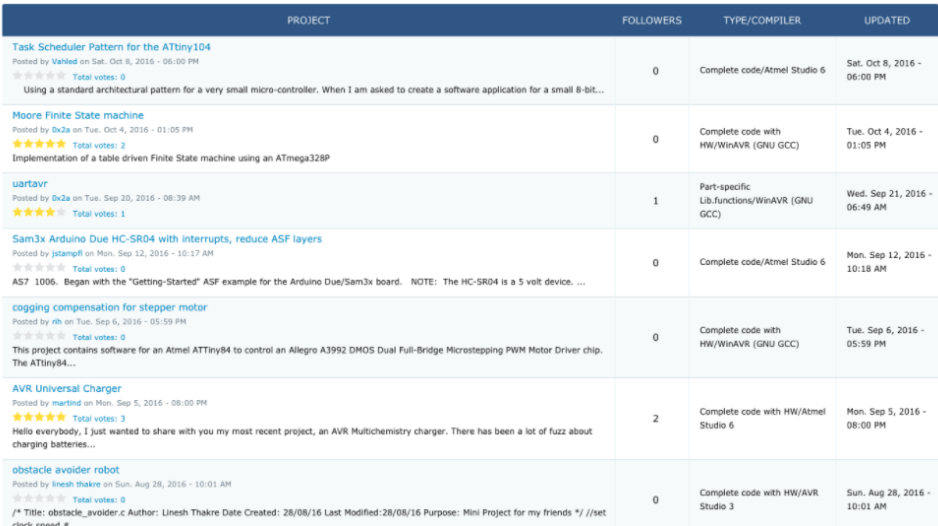
The use-case of Atmel does on the other hand apply a manual operation of adding content to the knowledge base and therefore is still valid for our calculation.

## Calculation of project repository value

The AVRfreaks project repository offers specific, direct value to Atmel in the form of tangible capital or learning capital described as part of Valuation Cycle 2 (Wenger, 2011). Tangible capital offers users privileged access to tools, documentation, information, source-code, early access software and reusable software libraries to reducing the Firm's internal cost of undertaking similar research and development and help customers reduce their effort and time to market in their own product design.

The AVRfreaks Project repository is a virtual document repository online to store and share information. Projects can contain any digital content and is typically source-code repositories of modules, sub-modules, applications or entire software, hardware, documentation and training files. AVRfreaks members can share software projects with other members of the community.

A total of 2,064 projects (Nov 2016) exist and include categorization, title, description and link to its author.



PROJECT	FOLLOWERS	TYPE/COMPILER	UPDATED
<b>Task Scheduler Pattern for the ATtiny104</b> Posted by <a href="#">Vahied</a> on Sat, Oct 8, 2016 - 06:00 PM Total votes: 0 Using a standard architectural pattern for a very small micro-controller. When I am asked to create a software application for a small 8-bit...	0	Complete code/Atmel Studio 6	Sat, Oct 8, 2016 - 06:00 PM
<b>Moore Finite State machine</b> Posted by <a href="#">0x2a</a> on Tue, Oct 4, 2016 - 01:05 PM ★★★★★ Total votes: 2 Implementation of a table driven Finite State machine using an ATmega328P	0	Complete code with HW/WinAVR (GNU GCC)	Tue, Oct 4, 2016 - 01:05 PM
<b>uartavr</b> Posted by <a href="#">0x2a</a> on Tue, Sep 20, 2016 - 08:39 AM ★★★★★ Total votes: 1	1	Part-specific Lib.functions/WinAVR (GNU GCC)	Wed, Sep 21, 2016 - 06:49 AM
<b>Sam3x Arduino Due HC-SR04 with interrupts, reduce ASF layers</b> Posted by <a href="#">jstamplf</a> on Mon, Sep 12, 2016 - 10:17 AM Total votes: 0 AS7 1006. Began with the "Getting-Started" ASF example for the Arduino Due/Sam3x board. NOTE: The HC-SR04 is a 5 volt device. ...	0	Complete code/Atmel Studio 6	Mon, Sep 12, 2016 - 10:18 AM
<b>cogging compensation for stepper motor</b> Posted by <a href="#">rth</a> on Tue, Sep 6, 2016 - 05:59 PM Total votes: 0 This project contains software for an Atmel ATtiny84 to control an Allegro A3992 DMOS Dual Full-Bridge Microstepping PWM Motor Driver chip. The ATtiny84...	0	Complete code with HW/WinAVR (GNU GCC)	Tue, Sep 6, 2016 - 05:59 PM
<b>AVR Universal Charger</b> Posted by <a href="#">martind</a> on Mon, Sep 5, 2016 - 08:00 PM ★★★★★ Total votes: 3 Hello everybody, I just wanted to share with you my most recent project, an AVR Multichemistry charger. There has been a lot of fuzz about charging batteries...	2	Complete code with HW/Atmel Studio 6	Mon, Sep 5, 2016 - 08:00 PM
<b>obstacle avoider robot</b> Posted by <a href="#">lshesh thakre</a> on Sun, Aug 28, 2016 - 10:01 AM Total votes: 0 /* Title: obstacle_avoider.c Author: Lshesh Thakre Date Created: 28/08/16 Last Modified: 28/08/16 Purpose: Mini Project for my friends */ //set clock speed #...	0	Complete code with HW/AVR Studio 3	Sun, Aug 28, 2016 - 10:01 AM

Figure 5.9: Screenshot of the projects section on www.avrfreaks.net

Surowiecki (2004) explained how important diversity is in creating value in communities, which

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we clearly understand in the context of AVRfreaks. Some of the projects are very simple software examples that assist new users in getting started with the AVR microcontroller (*uartavr*) and others are *full-fledged obstacle avoidance robots* or *Multichemistry Battery Charger* reference designs. Without a diverse background, interest and skillset such value creation would not happen.

How does this translate to value for Atmel? Atmels revenue is generated by selling microcontroller chips to a world-wide, industry-wide customer base. These customers invest a majority of their research and development budget in software development on microcontrollers, subsequently on hardware design. It is common practice in the industry to offer reference designs and application notes to customers intended to reduce the design complexity and effort of the customer. Atmel creates application notes, reference designs and software to its customers in the exact same model as the AVRfreaks project section and this is a good mapping between the community and company function.

We use the data presented in the empirical data chapter and map the categorization of the AVRfreaks projects to the equivalent internal investment cost of Atmel to calculate the total equivalent effort of content created by the community and find a total of 22,350 man-weeks of effort.

Is the 22,350 man-weeks of effort probable? We apply the research of Price (2001) and Sun et al (2014) that shows for large networks 90% of members read, 9% edit and 1% contribute to the network and we find that of the 300,000 users on AVRfreaks 3,000 would contribute and 27,000 would edit, to share the workload. The rest of the users consume and benefit this work.

23,350 man-weeks of effort shared with 3,000 people is 7,7 man-weeks of effort pr contributor and less than 1 man-week of effort in peer-reviewing and scrutiny by 27,000 users. And this is in a period of 15 years where these projects are accumulated leaving about half a man-week of effort yearly. Our observation is that this model is relevant for the case of AVRfreaks and Atmel.

Using the payscale (2016) data for US engineers to calculate the monetary value with a 1,850 hours of work in a year this is equivalent to 100 man-years of value. The total accumulated value of the AVRfreaks projects is equivalent to USD\$7 Million USD investment.

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We would argue strongly that the valuation of the AVRfreaks projects must be calibrated by a component that takes quality and applicability into consideration. Although the Atmel AVR Microcontrollers are used in all markets, industries and electronic applications world-wide there will still be applications that are less relevant in the project repository. The qualitative value of each project would be a good candidate for further research, both as an objective parameter in the community software where peer and customer-review and rating could be enabled.

### **Considerations: Replacing internal R&D with a community**

Can you replace technical product support, product knowledge base and applications-specific RD required to secure design-wins with customers entirely with a community effort? That is a relevant question based on the data we present in this study and we would argue that a blended model is required, just what we presented initially in this chapter with the goto-market strategies of Atmel. Direct relationships with businesses are managed by the company, while the long-tail of the market is autonomously maintained through the community effort.

We do not find any evidence that entire RD and support efforts of Atmel should be replaced with a community effort due a number of factors. Most importantly the products sold by any company, Atmel included, can contain proprietary intellectual property that is not shared openly. Technical product support will then come at a serious disadvantage as access to internal proprietary knowledge is required to solve a portion of the issues raised by users and customers. The fact that product support at this level is a requirement for customers to complete their designs also comes with a responsibility to offer timely and high quality support that a community of volunteers will find hard to support.

### **Valuation growth**

With a base-line valuation, we can apply growth-laws by Odlyzko et.al (2006) (covered on page 29) to simulate future valuation of a community, which by definition is a function of its members. An interesting realization is that a community value is not dependant on a constant growth or growth at all of the number of community members to offer value. Our study finds

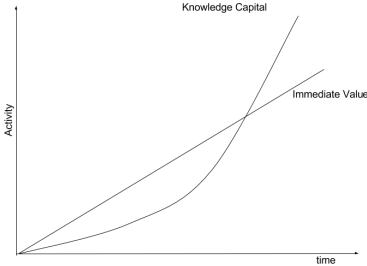
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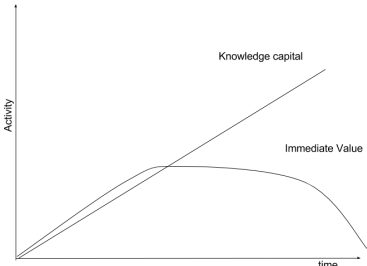
that to offer immediate value found in **Cycle-1**, the number of community members matter as there must be a dialog between requestors of information and those offering resolution. But due to the **Cycle-2** valuation of knowledge capital being accrued and made available to everyone with access to the community website.

An example is shown in figure below shows an increase in Cycle-2 value due to accumulation of postings as the members in the community grow and create immediate value.



**Figure 5.10:** Valuation in a community with growing number of members (simulated figures)

A community with a linearly growing number of community members create an increasing number of posts thus creating a growth in immediate value (cycle 1). The knowledge capital (cycle 2) grows stronger as it accumulates over time, also based on the number of posts as well as the projects generated by the community members. The model also shows that even if the amount of members decrease, the potential value of the community will increase while the immediate value is a function of the immediate activity in a discussion forum. See figure 5.11 on page 73



**Figure 5.11:** Valuation in a community where number of members decline over time (simulated figures)

This correlates with the experience we have with AVRfreaks, where user postings in the forums are used to resolve repeat questions and countless web searches that will result in a search hit on avrfreaks.net discussion forum website.

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## 5.4 Observations and calibration of the valuation models

We have chosen to calculate the equivalent cost of an investment business case to value the community. This was done specifically because Atmel's operating model already finds a specific relationship between the community forums and support as well as the community project repositories and Atmel application notes, software repository and reference designs.

We also chose this approach due to lack of public information about revenue generation for each of the activities (support, application notes and reference designs). For Atmel, a breakdown of revenue to specific individual product lines is not public, but had this information been available, research could have linked revenue to the activities supported by Atmel and replicated by the community, offering a calibration of the model based on revenue and not investment cost.

There are a number of factors that will vary in the model which are contextual to an industry but also a company. Most notably in our model the cost of an engineer, where we have usedayscale data from 2016 for US electrical engineers to calculate the equivalent internal cost represented by the output created in the AVRfreaks community. Companies will seek to reduce its operating expense by moving work to lower-cost countries with equivalent skillsets. Atmel operates from several European countries (Norway, France, Germany, UK) and from California in the US which are notably high salary regions and offset this cost by having operations in India and China. No public data exist for the split between high/low-cost countries where Atmel operate but it is fair to assume that the mean cost of an engineer is lower compared to the data we have used in the model.

For a final calibration of the model and calculation, assessment of the output of the community is important. It is fair to assume that not all forum topics are equivalent to support and not all project contributions are equivalent to a fully functional customer-specific reference design or application note.

It is also worthwhile to mention that similar cases of utilization of communities exist that go far beyond the involvement of Atmel to AVRfreaks. Transmeta corporation hired Linus Torvalds (Brashares, 2001) in a position where he continued his community effort on the Linux Kernel while being employed at Transmeta, thus creating a strong bond between the Linux community

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and the Transmeta Corporation. Linus Torvalds is the founder and main author of the Linux Kernel. It is not clear if Transmeta had any intention of getting value from the Linux kernel community in this effort. 3DRobotics offered equity to the highest rated and most valued contributor of source-code on the community webpage diydrones.org (Anderson, 2012) to ensure a tie-in with community hubs and simultaneously allowing a reduced immediate capital cost of the company at the expense of company shares. The community valuation for 3DRobotics is undoubtedly very strong as their internal R&D is in a sense completely outsourced to the community while control is maintained through equity sharing and buy-in.

## **5.5 Implications for theory**

Through the study of the AVRfreaks community we have demonstrated how a company can utilize a community to create immaterial, monetized value. The process and model applied to the valuation supports the Barabasi's classification theories of scale-free networks which allows us to describe and support how the hubs of communities is equivalent to the community moderators.

By using Mainelli and Harris theories on community classifications in general and Von Loewenfeld's model for brand communities specifically the study contributes empirically by classifying the AVRfreaks community as a brand community, following the classification rules outlined in the theory.

Applied use of Wengers value-cycles to build a generic model contributes empirically through the findings in the use-case to support the classification and typology. Waldens recommendation on controls-structures for online communities are supported in the findings and we find the management of the AVRfreaks community.

As an anecdotal remark, we know that best-practice approach was non-existent for communities when AVRfreaks was first created but the decisions we made in the Atmel management team from early 2000 to this date to grow, nurture the moderators and support the community and platform is strongly supported by the literature and research reviewed in this study.

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## 5.6 Limitations and Further Research

Although care has been taken to create a generalized model, we have not validated the model outside of the semiconductor industry. A limitation of the model is tied to the functions of Atmel Corporation and the mapping to the AVRfreaks community discussion forums and project pages. The validity of the model is tied to this mapping and the study would benefit from applying the model to multiple use-cases,. The AVRfreaks community also represents the industrys largest and most successful online community and it was difficult for the researchers to find communities similar in size and evolution to further calibrate the model for this use-case.

Also, to apply the model to another use-case, the company must have a structured, repeatable project process with key performance indicators to measure project duration and keep a record of cost as this is highly company and industry-specific.

There are also limitations to the model-design itself. We use the term community in this study exclusively on online, web-based communities, although communities also exist offline where this model will not be directly applicable

Although the recommendation in this study is to support the community due its fairly high potential value there are pitfalls that readers should be aware of. Opening up development of Intellectual Property to a community will come at the expense of ownership, control and direction of the development activity. The same consideration must be made for product forum discussions acting as support channels as involvement in, nurturing of and reliance on a community must have a strong buy-in from a companys management team.

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## Conclusion

The result of the study finds an annual valuation of AVRfreaks to Atmel to be multi-million dollars in the form of reduced customer support-cost and wider market reach and we find that the application of the model in other industries beyond microcontrollers is possible.

This study examines existing theories and literature in network theory and community valuation to show how to utilize a community and presents a generic model for valuation applied to the functional areas of support and RD at Atmel. The empirical studies correlate the data from AVRfreaks with Atmels internal data to calibrate the model to provide the valuation of the community.

The research of Wenger, Barabasi, Walden combined with empirical data from the AVRfreaks case-study concludes that Atmel has built a strong AVRfreaks community that serves as a model for other brand communities, answering the initial research question: How to utilize a community.

This bridges into the second question: How to value a community, where we created a model, applied it and conclude with a monetary valuation. Atmel is able to extend into the long-tail of customers through the community and does so effectively by trusting the community in handling support and applications R&D for the individual customers that are not supported in Atmel's business to business customer engagement model.

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## **Note on Researcher bias**

One of the researchers in this study was part of Atmel's Management team with responsibility for Atmel technical support and application-specific RD and participated in strategic planning cycles for the company as a business- and budget- owner for these areas. We do see this as a potential conflict of interest, but is counterbalanced by the insight into Atmel's Key Performance Indicators and costing models for business processes as well as applicability of this research across the semiconductor industry.

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