



# Promoting Open Source Models in the Danish Manufacturing Industry

An Interactive Qualifying Project  
Denmark Project Center

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# Abstract

Open source allows companies to innovate more quickly; companies can work together to create a shared platform of information where all contributors benefit. Our sponsor, the Danish Design Center, believes that more manufacturing companies should adopt these open principles. Thus, our team created an online Toolkit to provide wider access to the Danish Design Center's educational materials on open source. The accessibility provided by this website will help spread the open source movement in Danish manufacturing.

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# Authorship

Our project was the result of a large amount of team effort, whether that was on the paper or in creating the deliverables. This project would not have been possible without the full, coordinated effort of the entire team.

## Abstract

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## 2. Background

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### 2.3 Revenue Models for Open Source

#### 2.3.1 Software as a Service

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#### 2.3.2 Open Source Products

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- 4.3 Website Implementation
  - 4.3.1 Graphic Design
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## **5. Conclusions and Recommendations**

- 5.1 Information in the Toolkit should be highly structured
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- 5.2 User generated content will help increase the longevity of the Toolkit
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- 5.3 Our Toolkit can be used to guide further development
  - Written by: Wentao Yuan
  - Reviewed by: Saahil Claypool

### Appendix C: Case Studies

- Arduino – Sean Hunt
- Tesla – Sean Hunt
- RepRap – Sean Hunt
- Farmbot - Sean Hunt
- Riversimple – Sean Hunt
- IBM –Saahil Claypool
- Redhat – Saahil Claypool

# Executive Summary

Information sharing has become a crucial component in the development of modern technology. The shared-information development model has been very successful in the software industry through the use of open source software, which is “software whose source code is available free of charge to the public to use, copy, modify, sublicense, or distribute”. By using open source, software companies can build upon a shared body of software rather than creating each component from scratch. This open source design has been used effectively in many software products such as: Android operating system, based on Linux; the Mac OS X operating system, based on FreeBSD; and the Google Chrome web browser, based on WebKit.

The open source model has the potential to be used in the manufacturing industry to increase the speed at which products are developed, but manufacturing companies are still hesitant to release their proprietary work. Our sponsor, the Danish Design Center, aims to change this. They believe that promoting open source and information sharing in the manufacturing industry will increase the innovation and sustainability of the entire Danish manufacturing sector. The Danish Design Center has been working individually with companies to help them learn and transition to an open business model, through a program they call **REMODEL** (Figure 1). However, this system is currently not scalable to a large number of companies. Thus, the Danish Design Center planned to create an online toolkit, in the form of a website, to make their materials more broadly available.



Figure 1: REMODEL Logo

The goal of our project was to assist in the development of this **Open Source Business Model Toolkit**. The Toolkit provides companies with the information they need to *independently* develop an open source business model without direct assistance from the Danish Design Center. To accomplish this goal, our objectives were to:

1. Design the Business Model Toolkit
2. Enhance the online functionality of the Toolkit
3. Support user generated content and discussion within the Toolkit

In order to adapt the Danish Design Center’s REMODEL program for the web, we produced three major deliverables. First, we created **prototypes** for the REMODEL Toolkit to determine the functionality and content required to make the Toolkit. Second, we developed supplemental **case studies** to provide more context for companies independently using this toolkit. Finally, we used these prototypes and the additional content to implement the **REMODEL Toolkit website**.

## Design Prototypes

To design the structure and appearance of the website, we created and evaluated a number of prototypes. By creating prototypes of the website, we were able to quickly iterate over different designs and test these designs with focus groups of representative Toolkit users. We created and evaluated two prototypes for the website: First, we created a **website wireframe**, which was a box and arrow diagram that represented the connection between pages similar to a flow chart. We evaluated this prototype to identify how to structure the information in the Toolkit. Second, we created a **paper prototype**. This prototype ‘fleshed out’ the wireframe by creating a visual representation for each page of the Toolkit before it was implemented as a web page. This let us decide what each page of the Toolkit should look like and what information each page should contain.

These two design documents defined our vision for the **Toolkit** and helped guide our final creation of the website. Furthermore, these documents provide a comprehensive view of the ‘optimal’ function. This will help the Danish Design Center continue our work after we deliver our final website.

## Case Studies

Our second deliverable was a documented set of case studies to help **inspire first time users**. We attended a Fab City<sup>1</sup> talk hosted by the Danish Design Center which introduced open source manufacturing to a mixed group of manufacturers and startups in order to identify what concerns or aspirations new users are likely to have. After observing the questions of these newcomers, we were able to identify four areas that our case studies should focus on:

1. rapid innovation
2. shared cost of development
3. creating a community
4. generating revenue

Each case study focuses on a single company and their business model. These case studies are meant to provide concrete examples of successful companies using open source, and they should inspire new users, and give them a better idea of how open source can function in the private sector.

## REMODEL Website Implementation

Using the prototype designs and the content, we created the final REMODEL Toolkit website (Figure 2). We built the website using WordPress, a Content Management System that is used to create and manage websites. Because we had already created most of the designs and content before starting the website, we were able to focus on the visual design. We used the internal design documents used by the Danish Design Center to make our website ‘look and feel’ similar to other Danish Design Center’s websites. We also conducted a comparative analysis of other high-profile websites to determine how modern websites display their content so that we could use this information in our website design choices.

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<sup>1</sup> Fab City is a global movement to promote shared resource usage in cities by the Institute for Advanced Architecture of Catalonia.



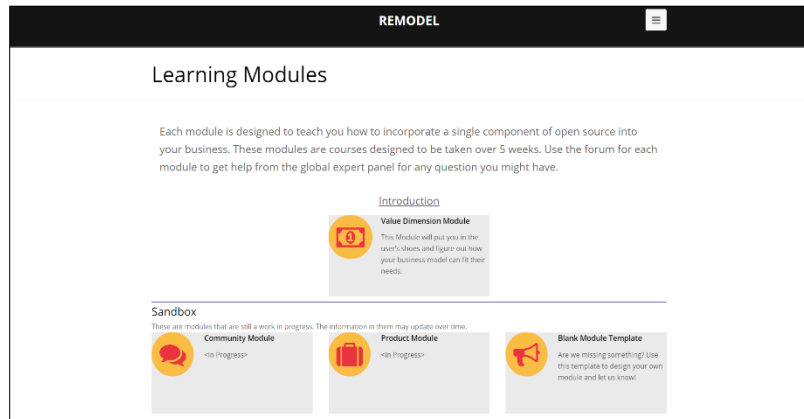


Figure 2: Learning Modules Overview

Our final goal was to add **user interaction** to the Toolkit. We did this by adding a **forum** for each topic in the Toolkit. This will allow users to contribute the questions and answers to the Toolkit as it is used. These answers could help the Toolkit stay relevant as new open source topics arise. Thus, using the prototypes, case studies, visual design documents and the forums, we were able to assemble a fully functional prototype for the Open Source Business Model Toolkit.

## Recommendations

While our team created a fully functional prototype of the Open Source Business Model Toolkit, the Toolkit is not quite a finished product. The Danish Design Center will continue the development of the Toolkit using our prototype as a framework for the REMODEL program's continued development. To aid in this development, our team formulated three recommendations to our sponsor based on our experience developing the Toolkit:

1. **Structure** the information in the Toolkit clearly:  
As we tested our design prototypes, we found that new users were very easily confused by ambiguous material and by too many choices. We recommend that material in the Toolkit be structured in lists or bullets, so that the user is presented with a small number of options at any time.
2. Enable users to **contribute** to the Toolkit  
Enabling users to contribute to the Toolkit will help ensure the information on the information in the Toolkit stays relevant. While the Toolkit contains current information on open source manufacturing, this field is still growing. As such, new information will likely arise. Thus, we recommend that the Danish Design Center develop more elaborate ways for users to contribute their knowledge, such as contributing their own experiences with open source, directly to the Toolkit.
3. Leverage our Toolkit to **guide** further development:  
Finally, we recommend our Toolkit be used as a framework for further development. We provided templates for each components of the website and a developer guide on how to use these templates. These templates should allow the Danish Design Center to quickly produce material with the same visual appearance as the material currently on the website without creating the look and feel from scratch each time.

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# 1. Introduction

Due to computers and networks, information sharing has become a crucial component in the development of modern technology. But, in the traditional business model, companies still rely on internal research and development (R&D) to create their largely proprietary products.<sup>2</sup> This internal development does not maximize the benefits of information sharing.

The shared-information development model has been very successful in the software industry with open source software. *Open source* refers to “software whose source code is available free of charge to the public to use, copy, modify, sublicense, or distribute”.<sup>3</sup> Compared to the closed source model, the internals of an open source program are freely available to view, modify and redistribute. By using open source, software companies can build upon a shared body of software rather than creating each component from scratch. This open source design has been used effectively in many software products such as: the Android operating system, based on Linux; the Mac OS X operating system, based on FreeBSD; and the Google Chrome web browser, based on WebKit.<sup>4</sup> Each of these products uses open source components, thus allowing the product owners to benefit from the contributions of other companies while also allowing the external companies to build upon the original product.

The open source model from the software industry also has the potential to be applied to the manufacturing industry to **increase the speed at which products are developed**. In fact, this has been done recently by the Tesla Motors. On June 11th, 2014, Tesla open-sourced (stopped enforcing) all of their Tesla car patents to create a “common, rapidly-evolving technology platform” where more manufacturing companies are contributing to the same open knowledge base.<sup>5</sup> Creating a shared information platform will help both Tesla and the electric car industry due to an improved infrastructure. But, despite the potential benefits, manufacturing companies still rarely use open source in their work.

To remedy this, our sponsor, the Danish Design Center, is working to promote more effective business practices within Denmark. The Danish Design Center is funded by the Danish Ministry of Growth, and it aims to increase the innovation and sustainability of the Danish manufacturing sector. Specifically, we worked with the REMODEL team within the Danish Design Center, who are exploring the possibility of using open design principles borrowed from the software industry to increase the amount of information sharing in the manufacturing industry.

Although some companies in the manufacturing industry have begun to adopt open source ideologies, open source is not yet widespread. Our sponsor aims to increase the adoption rate by providing companies with the tools they need to transition to open source. Our sponsor does this by providing training programs for companies interested in open source.<sup>6</sup> However, their system is not scalable to a large number of companies because the material from these sessions is only useable with the direct assistance of the Danish Design Center. To fix this, our sponsor wishes to create an online toolkit to house these materials, thus exposing their open source learning materials to more companies.

The goal of our project was to assist in the development of the Open Source Business Model Toolkit. This Toolkit provides companies with the information they need to **independently develop an open source business model**. This would allow the REMODEL team’s resources to be used by a larger audience, because the REMODEL team would not need to engage directly with each user. We implemented the Toolkit as a website that provides any interested company with guidance and online access to the open source learning modules created by the REMODEL team. Toward this goal, we aimed to:

1. Design the Business Model Toolkit to be used independently
2. Enhance the online functionality of the Toolkit
3. Support user generated content and discussion within the Toolkit

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<sup>2</sup> Lerner, 2002

## 2. Background

In this chapter we discuss the issues in the traditional business model and how it can restrict the shared information between companies. Specifically, we focus on how this model is especially restrictive to small companies, which are common in Denmark. We then contrast this closed model with open source and determine how it functions in the software industry. Finally, we discuss how open source can be applied to the manufacturing industry.

### 2.1 Information Sharing in the Traditional Business Model

In a traditional business model, research and development (R&D) happens within a closed frame of the company. This research and development focuses on creating new, proprietary intellectual property (IP), which can then be used to gain a distinct advantage over the competition. But, this closed development model does not emphasize shared information between companies. Thus, when a product does not reach the market, much of the research and development that was put into that product is ‘lost’ and never useful to any company in that field.<sup>7</sup>

During the twentieth century, most companies adopted closed source business models. These business models emphasized new inventions; companies were rushing to be the first to create a new product and gain a competitive edge over other companies.<sup>8</sup> Some economists attributed this rise in closed innovation to the lower cost of internal innovation inside the firm.<sup>9</sup> Because it was cheap to create new products internally, little incentive remained for companies to look externally for innovation. Moreover, companies had a large incentive to developing internally; by being the first company to create a new product, companies could then patent this product to gain an advantage over their competitors.

Patents are meant to be “an incentive to those that innovate in a genuine way” because patents give the inventor exclusive rights to his or her invention.<sup>10</sup> The patent ensures that no other company or individual can use that invention without due permission by the inventor, thus providing the inventor an advantage over the competition by stopping other companies from simply stealing the patented invention. This advantage can be used to either dominate a product market or as leverage in a merger or acquisition.<sup>11</sup> However, patents may be inhibiting rather than stimulating innovation. Some scholars postulate that “broad patent protection... may slow the rate of technical change by impeding subsequent innovations.”<sup>12</sup> By giving a single company exclusive rights to an invention, patents can prohibit the joint innovation of multiple parties because the patent owner can restrict others from building upon their work.

A specific example of this reduced innovation happened in the biomedical industry. Myriad Genetics, a biomedical company, held two patents for discovering genes that can trigger breast cancer. These patents stipulated that no other company or researcher could target these genes without properly paying or receiving a license from Myriad Genetics. This forced a number of clinical researchers to abandon their work entirely, thus precluding them from contributing to the breast cancer research.<sup>13</sup> This shows how a traditional closed model has the possibility to effectively stop innovation. Other companies, who may have contributed similar breakthroughs, had to stop development due to the restrictions of patents.

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3 open source. (n.d.). Dictionary.com

4 “Chrome”, 2017; Kahn, 2015; Shui, Yasumoto, 2016

5 Musk, 2014

6 Villum, 2016

7 Chesbrough, 2006

8 Chandler, 1990

9 Mowery, 1983

10 Wesley, M. C. (Ed.), 2003.

11 Bouchoux, 2012

12 Wesley, M. C. (Ed.), 2003.

13 Jaffe, 2006

### 2.1.1 Implications for Small Danish Companies

The traditional business model restricts innovation more significantly in small companies in high technology sector. High technology refers to cutting edge technology, usually involving new research or experimental markets. When companies share little knowledge on research and design, high technology products become costly and difficult to build on a small scale because all of the research and development must be done internally.<sup>14</sup> This cost is not as apparent in large companies since they can afford to fund long-term development of products internally. However, small companies do not have resources to do this research independently, and thus cannot break into the high technology sector with traditional business models. This is especially seen in the Danish manufacturing where most of the companies are of a small or medium size.

Since Danish industry consists of a high proportion of small-and medium-sized enterprises, the high-technology sector is relatively weak. As the high-technology businesses requires more research resources, many small-and medium-sized Danish enterprises concentrate on less-expensive technology. This can be seen in Figure 3: Percentage share of high and low-tech products in manufacturing exports, which shows that, as of 2011, just 0.6% of the Danish technology industry focuses on high tech products. Compared to the surrounding European countries, Danish high-tech industry growth is low, as seen in Figure 4: Rate of change of Denmark high-tech exports to the rest of the world. This supports the idea that high tech industries are less accessible to the small Danish manufacturing companies.

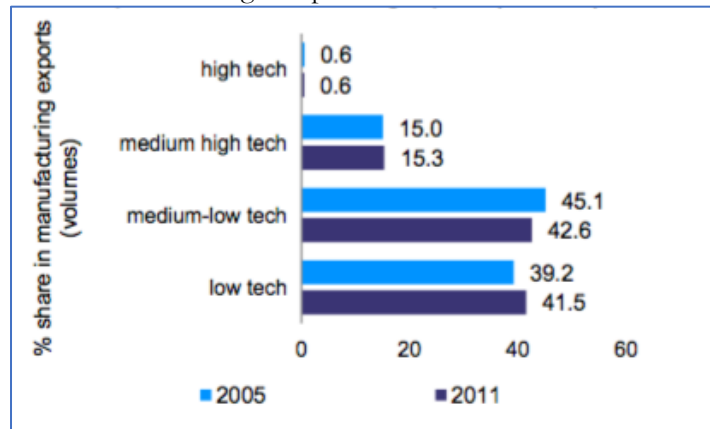


Figure 3: Percentage share of high and low-tech products in manufacturing exports

This graph shows percent of Denmark's exports of each technology sector in 2005 and 2011. High-tech products make up only 0.6 percent of total Danish manufacturing exports.

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14 Edquist, 2008

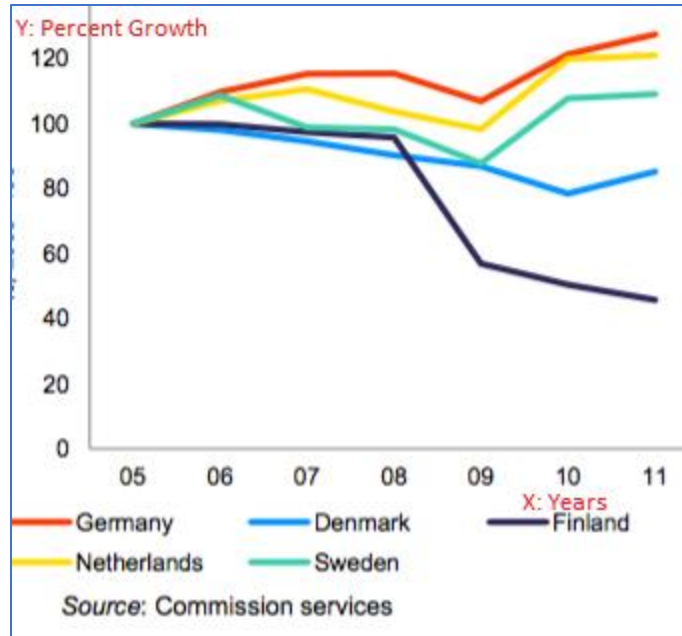


Figure 4: Rate of change of Denmark high-tech exports to the rest of the world

The X axis indicates the years from 2005 to 2011. The Y axis indicates the percentage of rate of growth. This chart shows the rate of change of Denmark high-tech exports. Denmark shows a relatively low growth on high-tech sector, when compared to other European countries like Germany.

The sharing of research and design may help the high-technology industry to become more competitive. By sharing their knowledge, small Danish companies have the option to collaborate on high-tech products. This collaboration would share the research and development costs among high-tech companies and thus make the high-tech industry more accessible to these small Danish companies. With lowered costs for research and development, it allows for more resources to be focused on production.

## 2.2 Open Source Business Models

*Open source* can be defined as the process of creating a product that can be developed, modified, and redistributed freely by any user or organization. In contrast to proprietary or patented work, open source development focuses on transparent development. This transparency gives the community opportunities to look into what would traditionally be confidential and create their own improvements for the system. This system allows companies to work with their users, or even other companies, to create better products.



The term open source was first used in February 1998 as a marketing device in the software industry to overcome the free of cost software trend, it was used as a new way to define the idea of “free software”. Free software was often, and incorrectly, assumed to be free of cost.<sup>15</sup> However Richard Stallman, one of the leaders of the Open Source Initiative, says free “does not refer to the cost but rather to freedom of software users to modify source code for their own purposes and the freedom to redistribute the modified software freely.”<sup>16</sup> By making source code available across industries, it allows programmers to adapt the code to better suit their employers’ needs and create improved versions for other users. Open source principles allow a community of users and developers to improve the overall quality of the open product by contributing directly to the product. Both the functionality and the quality of the software are improved by this system, as it allows for more eyes to develop, review, and test the software. Additionally, this system allows the users who are most affected by a given product to provide input on the direction of development while keeping the more experienced developers in control.<sup>17</sup>

The Open Source Initiative<sup>18</sup> provides guidelines to define what an *open source* project is. These guidelines are called the Open Source Definition.<sup>19</sup> The Open Source Definition is enforced by a set of legal licenses that define how the open source product can be modified and redistributed.

### 2.2.1 Legal Implications of Open Source

Open source software is not the same as unlicensed software. Rather, **open source software is protected under a set of legal licenses**. Violating a license can be grounds for a lawsuit.<sup>20</sup> Thus, despite being free, **open source software is typically highly regulated**. This ensures that companies that open source their products do not lose all control of their work.

Furthermore, open source licenses differ in how much freedom they give the users. Not all open source licenses fully abide by the open definition, and a company does not need to use an open source license on every part of its product. Rather, companies can choose which parts of their products are open source and which licenses (or patents) they use to protect their work. There are different implementations of the open source definition including Creative Commons and the Gnu Public License.<sup>21</sup>

Reciprocity, also sometimes known as *copyleft*, states that, if the original piece of software is freely editable and redistributable, then all future iterations must also remain free. In the example of software, the initial creator licenses the source code and then distributes it to be further worked on. All those that benefit and work on the code must agree that they will continue to redistribute the project leaving the distribution terms unchanged.<sup>22</sup> This is a common version of an open source license because it is the most straightforward implementation of open source. While reciprocity is not a legally binding license, this idea forms the basis of most open source licenses and practices.

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15 Fitzgerald, 2011

16 Fitzgerald, 2011

17 Goldman, 29

18 Open Source Initiative

19 The Open Source Initiative. The open source definition

20 Fontana, 2017

21 Dixon, 2003

22 Dixon, 2003

**The General Public License (GPL)** is similar to reciprocity, but allows for more customization. This license can be summarized as: “if you benefit from open software, then any changes or contributions you make should benefit others as well”.<sup>23</sup> This means that any changes made to a product under the GPL license must be released publicly for all other users. This forces companies that use a GPL licensed product to continue building upon that software. The GPL is the most widely used licensing group; about 60% of all open source projects using some form of GPL.<sup>24</sup> Furthermore 65% of software companies are contributing to open source projects in some way.<sup>25</sup> This license was authored by Richard Stallman, the same person who helped create of the Open Source Initiative.

Within the GPL, other versions allow for less restrictions. This is known as the LGPL, or Lesser General Public License, which allows for a company to add some of their own contributions to an open source project, such as libraries, and maintain them as private entities, while still contributing in other aspects to the open source project. This type of license allows for a middle ground between the extreme ends of open and closed source. This middle ground can allow companies to keep some aspects of their product proprietary while licensing other aspects as open source.

## 2.3 Revenue Models for Open Source Projects

The open source licenses ensure that open source software **remains freely available**, but that does not mean that companies cannot make money using this free software. In this section we will go over two of the most popular business models for software companies: **software as a service, and open sourcing core components of business applications.**

### 2.3.1 Software as a Service

When open source software is freely distributable, it may seem unclear how a company can make money with it; a user does not need to pay to purchase software that is free. But, *selling* software is not the only way to make money. Rather, companies can **make money selling the support for software instead of the software itself.**

One of the largest service-based companies is Red Hat, which as of 2012 was valued at \$14 billion.<sup>26</sup> Red Hat sells support for the open source operating system called Linux. Linux itself is completely open source; all users can view, modify and download the Linux operating system to the computers of their choosing. In fact, an exact clone of the Red Hat Linux operating system exists called CentOS.<sup>27</sup> But, even though an identical product exists, Red Hat is still able to be extremely profitable because it sells their service rather than the open source product. Service is not a product that can be copied directly by another company, and thus a service-based business model for open source products cannot simply be copied by another company.

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23 Fink, 2002

24 Daffaro, 2011

25 Black Duck Software, 2016

26 Brodtkin, 2012

27

Another type of service-based revenue model is called Software as a Service, or *SaaS*. In this model, software providers allow clients to “rent or borrow” services rather than purchasing. This has become increasingly common in software industry.<sup>28</sup> For example, Microsoft has recently been supporting open source through its Azure platform. Azure is a cloud computing service; companies pay money for Microsoft to host their applications or their databases. On this cloud computing platform, it is not the *product* that is sold, but rather the *use* of the platform. Companies pay to host their websites and databases on Microsoft’s servers because it is cheaper than operating their own servers. This cloud-based model is almost entirely run using open source software. As of 2014, 79% of all cloud servers ran Linux, the most popular open source operating system.<sup>29</sup> Thus, Microsoft can “heartily embrace open source without having to sell a line of it... [because] they sell services based on open source”.<sup>30</sup> This software as a service model allows highly profitable software companies to support open source because their profits are not tied to their intellectual property but rather their service.

### 2.3.2 Open Source Products

Providing service for an open source software product is not the only way that companies can profit from open source software. In fact, many of the most popular applications are based on open source components. The companies can add their own unique closed source components to an open source foundation to create a product that is unique, but still benefits from open source contributions.

For example, Google Chrome, the world’s most popular web browser, relies heavily on the open source Blink rendering (display) engine. Google built the Blink engine as an extension of Apple’s open source WebKit Safari engine.<sup>31</sup> Because this WebKit engine was open source under the GPL license, Google was able to build upon Apple’s work rather than reinventing the Blink rendering engine from scratch. Furthermore, Google’s Blink engine itself is open source and this has allowed for other browsers such as the Opera web browser to also incorporate and contribute to the Blink project rather than creating its own rendering solutions.<sup>32</sup> Each company built upon the work of other companies, which lead to faster development for the entire industry. This is different from a fully open product as some parts of the design are not visible to the public. However, because the cores are publicly visible, companies are able to benefit from a shared platform where other companies and users contribute to the project.

Furthermore, a company that uses an open source core for its product does not risk having its unique product completely copied by a competitor. This is because the company can keep its unique components closed source thus allowing them to differentiate their product from their competitors’ products. This allows companies to contribute to open source projects and still compete in the market.

## 2.4 Open Source in the Manufacturing Industry

Open source is an established business model in the manufacturing industry, but its acceptance is still growing in other industries. This growth may be limited because of the small community and by the fact that companies in the manufacturing industry are accustomed to using a traditional, patent-based business model. Despite this, open source principles have been implemented effectively in the manufacturing industry. This indicates that there is potential for open source design principles to be more widely adopted in the manufacturing industry.

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28 Gil, 2017

29 Vaughan-Nichols, 2014

30 Asay, 2016

31 “Chrome”, 2017

32 Protalinski, 2013

## 2.4.1 The Open Hardware Community

While the software industry has found many ways to profit from open source, other industries have only just begun to adopt similar principles. Specifically, in the hardware industry, there has been a push for ‘open design’ of hardware. Open design hardware “refers to the design specifications of a physical object that are licensed in such a way that the object can be studied, modified, created, and distributed by anyone.” This idea is very similar to open source software; anyone is allowed to see how something works and build upon that platform. Therefore, many of the open source ideas in the software industry should be transferable to the manufacturing industry. The Open Source Hardware Association (OSHW), a branch of the Open Source Initiative<sup>33</sup> responsible for much of the open source software adoption, is one of the leaders for the adoption of open source hardware. Still, most manufacturers are reluctant to adopt open source business models.

## 2.4.2 Profit Potentials for Open Source in the Manufacturing Sector

One of the concerns that companies have with open source models is that it seems unclear how a company can profit from a product after it is publicly available. This may be because companies using the traditional business model rely on their intellectual property to maintain an advantage over their competition. By releasing their work as open source, the company would lose this intellectual advantage. While this is a valid concern, the open source licenses do protect the original inventor in this regard; open source licenses such as the GPL license ensure that once a product is open sourced, it remain open source. This means that if a competitor copies the intellectual property of the inventor, competitor must keep their work open source. This would then allow the original inventor to benefit equally from the progress of their competitor

Another obstacle in creating an open source business model in the manufacturing industry is creating a modular project. To allow users, or other companies, to contribute to a project, it must be possible for them to access a small part of the project without substantial investment. In the software industry, this is a much smaller issue; the only investment needed to contribute to a software project is a computer (and some software programs). In comparison, industries such as the manufacturing industry involve higher initial investment to work on a project.<sup>34</sup> This may limit the number of external contributors to open manufacturing business, thus reducing the benefit of open source. But, this does not make open manufacturing impossible; open source manufacturing has been used effectively before by inviting other companies to contribute to a shared architecture.

## 2.4.3 The Success of Open Architecture

While open hardware design is less common than open source software, there is evidence that it is effective in facilitating the rapid growth of novel hardware platforms. This open design is often referred to as ‘open architecture.’ Open architecture is when all parts of the *physical* architecture are accessible to any user for “adding, upgrading, modifying and swapping components.”<sup>35</sup> This is analogous to open source in the software industry; much like how open source allows users to modify an existing open source program, open architecture allows the user to modify the existing components of a system. Thus, open architecture invites users and other companies to contribute to the hardware platform.

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33 Open Source Initiative

34 Lerner, 2002

35 Ericson II, 2011

One of the largest companies that used open design in their work was IBM when they constructed the IBM Personal Computer (PC). The IBM PC was one of the first affordable and small-sized personal computers to hit the market, and as a result little-third party support was available for software or hardware for these computers.<sup>36</sup> Dave Bradley, an engineer working on the IBM computer, realized that “even a company the size of IBM couldn't develop all of the hardware and software to make a personal computer a success.”<sup>37</sup> But, by taking an open architecture approach and publishing all of their circuit (and software) designs, IBM allowed other companies to make peripherals and thus boost the support for the IBM PCs. Furthermore, their open architecture became the *de facto* standard in the personal computer industry; every piece of hardware that was IBM compatible allowed all the IBM software to run on the non-IBM machine. And, all the software built for these IBM compatible machines would, in turn, run in the IBM PCs. This gave the IBM ecosystem a huge number of external contributors who targeted the IBM platform.<sup>38</sup> As a result, IBM's third-party support was unparalleled when compared to its competitor, the Apple Macintosh, which was more elegant, but closed platform.

More recently, the electric car company, Tesla has also opened their design to encourage more companies to contribute the electric car industry.<sup>39</sup> This allows any company that wishes to improve upon the Tesla design and sell it as their own without legal ramifications. The Tesla company believes that, by allowing other companies to use their intellectual property, more companies will join the electric car sector. The increased number of electric cars will lead to an increased infrastructure such as charging stations for all electric cars, including Teslas. Furthermore, costs of research and development would be greatly decreased, since Tesla would not be only ones developing the technology.

Both IBM and Tesla opened their hardware design for a similar reason: to increase the number of third party contributions to their platform, thus increasing each company's growth. Furthermore, both IBM and Tesla released patents on novel products that allowed them to define *de facto* standards in their respective industries and thus ensure that all future innovations would benefit their product. These examples indicate that an open architecture design can be used effectively in novel technological areas to promote rapid expansion and ensure that the future work in the area benefits the original product.

By borrowing design practices from the software industry, open source hardware design has the potential to increase innovation in the hardware industry. However, this movement is only successful if companies buy into this movement. Open source is powerful because it allows a community to contribute to a shared knowledge base. If only a single company contributes, there is no shared knowledge. The goal of our project is to help our sponsor encourage the shared adoption of open source by manufacturers, thus helping to start this shared knowledge platform.

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36 McGoogan, 2016

37 Miller, 2011

38 Curran, 1984

39 Musk, 2014

## 3. Methodology

The goal of this project is to assist the Danish Design Center in the development and promotion of an Open Source Business Model Toolkit for both Danish and international manufacturing companies. To accomplish this, we created a website to give companies online and independent access to our sponsor's open source learning modules.<sup>40</sup> Our specific objectives are:

1. To design the Business Model Toolkit to be used independently
2. To enhance the online functionality of the Toolkit
3. To support user generated content and discussion within the Toolkit

Our project focused specifically on promoting open manufacturing design in Denmark. We created a working prototype of the Toolkit that can be used by the Danish Design Center later when the REMODEL team officially launches its Toolkit to promote open source design.

### 3.1 Designing the Business Model Toolkit

Before the start of this project, the Danish Design Center had a number of resources that they shared with a small group of companies to aid their adoption of open source business models in their operations. One of our goals was to allow future companies to use these and other new resources independently and online, without direct assistance from the Danish Design Center. To accomplish this, we did the following: first, we **created concrete examples of open source implementations**. These examples were to encourage companies to consider open sourcing some part of their businesses by providing concrete examples of the potential benefits of open source. Second, after presenting the potential benefits to prospective companies, we **created a process for adopting Open Business Models** to help companies independently adopt open source without direct assistance from the Danish Design Center.

#### 3.1.1 Documenting Concrete Examples of Open Source Implementations

The Toolkit provides convincing cases for adopting open source business practices by presenting concrete open source success stories. We documented these case studies by collecting success stories from other businesses in the same industry that have already made the transition to an open source model. By writing short articles about the experiences of these companies, the Danish Design Center provided some examples, then instructed our team to create more on companies of our choosing. We defined a *successful company* as a company that has transitioned from closed source to open source in some way and that has either benefitted from the transition or maintained their previous successes they were experiencing prior to the change.

The first step in creating these case studies was to document which companies are currently using this model and where they are located. Before our arrival, our sponsor was already working with two companies, Thurmer Tools and Bang and Olufsen. These were essential to our research since they had already gone through the program with REMODEL. Our toolkit includes a case study for both of these companies, which were used as 'models' for all our other case studies. Our other case studies include high profile companies such as Tesla, Arduino, and IBM.

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<sup>40</sup> The open source learning modules were created by the Danish Design Center to help companies adopt open source in their business. Some of these modules were created by the Danish Design Center prior to our project.

For each case study, we wrote a short summary of the company that focused on three common misconceptions about open source. First, we showed how open source was previously used in the manufacturing industry. The term open source is most often associated with software, but we display how actual manufacturing companies have already used open source. Second, we emphasized how each company in the case study makes money, contrary to popular perception that open source is often associated with free products, not profits. Third, open source is a spectrum; we showed how some aspects of each company is closed, while the company still maintains an open source model.

These case studies contain short, concrete examples of companies benefitting from open source principles. The goal of these examples is to educate the user of the website while illustrating the possible benefits of an open source approach. Open source is an abstract idea; these concrete examples can help entice prospective businesses into exploring open source business practices.

### 3.1.2 Creating a Process for Adopting Open Business Models

Once companies are inspired to adopt open source, they need a process to actually adopt open source in their business. We adapted the step-by-step guides created by the Danish Design Center in order to provide this process. Creating this guide was essential because providing context for information increases critical thinking and understanding.<sup>41</sup> The REMODEL team had already created a number of individual learning modules or mini-courses. These mini-courses address the specific steps that a company must take to transition from a closed source model to an open source model. Our process combines the stories from real companies with these existing modules to provide context for the individual steps in the transition to open source. Using this guide, companies should be able to work through each module independently as part of their transitions to open source.

To create this guided implementation process, we conducted a comparative analysis of case studies from companies that have transitioned to open source models. By comparing the experiences of various companies, we looked at which modules the companies needed at each step of their transitions to open business models, as well as which modules were the most effective to a company. Using this information, we created an effective way to organize the material that the Danish Design Center has already created.

Specifically, we explored case studies from two companies: Bang & Olufsen and Thurmer Tools. Both of these companies were going through a series of small modules or programs created by the REMODEL team to adopt business practices prior to our involvement with this project. We used the experiences of these two companies to divide the materials they were given into three categories: introductions, essentials, and extra information. We used these experiences to create a structure of the Toolkit that would best fit the average company using the Toolkit.

To design the structure of the website, we used two different prototypes: a wireframe and a paper prototype. These prototypes allowed us to quickly design and test different layouts for the website before committing to a single design. Our first prototype was the website wireframe. A *wireframe* is a diagram that shows the connection between pages in the website. We used this as a model for how a user would ‘walk’ through the Toolkit from the home page to the modules page. This allowed us to quickly create and test different layout options for the site. We tested these different layouts on a focus group of WPI students to see how a user unfamiliar with open source, similar to most students, would interact with the website. We then incorporated the feedback from these focus groups into design of the paper prototype.

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41 Butcher, 2006

This paper prototype contained all of the page layouts and page contents for the entire toolkit. We created these mockups for the website in Google Slides, an online presentation-making tool. We then tested this paper prototype using a focus group of workers at *UNDERBROEN*, a manufacturing workshop affiliated with our sponsor.<sup>42</sup> The people working at *Underbroen* are very close to the target audience of this toolkit because most of them are starting or working for small companies that are interested in scaling up their production using modern manufacturing tools. Thus, these workers were good candidates for learning about open source design. We walked these workers through our paper prototype by switching the page (Google slide) each time they would normally click. This gave us a realistic picture of how a user would walk through our website. We then used the experience of the focus group to make changes to the design and layout of the pages, thus creating the final paper prototype.

## 3.2 Enhancing the Online Functionality of the Toolkit

After organizing and designing the contents of the website with paper and other tools, we needed to put the content online to make it accessible to potential users. We did this by **creating online accessible material** using *WordPress*. Furthermore, we did an **analysis of Danish website design** to find what design trends made a website successful in Denmark. We focused specifically on Denmark as that is where the Business Model Toolkit will initially be focused.

### 3.2.1 Organizing Digital Material

We could have chosen among a number of different Content Management Systems (CMS). We mainly focused on the differences between *Drupal* and *WordPress*, as these are two of the most popular, free and open source Content Management Systems. In Denmark as of 2017, 40 percent of the websites made with a CMS were written using *WordPress*. *Drupal* had just 7.2% of the market share.<sup>43</sup> This indicated that the *WordPress* community is probably larger than that of *Drupal*, which would allow for more resources to be available for us to learn from. Furthermore, *Drupal* seems to cater to experienced designers who require a large amount of customization. The flexibility of *Drupal* comes at the cost of ease of use.<sup>44</sup> As a result, we chose to use *WordPress* to allow us to focus on the website design rather than the engineering process.

### 3.2.2 Analyzing Danish Website Design

Websites from different cultures typically convey information differently.<sup>45</sup> And, because our sponsor is primarily targeting Danish companies, we needed to create a website that looks and functions like Danish websites. By sampling website designs, we were able to design a website to better convey our message to the Danish manufacturing community. In order to design a website that meets the standards of typical Danish design, we conducted content analysis on recent, award-winning Danish websites.

The analyzed samples were chosen from winners of CSS Design Awards (CSSDA). CSSDA is an international web design and development award that honors designers for extraordinary work.<sup>46</sup> Since website design fashion changes, we selected the twenty most recent Danish websites that won a CSSDA. We analyzed these websites to inform our user interface decisions.

Specifically, we focused on the structural and functional aspects of these Danish websites. We used a systematic set of criteria to get quantitative measures of functionality, usability, and design features. We also focused on qualitative information such as the types of images, background colors, and videos used in the selected Danish sites. We used this information to inform us on the stylistic choices for the toolkit.

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42 <http://underbroen.com/>

43 CMS usage in Denmark, 2017

44 Best Content Management, 2017

45 Wurtz, 2005

46 CSS Design Awards, 2017



We also worked with the art director, Ms. My Buemann, at the Danish Design Center who helped us create overall appeal of the toolkit. The Danish Design Center's art director created the logo and color pallets for the website. This allowed us to focus on the layout rather than the color and aesthetic of the toolkit.

We found that the content analysis of award winning Danish websites was fundamental to the implementation of the open source business model toolkit. Our website acts as the primary means of conveying our research to the Danish manufacturing community. One advantage of a website is that it can be easily accessed and shared; however, people would not read our research if the website design were not visually appealing.

### 3.3. Supporting User Generated Content and Discussion

Open source relies on the collaboration of a community to be more beneficial than the traditional closed business models. Without a community, there are no collaborative benefits. Thus, our Toolkit must facilitate direct interaction among companies using the toolkit website and allow these companies to contribute their own information. This allows the toolkit to act as a central community hub for the companies transitioning to open business models.

We identified which mechanisms were needed to allow users to form their own interactive community through our toolkit. Research in the education field shows that platforms that encourage user contributions, such as wiki pages, are correlated with better performance of the participants.<sup>47</sup> Furthermore, by allowing participants to contribute to the toolkit, the toolkit itself can grow and evolve beyond its initial design. Allowing user contributions to the content of the toolkit is especially important because open source manufacturing is a relatively new area; by allowing users to contribute to the toolkit, the toolkit can naturally evolve to incorporate new information as it arises.

To find out the best way to add user-made material, we did a comparative analysis of several popular user interaction styles, such as forums, wiki-style sites, and question-and-answer sites, to identify the best way to incorporate user experiences and interactions to the Toolkit. We did a qualitative analysis of each of the different interaction types to determine how we should allow users to contribute to the online toolkit. This analysis consisted of information from reports online about the benefits and cost of each type of interaction. Specifically, we focused on the typical veracity and the percent of participation for each interaction type. Veracity is important to ensure the toolkit always contains truthful information, and participation is important to ensure the toolkit is developed by the participants in the future. Using these metrics, we determined which interaction types to support in the online toolkit.

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<sup>47</sup> [Hadjerrouit, S., 2013](#)

## 4. Results and Analysis

In order to adapt the Danish Design Center's REMODEL program for the web, we made three major sets of deliverables. First, we created **prototypes** for the REMODEL Toolkit to identify the functionality and content required to make the Toolkit. Second, we developed **supplemental case studies** to provide more context for companies who are using this toolkit independently. Finally, we used these prototypes and the additional content to implement the REMODEL **Toolkit website**.

### 4.1. Prototype of the REMODEL Toolkit

The REMODEL Toolkit was built to provide online access to the Danish Design Center's existing open source learning materials. These materials were meant to be used without direct assistance from the Danish Design Center. As a result, we structured the Toolkit website to guide prospective users through the material the same way that the Danish Design Center would have normally helped an in-person client. To design this structure, we created and evaluated two prototypes for the website:

1. First, we created a **website wireframe**. This wireframe is a box and arrow diagram that represents the connection between pages similar to a flow chart. We evaluated this prototype to determine how to structure the information in the Toolkit.
2. Second, we created a **paper prototype**. This prototype 'fleshed out' the wireframe by creating each page for the Toolkit on paper. This let us figure out what each page of the Toolkit should look like and contain.

These two design documents defined our vision for the Toolkit and helped guide our final creation of the website. Furthermore, these documents provide a comprehensive view of what the 'optimal' Toolkit would contain in information. This will help the Danish Design Center continue our work after we deliver our final website.

#### 4.1.1 Website Wireframe

We identified two different groups of users when we designed the functionality of the website: the **first-time user**, and the **returning user**. We considered the first-time user to be any user who is *not* familiar with the REMODEL program or open source business models. These users would require a gentle, simple introduction that provides a background on open source, thus allowing them to make sense of the REMODEL program. We considered the second group, the returning users, to be any users who were already using the REMODEL program. These users would need the site layout to be informative and fast. The main components of the website include:

1. The Guided Tour for first time users
2. The Open Source Info Page
3. The Learning Module Page
4. The Discussion Forum

We used a wireframe diagram to create different possible page layouts for the website and evaluated these designs with focus groups and our sponsor. We did this to determine which page flow would best match these two user groups' needs. Figure 5 shows our initial wireframe diagram for the general layout of the toolkit. The entire wireframe can be seen in Appendix A: Toolkit Wireframe. Each box represents a single 'page' of information. These pages do not necessarily have a 1 to 1 relationship to pages on the final Toolkit, but each of these pages represented a full unit of information that could ostensibly be represented on its own page. The arrows represent a link or a click that would take the user from one page or information block to the next.

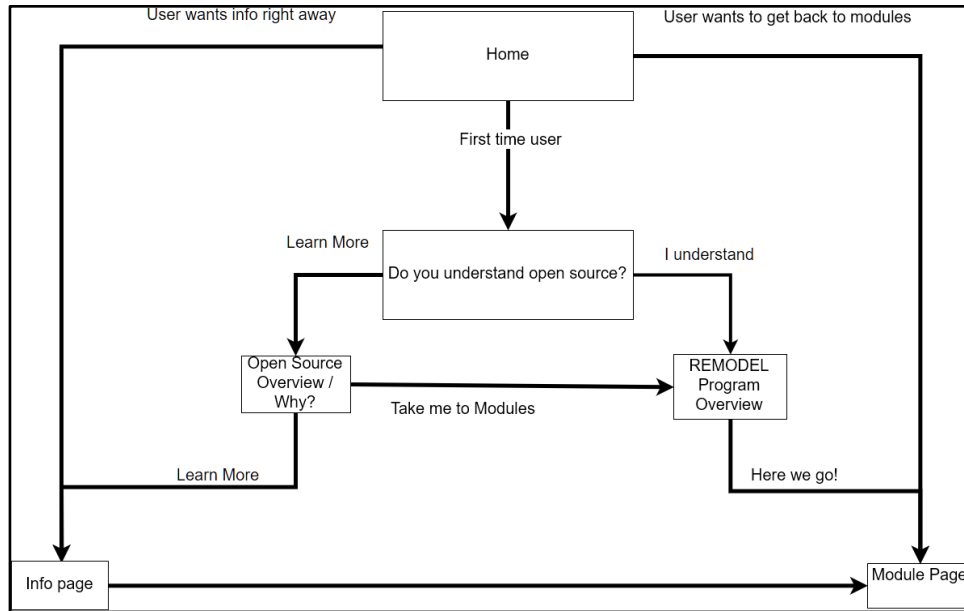


Figure 5: Wireframe Prototype Overview

The “**Guided Tour**” overview is depicted in the center of Figure 5. On the first page – the “Home” page – we aimed to filter the prospective users into the two target user categories. First, and most importantly, we wanted the first-time user to have a clear path to learn more about open source and the REMODEL Toolkit. This option is shown on the “first time user” arrow on Figure 5. For returning users, we wanted to give them the option to quickly skip past the slower introduction. We did this by providing the options to the left and right of the “Home” page. A returning user would not need the slow tour, and thus would want a direct path to the learning modules or the information page.

The first-time user would then be taken the new page in Figure 5 labeled “Do you understand open source?”. The purpose of this page would be to provide a brief overview of what open source is and then filter the first-time users into two categories: the users that *do* and *do not* have experience with open source. Users that do not have experience with open source would be taken to a page giving a more detailed explanation of what open source is and why a company might want to use open source. This page is labeled “Open Source Overview / Why?” on Figure 5. From this page, the user could either decide he or she is confident enough in their background of open source and continue to learn more about the REMODEL program overview. This would take the user to the “REMODEL Program Overview”. This page would give an overview of what the REMODEL program is and how the user could use this program to help this user adopt a more open business model. Alternatively, the user could continue to the “Info Page”.

The “**Info Page**” would provide a much more in-depth overview of open source as well as a number of concrete examples of companies making use of an open source business model. This page, shown in Figure 6, is meant to provide a way for users to browse more open source information. At this point in the wireframe, the user is likely still unsure about open source. Thus, this page would provide concrete case studies of how open source could benefit a company, another explanation of open source, and a way to browse for more information. And, most importantly, this page would give the user a way to get to the “**Module Page**” once he or she have learned enough about open source.

Once the user is comfortable with the concept of open source in the manufacturing industry, the user is guided toward the **module page**; these modules are the main purpose of Toolkit. At this point, the user should have some background knowledge about open source and an idea of how it might help them. The purpose of this section is to help the user use the Danish Design Center's REMODEL program and learn how to use open source in their business.

The learning **module page** provides an overview of all of the possible modules. At the time of the creation of the toolkit, only two modules had been finished and a third one was in progress. Because of this ongoing development, we built the toolkit to be able to contain any number of modules split into categories. We intended to spend more time organizing the modules, but the other module categories were still in development. Our design should scale to multiple modules as the Danish Design Center finishes the next set of modules. The user would then go from the module overview page to an individual module page.

Each module is meant to teach the user a single skill in transitioning to an open source business model. This goal would be summarized at the top of the module page. The module is meant to be completed over five to seven weeks. The individual weeks would be summarized on this **individual module overview page** along with the sub-goals for each week. The user would then be able to click on any week that he or she is currently in to go to that week's materials.

The **week module page** would reiterate that week's goals and directions and would contain a link to the respective offline materials. These materials were previously created by the Danish Design Center. The rest of the module wireframe is meant to provide a structure for reading these materials.

We evaluated this wireframe by walking a focus group of our sponsors and advisors through the diagram as if they were a first-time users, and again as if they were returning users. We would describe verbally how each page *would* function once we finished the Toolkit. The goal of this was to determine if the connection between pages makes sense, and if there were any information that we could not fit into our Toolkit model. This led to a number of small changes in our design:

1. Our sponsors believed that it took too long for the first-time user to get to the information contained in the modules; they believed that a first-time user would want **concrete information** earlier in the learning process.
2. Our advisors believed the forum feature should be **decoupled from individual modules**. As users, they would want the ability to get to an overview of all the forums rather than be limited to a single discussion for each module.

This feedback helped inform our design decisions for our next prototype. We did use an additional focus group of WPI students to test the structure of the website, but this focus group did not give significant results. The wireframe is a very sparse representation of the Toolkit, and the students were not familiar enough with the REMODEL program to visualize this representation of the Website. Thus, we decided to instead use the student focus group to evaluate our paper prototype, which would include enough information to be self-explanatory.

#### 4.1.2 Paper Prototype

The paper prototype expands on the wireframe diagram by creating a rough outline for each individual page defined in the wireframe. While the wireframe diagram was useful in determining the general structure, **the paper prototype was used to determine the content and structure needed for each individual page**. We created this paper prototype using Google Slides, a presentation creation tool. The entire prototype can be seen in Appendix B: Paper Prototype. By creating actual pages, a user could see, we were able to easily test the 'paper' design with real users. This allowed us to get much more specific feedback than with the wireframe diagram. Specifically, we focused on the design for the following pages:

1. Home Page
2. Guided Tour
3. Open Source Information Page
4. Learning Module Page

## Home Page

The home page needed to satisfy both a first-time user as well as the returning user. One of the main focuses of this design was to create simple website for the first-time user with as little chance to get lost as possible. Because the home page is the first page a new user will see, we needed to make sure this page did not overwhelm the user with information. But, we also needed to ensure that returning users could quickly get to their desired sections of the Toolkit. Figure 6 shows our first iteration of the home page.

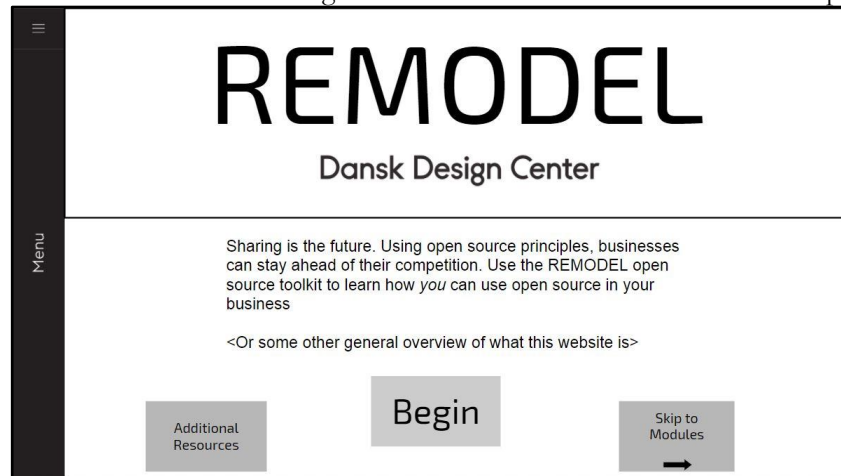


Figure 6: First Iteration Wireframe Homepage

The home page shown in Figure 6 is built to fit the needs of both new and returning users. The main focus of the page is the REMODEL logo and a catchphrase for the open website. This is meant to provide an enticing introduction to the website while flooding the new user with information. Below, the three buttons are designed to filter users based on their interest. The **Begin** button should be the most obvious, thus directing the new users to the guided tour. The other two buttons would allow returning users to skip this introduction.

After walking our sponsor through this page, we received a great deal of feedback that we would later incorporate into the final website design. First, our sponsors Ms. Julie Hjort and Mr. Christian Villum believed that a user would be “equally likely to click on either of the three buttons and end up in the same place.” This indicated two things: first, the buttons did not have descriptive enough names, and second, there were too many options that seemed equally important. To fix this, we would later design the website to include just a “Start Learning” button (leading to the guided tour). Below that button, a simple link would prompt the returning user to continue to the learning resources.

## Guided Tour

The guided tour is designed to provide first-time users with foundational knowledge of open source. This knowledge is important to motivate the first-time users to actually take the learning modules, and help them make sense of the modules once they decide to take them. Thus, the guided tour starts with a brief overview of open source before then providing more information on specific aspects of open source. It ends by directing the user to more resources within the website.

The first iteration of the guided tour started with a simple question, “Do you understand the basics of open source?” When we presented this to an *Underbroen* employee, that employee stated that understanding “open source” was too general of a question; even if the user understood open source software, they would not necessarily understand open source hardware. We would later incorporate this feedback into the final website design.

Additionally, instead the users who tried this design by found the guided tour to be to sporadic; each section of material brought the users to a new page, which they found confusing. Instead of having a separate page for the Guided Tour, we included the information on the front page of the website below the introductory content. This allows for the users to click on the “Start Learning” button, which scrolls the page automatically to the beginning of the tour.

The main content of the Guided Tour focuses on providing new users with a strong background in four aspects of open source: generating revenue, increasing innovation, sharing development cost, and creating a community. We identified these areas as the ‘selling points’ for open business models. At the end of the tour, we would then prompt the user to fill out a questionnaire that asked which of these points was of the most interest. This questionnaire had two purposes:

1. To allow the Danish Design Center to collect information on what aspects of open source their users were interested in.
2. To provide the user with new content based on their interest.

The custom content would be provided in the form of a case study that focuses more on the on the user’s specific interests. The user would then be able to continue to the open source information page or the learning modules.

## Open Source Info Page

The open source info page is the central location for our content and gathered to help users learn more about open source principles. This page contains two main sections: the case studies and the articles. The cases section contains the curated set of case studies, whereas the articles section contains just links to more external resources.

Our initial design for the cases page, Figure 7, used the logo of the subject company. Our initial design displayed a brief description of the cases at the top. Each case study was represented by an icon, a title, and the list of tags associated with this case study. These tags would help the user understand the topic of the case study before reading. A brief summary of a case study would be shown when the user put his or her mouse over the respective icon. The articles page was designed to have a similar format. The page consists of a similar grid of images, each one linking to an external article. These articles allow the Toolkit to cover a much broader set of categories than the case studies.

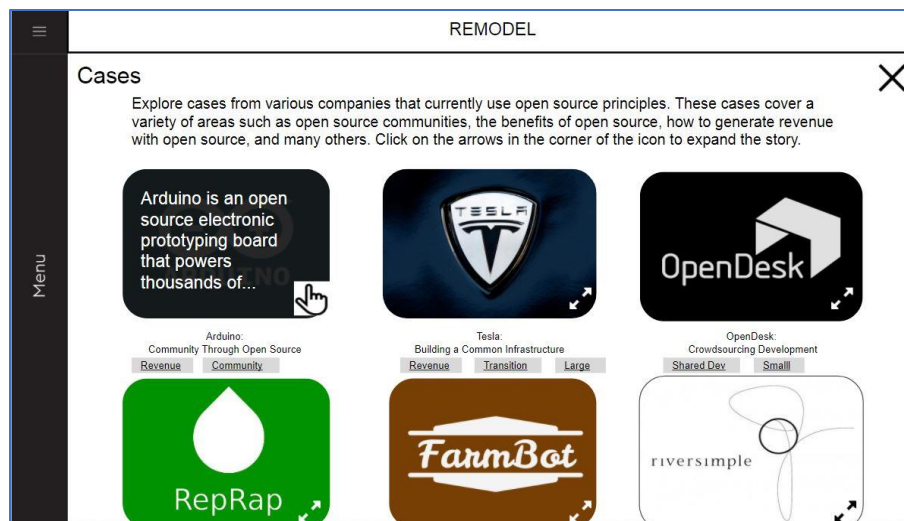


Figure 7: Case Study Central Hub

After showing this page to our sponsors and advisors, we found that showing the summary of a case study by hovering the mouse was not intuitive. Furthermore, the summaries themselves needed to be more descriptive; just showing the first few sentences of a case did not provide the user with enough information on the goal of the case study.

After reading more of the cases and articles, a user *should* have enough information and motivation to make sense of the learning modules. Thus, as the bottom of the open source information page the users are directed to the learning modules as these are the main focus of the Toolkit.

## Learning Module Page

The Learning Modules contain the main content of the website and were previously created by the DDC. Our goal was to create a design that would help these modules make sense as a web pages. The original modules are separated into different phases, and each phase is meant to take about one week to complete. Three modules have been completed, however only one module will be used to launch the toolkit. **This module will serve as a template** for the future modules the DDC publishes to the website.

Similar to the homepage, we needed a brief description of the purpose of the current section of the website, since “Learning Modules” alone may not be descriptive. The modules themselves are accessed by clicking on the buttons at the bottom of the screen. In our prototype we show the **Value Dimension Module**. The DDC will be publishing just this module with the launch of the Toolkit.

Clicking on a module brings the user to a module overview page. This overview page reiterates the purpose of the module and provides a list structure for each week. Each of these weeks has a single sub-objective and a brief description of what is to be expected for that phase or week.

Each individual module week contains the bulk of the content for each module. Each week contains a brief description of the goals for that module at the top, and a “download all” button to download the materials for that week. This would download the original module resources created by the DDC.

After reviewing with our sponsor, we found the “download all” button to be non-intuitive for users. Forcing a user to download a large set of material and make sense of the information was likely to lose the user. Thus, in the final website implementation, we changed the layout to include the directions directly on the page in both video and written form. Each resource that is needed for a given step would be provided for immediate download.

## 4.2 Supplemental Case Studies

First time users of the Toolkit will not necessarily know very much about open source. The Toolkit needs to be able to provide *enough background information* about open source to entice users to continue to the learning modules. Thus, we provided concrete examples of manufacturing businesses successfully using open source in the form of documented case studies.

We wrote eight case studies as short articles that highlight one or more of four categories: *improved innovation, shared cost of development, improved community, and generate revenue*. These case studies can be found in Appendix C: Case Studies. We identified these four areas of interest after attending the Fab City Talk<sup>48</sup> hosted by the Danish Design Center and *Underbroen*. This event hosted a set of speakers who each discussed the possibilities of open source manufacturing in cities; these categories were motifs in all of the speakers’ presentations. Thus, we focused each of these case studies on one of these topics to clearly illustrate a benefit of open source. The eight articles each target a subset of these categories of interest. Furthermore, we created a basic template for each case study that would allow the DDC or other users to quickly create case studies in a similar format.

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<sup>48</sup> Fab City is a global movement to promote shared resource usage in cities by the Institute for Advanced Architecture of Catalonia

We wrote up a specific case study about the IBM PC, which was released in the 1980s. This article illustrates how IBM had successfully used open architecture (similar to open source) to share the cost of development for their PC. This allowed IBM to support the needs of far more customers, and thus expand much more quickly and cheaply than their competitor closed-source competitor Apple, thus allowing them to dominate the market. Our article is approximately one page in length. This article (and other articles) contain links to more information on the topic. This provides the users an opportunity to gain a strong background in open source before continuing to the learning modules. Each complete case study can be viewed in the Appendix.

## 4.3 Website Implementation

We integrated contents, navigation and graphic design into a functional website. The website implementation transforms our paper prototype into an actual toolkit. The implementation of the website consists of the following three aspects:

1. Graphic Design
2. Technical Implementation
3. Clear User Experience

We focused on these three aspects to create our final website that was **educational, inspirational,** and able to be **used independently**. Each of these sections can be seen in further detail in Appendix E: Toolkit Website Screenshots.

### 4.3.1 Graphic Design

To form a general idea of what kind of website visual designs would attract Danish users, we studied the 20 most recent Danish **winners of CSS Design Awards (CSSDA)**. CSSDA honors international designers for extraordinary work on website development. We focused on the following design aspects: **menu location, page layout, homepage backgrounds, and multimedia aspects**.



Quantitative Content Analysis On 20 Most Recent CSS Award Winning Danish Website									
Web#	Web Name	Menu Bar Location		Page Layout Style		Homepage Background		Multimedia	
		Head	Side	Single Page	Wizzard Page	Photo	Solid	Video	Moving Icon
1	Beoplay E8	x		x			x	x	x
2	Subway Surfer		x	x		x		x	
3	Carlsberg		x	x		x		x	
4	Essential	x		x			x	x	
5	Departures		x	x		x			x
6	Onea		x	x			x		x
7	B&O Play	x		x			x		x
8	Opsundbay		x	x		x			
9	Beoplay H4	x		x			x	x	x
10	Beoplay M5	x		x			x		x
11	Radoorco		x	x			x		x
12	Super16	x		x			x		
13	Liviskive		x	x		x			
14	B&O 2016 W	x		x				x	
15	HelloMind		x	x			x	x	x
16	FWA		x	x			x		x
17	Navigating		x	x		x			x
18	Serio		x	x			x		x
19	Spring&Summer		x	x		x			x
20	Space10		x	x			x	x	x

Figure 8: CSS Design Awards Feature Analysis

The four categories investigated are shown at the top: Menu Bar Location, Page Layout Style, Homepage Background, and Multimedia. Menu location is defined as on the top or on the side. Page layout is defined as either a single page where content is split into blocks, or a wizard page (multi page). The homepage background is measured as either an image or a solid color. The multimedia measures how visual content is displayed on the page. This chart measures videos, and moving icons (such as a moving grid of still photos). If neither is used, the row is left blank.

Figure 8 displays the frequency of each feature on the top 20 sites from the CSSDA. The location of the menu bar is most often on the side. All analyzed websites adopt the “**One Page**” design style where users read more content by scrolling down instead of clicking on many links. These sites use **background images** behind content to portray the website’s main theme. We used these information on the stylistic choices we made for the toolkit. Specifically, we implemented a “**One Page**” design on the homepage of our application. Although this research did help inform some of our decisions, we were mostly influenced by the Danish Design Center’s internal graphic design team. We worked closely with the art director Ms. My Bue-mann to ensure that our website maintains the consistent theming and branding desired by our sponsor. She provided us with a branding manual that contains information on design guidelines, color palettes, and typography. Pertinent parts of this design guide are located in Appendix D: Danish Design Center Branding Manual.

The color palette defines the core colors for a website; by adhering to these colors, all of the Danish Design Center’s online materials appear similar. The colors include four basic colors, four muted tones of the basic colors and eight gradients consisting of combinations of the above colors. Since Danish Design Center does not link the colors to specific areas of activities, we freely chose how to use these components throughout our website. However, we used no more than three different colors in a given context (print, event, etc.) to be consistent with the minimalist style of Scandinavian design.

Additionally, photos are often color-corrected to fit the Danish Design Center’s color palette. The Danish Design Center commonly uses this technique on uninteresting or uninformative images to keep them consistent across the site. We worked with design team to ensure that our photos matched this style and color palette.

This design manual recommends that we use capitalization and bold to emphasize certain words. The combination of different styles in a title captures the reader’s attention by creating a visual impact. This emphasis is commonly used throughout the Danish Design Center’s materials. In addition, Ms. My Bue-mann provided a specific font – Euclid Flex – to be used across the website.

### 4.3.2 Technical Implementation

The last step in creating our main deliverable was the **transition from the paper prototype to the physical creation in WordPress**. The purpose of focusing on all of the design aspects beforehand is so this transition would be as smooth and simple as possible, which was necessary because our group had very little experience with WordPress before this project.

To get started with the actual implementation of the Toolkit, the group used a different website to test the WordPress tools and to become more experienced with the software before working with the official domain that will be used by our sponsor. Our group discussed with the Danish Design Center to select a WordPress template that would fit the website needs. In WordPress, a template determines the basic functionality of a site. Thus, it was very important that we chose a theme that would fit the requirements defined by our paper prototype and wireframe diagrams. Eventually, after consulting the lead art director My Baumann and our sponsor Christian Villum, we and our sponsors decided to use the “Total” theme. We chose this theme because of its easy to use customization tools. This means that we could implement the website faster and more efficiently without relying on heavy coding. The website’s hosting was set up by the Danish Design Center’s IT manager, Jonas Hansen.

The Total theme provided an additional plug-in called Visual Composer that provides a very simple drag-and-drop interface for building webpages. This allowed us to create the structure of each web page so that it looks similar to our paper prototype designs, while also leaving the room to expand features to fit the required design aspects of the specific branding of the Danish Design Center.

After creating the website, we were able to walk users, our sponsors in this case, through the website one more time. In that iteration of the website, the guided tour was split across two pages. But, our sponsor Christian Villum found this disconcerting, as switching pages would break the cohesiveness of the website. To fix this, we decided to implement a style similar to the “one page” style on the home page. This meant that the entire guided tour was split into screen-sized chunks and displayed linearly on the home page. This would allow the users to scroll the chunks of the guided tour at their own pace rather than having the entire page be reloaded whenever they wanted to move to the next section. Other than this change, we were able to design the website very closely to the paper prototype and incorporate the feedback from those sections into the website.

### 4.3.3 Online User Experience

As with the wireframe diagram and the paper prototype, we focused most heavily on creating a simple user experience for the Toolkit to ensure that first time users would be able to use it independently. Specifically, for the new user, we created four key sections of the Toolkit to help educate and inspire the new user to use open source:

1. **Guided Introduction to Open Source**  
First, we provide a gentle introduction explaining open source.
2. **Case Studies**  
Second, we display the case studies of *real companies* using open source to motivate the reader.
3. **Learning Modules**  
Third, we guide the users to the learning modules to learn how *they* can use open source in their business.
4. **Discussion Forum**  
Finally, we encourage the users to discuss the modules and gain a deeper understanding of open source by interacting with the Danish Design Center directly.

## Guided Introduction to Open Source

New Toolkit users may not know anything about open source. Thus, it is important that the final Toolkit could provide enough information to teach to teach the basics of open source. We were able to use almost all of our paper prototype design for this section. This section, shown in Figure 9, starts with a brief description of open source, and then moves on to the ‘why’ section. This expands on the four case study categories and provides key examples of successful companies using open source. These examples are meant to help inspire the prospective new users, and show them what open source can be used for. After going through this tour, users will have a basic understanding of open source and will be ready to learn more in depth information about open source in business.

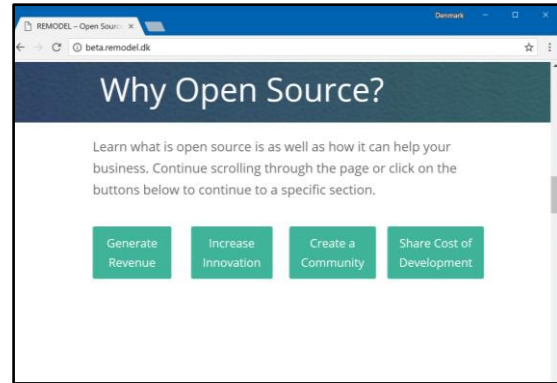


Figure 9: Guided Tour Webpage

## Case Studies

Once the inexperienced users understand the basics of open source, they are ready to learn more about how open source can be used to make a real profit. Thus, the user is guided to the case study section of the site. An example case study is shown in Figure 10. We created these case studies to help *motivate* new users and show them real people using open source. Specifically, the case study section is designed to help a user find the information he or she is looking for quickly. Rather than have the users look through all of the case studies to find one they are interested in, we provide a filtering mechanism. This filter allows the case studies to be broken down into the four categories, thus allowing the users to read just the cases that may pertain to their businesses. After going through this section, users should have a clear idea of *how* open source can be used in a business.

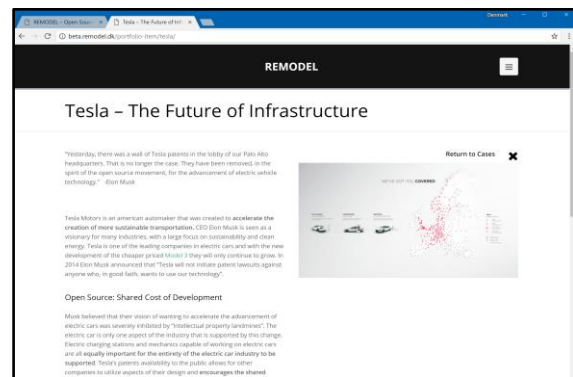


Figure 10: Case Study Example Webpage

## Learning Modules

After the first two sections, new users should have enough background knowledge to start learning how to develop *their own* open source business models. The learning modules section, shown in Figure 11, is built to help the user learn how to develop these models. The overall design of this online learning module section is similar to the one we designed with the paper prototype. The modules are split into three parts: an overview page, a module description page, and each individual module phase separated by week. We focused on simplifying the user experience in each of the module phases.

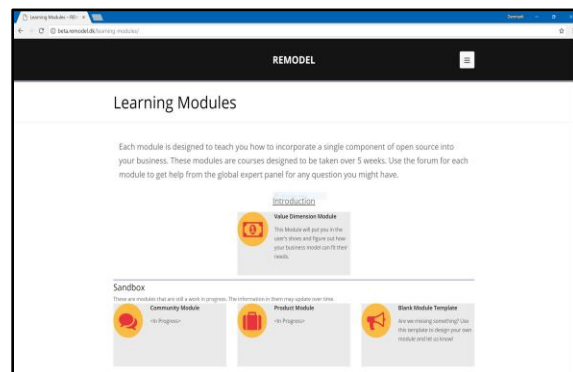


Figure 11: Learning Modules Overview

Originally in the paper prototype, we planned for the users to read a summary of the module phase, download *all* the materials for that phase, and find the directions in the folder they downloaded. But, we found this to be very unfriendly to the new users; by having a user to download an entire folder at once, we forced them to make sense of the entire the material themselves. This overloaded the users with information. To remedy this, we put the directions on the actual website. For each step that requires the user to download worksheets, we placed download links directly in each step. By doing this, we reduced the amount of material a user would need to process at a single time, thus making the learning modules easier for independent users.

### Discussion forum

While using the learning modules, the users may have questions. Rather than having users ask these questions through an Email, we added a discussion forum within the Toolkit. This allows the answer for one user to be seen by every other user of the Toolkit, thus helping other users with the same question. This discussion forum structure mirrors the structure of the modules; a sub-forum accompanies each learning module and sub-phase of each module. While it is impossible to judge the effectiveness of this forum before the Toolkit is used, this forum has the potential to help the Danish Design Center to see what questions users have after using the modules, and to answer these problems as they arise.

## 5. Conclusions and Recommendations

Our team completed a working prototype of the REMODEL Toolkit. This Toolkit contains all of the *current* information from the REMODEL program. Thus, the Toolkit is useable by manufacturing companies looking for help or information on the transition to an open source business model. However, the Toolkit is not a finished product. Rather, the Danish Design Center is continuing the creation of the Toolkit; our prototype is meant to serve as a framework for the REMODEL program's continued development. To aid in this development, our team has three recommendations to our sponsor based on our experience developing the Toolkit:

1. Structure the information in the Toolkit clearly
2. Enable users to contribute to the Toolkit
3. Leverage our Toolkit to guide further development

### 5.1 Structure the Information in the Toolkit Clearly

We found it important to provide a **clear structure for content** on the Toolkit to allow the novice user to use the Toolkit independently. This structure helps reduce the complexity of the material, thus allowing it to be understood without additional help from the Danish Design Center. We accomplished this by providing the user with few choices and few sequential steps for progressing through content.

Reducing the choices was especially important in the guided tour on the homepage. This tour starts from a stand-alone button and then provides the user with the basic concepts of open source. This helps the novice user make sense of the rest of the Toolkit. Originally, we planned this tour to take the user through a set of pages, with each page teaching the user a new component of open source. However, we found that splitting the content over a sequence of pages with many choices reduced the clarity and confused the users. Instead, we turned this tour into a single page of content divided into blocks. By turning the guided tour into a single page, we reduced the number of decisions a user has to make. The user no longer has to decide when to go to the next page or back to the previous page. This helps the user to focus on the content provided thus making open source introduction a less confusing experience.

We found that **reducing the complexity** of the Toolkit was particularly important in content-dense sections of the Toolkit, such as in the "Learning Modules." To help the novice reader make sense of this material, we found it very important to provide as much structure as possible to this section. Originally, our sponsor had planned on having the user download a folder of material and go through the directions for that week. But, after implementing this, we found this interaction to be confusing; simply downloading a folder of material does not provide enough structure for how the user should approach the content. To fix this, we rendered all of the directions as a sequential list of steps. At each step, the user would be prompted to download the *individual* materials for that step, thus reducing the amount of information the user has to process at a single time. This helps the user progress through the complex material without getting lost.

Going forward, we recommend that our sponsor follow a similar structure for the new material they add to the Toolkit. Any step that requires the user to 'figure out' what to do next is likely to confuse a novice user, especially when the content is dense. The Toolkit we created will help provide a framework for the Danish Design Center as it creates new material by providing templates for these content-dense pages. These templates can be used to create new pages with the same structure as the ones we created. For example, when the Danish Design Center creates a new module, it will be able to copy the exact structure of an existing module, thus ensuring that each module page follows the same, structured layout. This should help reduce the complexity of the Toolkit, allowing new users to easily make sense of the material.

## 5.2 Enable Users to Contribute to the Toolkit

We recognize that, once we have completed our project, the toolkit will need to be maintained and further adapted. Open source manufacturing and the REMODEL program are still in their infancy and will continue to grow after this project. To help our Toolkit stay relevant, we believe it important to allow it to incorporate new material as it arises. In our iteration, we allowed this to some extent by providing a forum for users to discuss each module. This allows users to discuss current topics relevant to each module, even after the material has been created. By exposing these discussions on a forum, the answers to commonly asked questions will always be available to new users. Additionally, the questions on these forums will help indicate what gaps are missing in the user's knowledge, thus helping determine which topics should be covered next by the Danish Design Center. We recommend that the Danish Design Center continue to monitor the forums; a forum will only grow if it seems active. The Danish Design Center should therefore answer questions as quickly as possible to ensure the forum appears active, and the information on the forum remains factual.

Building upon the idea of user-generated content, we recommend that our sponsor provide a way for users to suggest entire modules and case studies. This could be done by exposing templates similar to our paper prototype to users. This would allow users to create their own modules and case studies with the same structure as the existing material in the Toolkit. This will allow the Danish Design Center to more easily evaluate the new material contributed by users. Our sponsor originally wanted to create a more open model for user contributed content, where the user would directly make modifications to the site. However, we believe that this could hinder the cohesiveness of the Toolkit. By providing templates for user contributions, the Danish Design Center can gain valuable content from the users but still be in control of the final content that reaches the website.

## 5.3 Leverage our Toolkit to Guide Further Development

Our final recommendation to the Danish Design Center is to treat our Toolkit as a framework for further development. In addition to the case studies and learning modules we created, we provided WordPress page templates to structure new case studies and modules. These templates define the categories and layouts for each of the major sections of the Toolkit: Modules, Weekly Phases, and Case Studies. These page templates will allow the Danish Design Center to focus on the content for their new modules, thus allowing the Danish Design Center to rapidly expand upon the existing online page material.

We describe how to use these templates, as well as how to develop the site in a transition guide that our team created.<sup>49</sup> This guide is meant to be used by the Danish Design Center to support their continued development of the Toolkit. The guide details the layout of the website and provides a brief WordPress guide as it pertains to the Toolkit. Furthermore, the guide indicates the areas that we believe should be expanded further. Specifically, these include: imagery, expert testimonials, and creating more learning modules. These categories will add polish, fill out the Toolkit, and build upon the work we did in Copenhagen.

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<sup>49</sup> The transition guide can be found in Appendix F: Transition Manual

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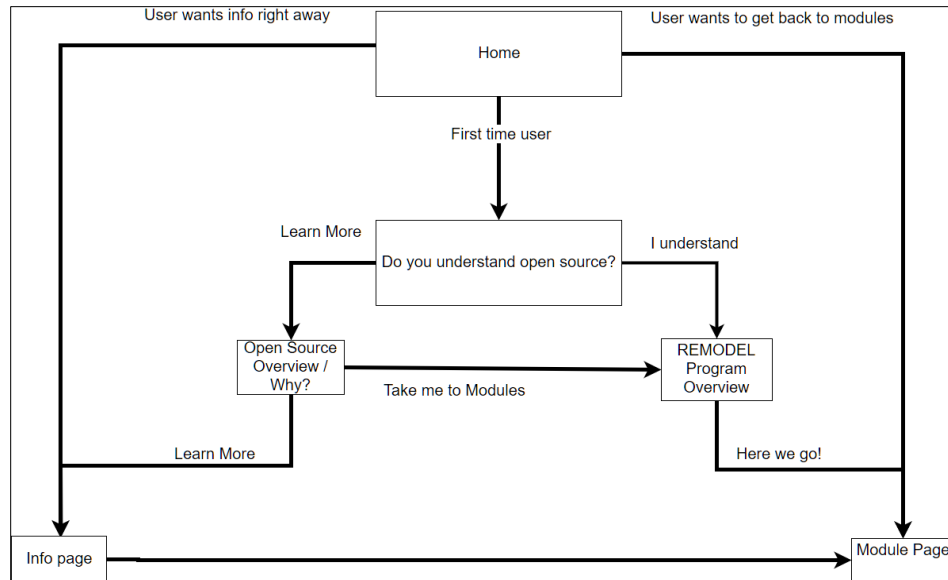
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Wesley, M. C. (Ed.). (2003). <i>Patents in the knowledge-based economy</i>. Retrieved from <https://ebookcentral-proquest-com.ezproxy.wpi.edu>

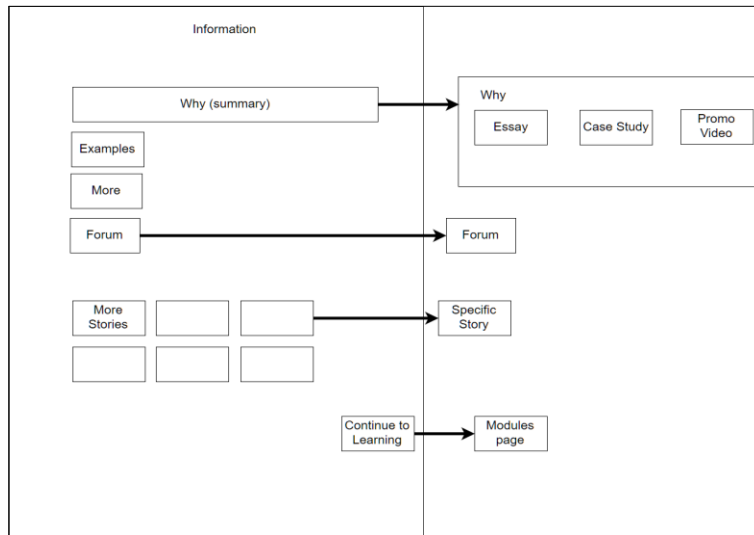
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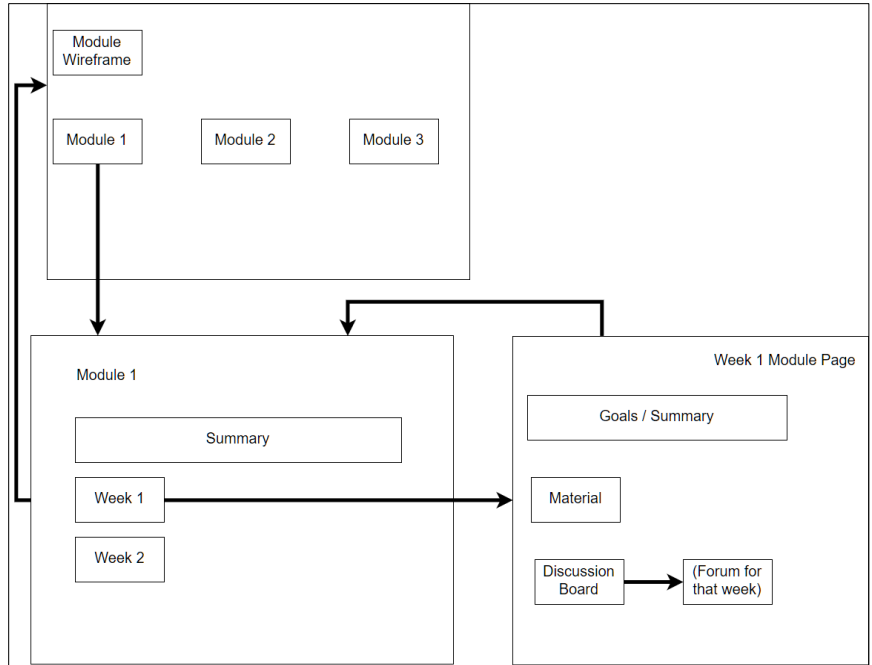
# Appendix A: Toolkit Wireframe



*Appendix A. 1: General Wireframe of website*

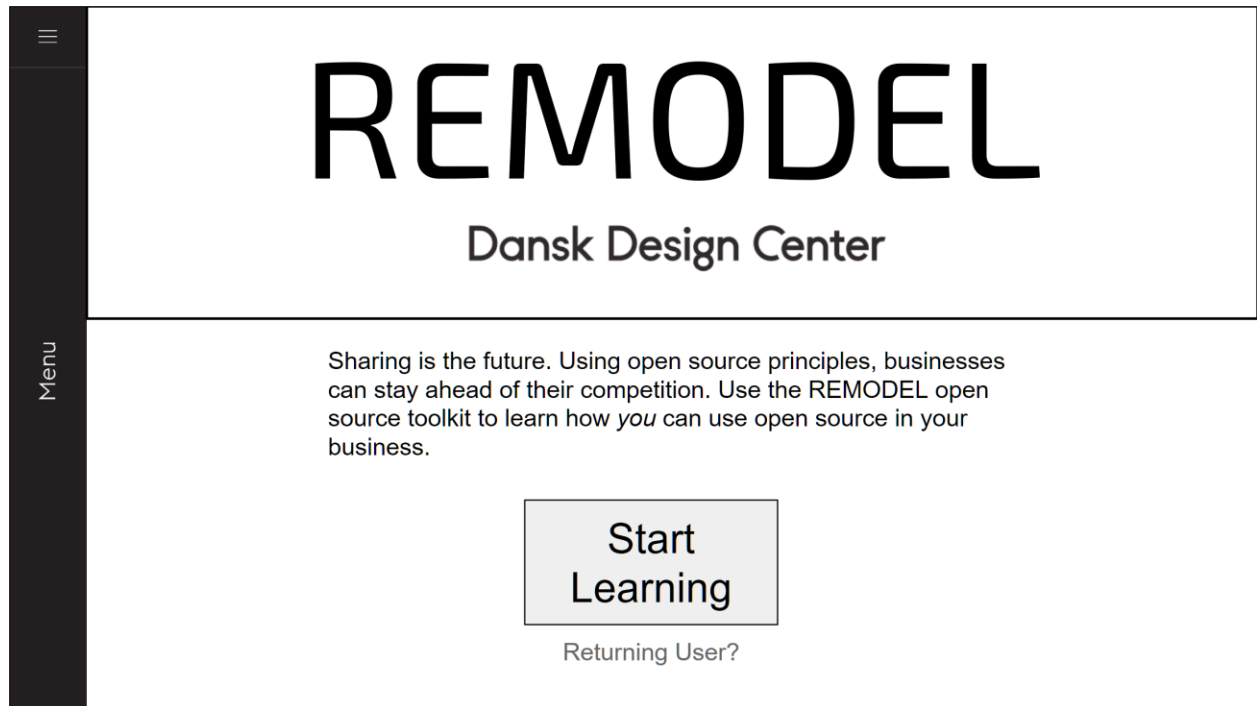


*Appendix A. 2: Information page wireframe*

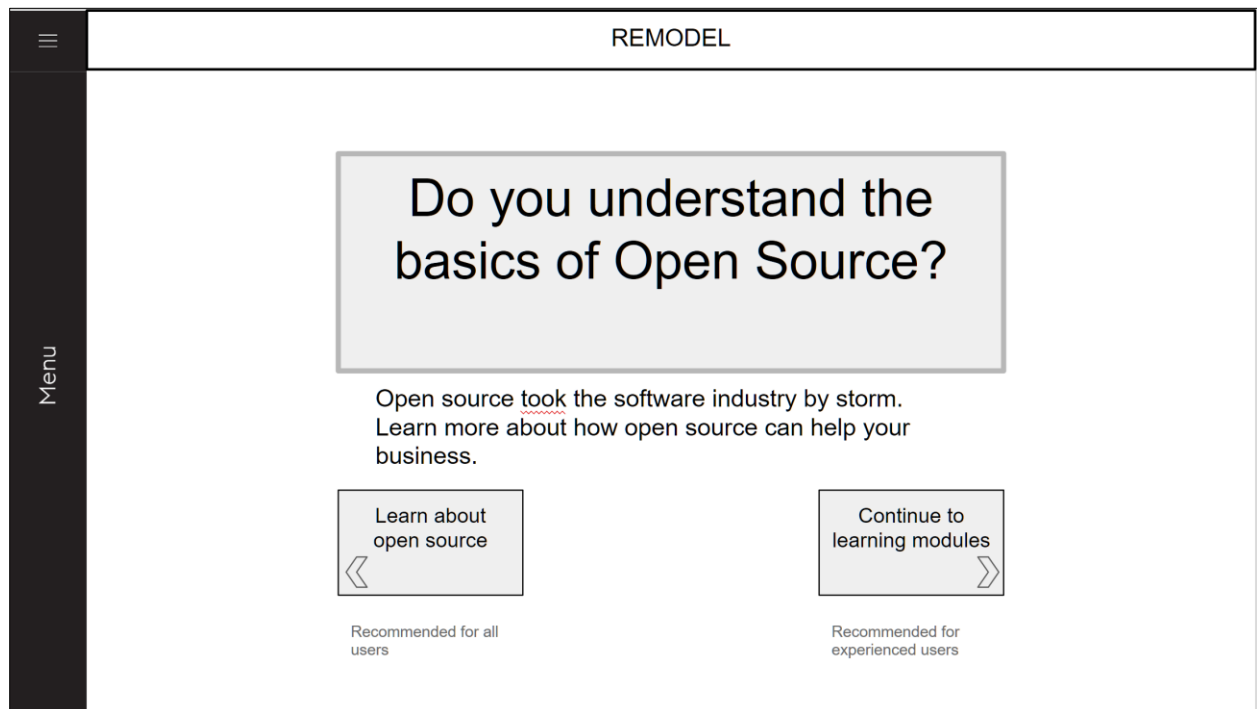


*Appendix A. 3: Learning Modules Page Wireframe*

## Appendix B: Paper Prototype



*Appendix B. 1: Home Page*



*Appendix B. 2: Basics of Open Source Question*

REMODEL

Menu


## Why Open Source?

Open source can help you:

- **Generate Revenue**
- **Increase Innovation**
- **Create a community**
- **Share the cost of development**

## What is Open Source?

The term 'open source' originates from the software industry, but has since had an impact on many other industries, and is part of the huge digitization wave we are in the middle of as a result of new, disruptive technology. Open source encourages community development by allowing users to view the source code behind a project instead of hiding the company's secrets behind a patent wall. This not only creates a community that is interested and dedicated to your product, but also allows them to help further develop the product they are interested in. This both increases the speed of innovation and decreases the cost of development.



Open Source: Explained by Legos

*Appendix B. 3: Guided Tour part 1*

REMODEL

Menu

### Generate Revenue

Open Source is 'free', so how can you make money? There are a number of different options. For example, micro controller manufacturer **Arduino** makes money by *selling service* and their *brand name*.

### Increase Innovation

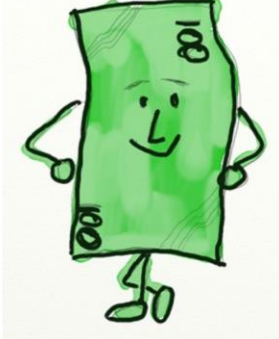
By adopting open source, you are no longer confined to ideas within your company. You can *share* a knowledge platform. Electric car company **Tesla Motors** released its patents to increase the innovation in the entire electric car industry.

### Create Community

Allowing anyone to contribute to an open source project allows a *community* of users to contribute to your product. Chair manufacturer **Open Desk** uses this *hive mind* generate designs for the chairs they create.

### Share Development Cost

Starting a new company is expensive; by adopting open source you can *reuse* existing components and *reduce the startup cost*.



*Appendix B. 4: Guided Tour Part 2*

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**What benefit of an open source model most interests you?**

Increased Innovation   
  Creating a Community   
  Shared Cost of Development

**Enter in the type of industry you would like to apply open source too.**

Electronics, Furniture, Tools, etc. ▼


See Results ➤

*Appendix B. 5: Guided Tour Part 3*

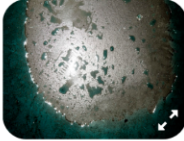
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**Recommend Resources**

Based off of your responses on the previous page. Here are some additional resources you may be interested in.



Arduino: A Community Through Open Source



Designing Sustainable Business Models

If you would like to continue learning about open source visit the Info Page, which contains cases and articles about open source. Otherwise, continue to the learning modules

Go to the Info page ➤

Continue to learning modules ➤

*Appendix B. 6: Recommended Resources*

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## Open Source Information

**Why Choose Open Source?**  
 A guided walkthrough to help you understand what is open source and why it should be used. ➤

**Cases**  
 Explore cases from various companies that currently use open source principles. ➤

**Articles**  
 Explore useful articles to further your understanding of Open Source. ➤

Continue to Learning Modules ➤

Menu

*Appendix B. 7: Open Source Information Home Page*

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## Cases

Explore cases from various companies that currently use open source principles. These cases cover a variety of areas such as open source communities, the benefits of open source, how to generate revenue with open source, and many others. Click on the arrows in the corner of the icon to expand the story.

Arduino is an open source electronic prototyping board that powers thousands of...

Arduino:  
Community Through Open Source

Revenue Community

Tesla:  
Building a Common Infrastructure

Revenue Transition Large


OpenDesk:  
Crowdsourcing Development

Shared.Dev Small

Menu

*Appendix B. 8: Case Studies Page*

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## Arduino: Community Through Open Source

**Arduino** is an open source electronic prototyping board that powers thousands of projects throughout the world. With an easy to user interface and a driven community, Arduino brings in millions of users monthly to find out how they can bring their ideas to life. Ideas ranging from as simple as an automatic toaster to prototypes of companies newly developed products.

As more people utilize their boards the more the Arduino network will grow, under the [Creative Commons license](#), anyone is allowed to produce copies of the board, to redesign it, or even to sell boards that copy the design, however they must credit the Arduino group and offer the same open source service for people to recreate their product.

Arduino themselves make only a small percentage from the sale price of the board which gets cycled back into development. Instead most of their revenue is generated from offering their expertise as the inventors of the product as more of a consultant role.




*Appendix B. 9: Individual Case Study Page*

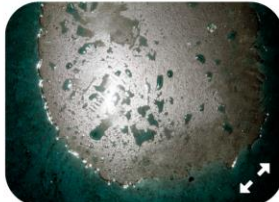
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### Articles


Explore useful articles to further your understanding of Open Source. Each link should help improve your general knowledge as well as more specific information. Click on the arrows in the corner of the icon to expand the story or transfer you to the website containing the article.




Understanding Open Source Manufacturing in 30 Minutes




Designing Sustainable Business Models




Another Article



Another Article



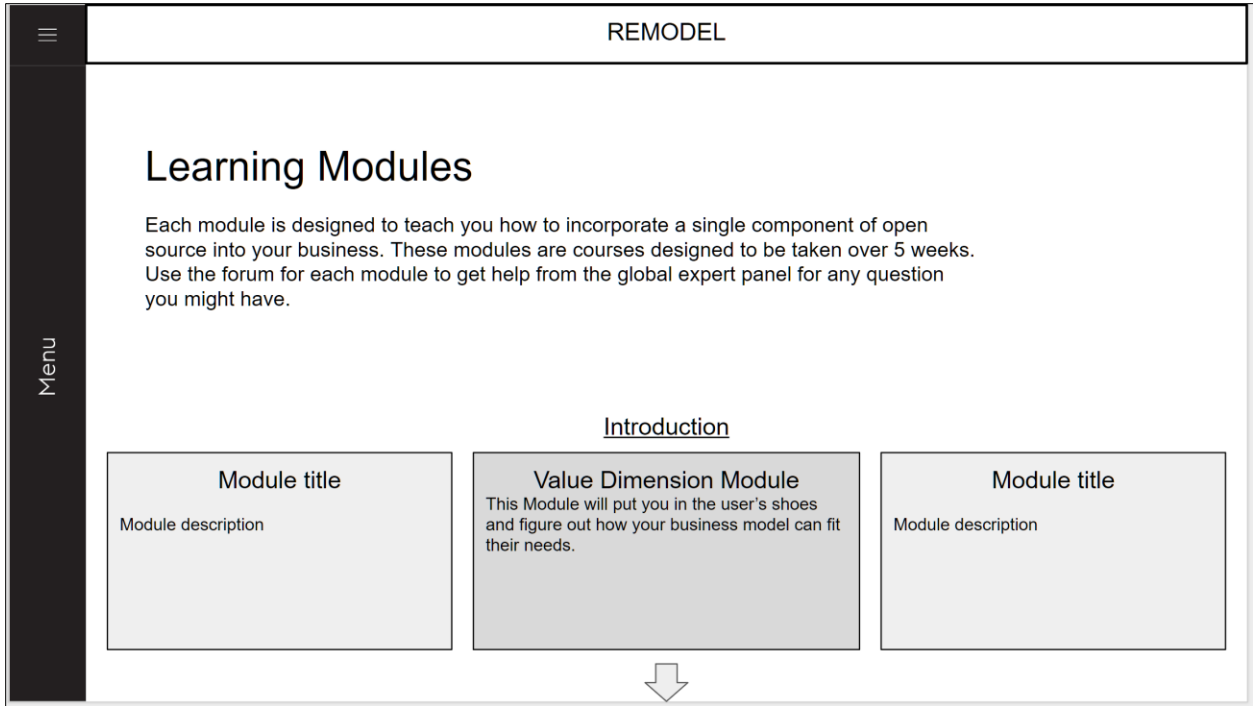
Another Article



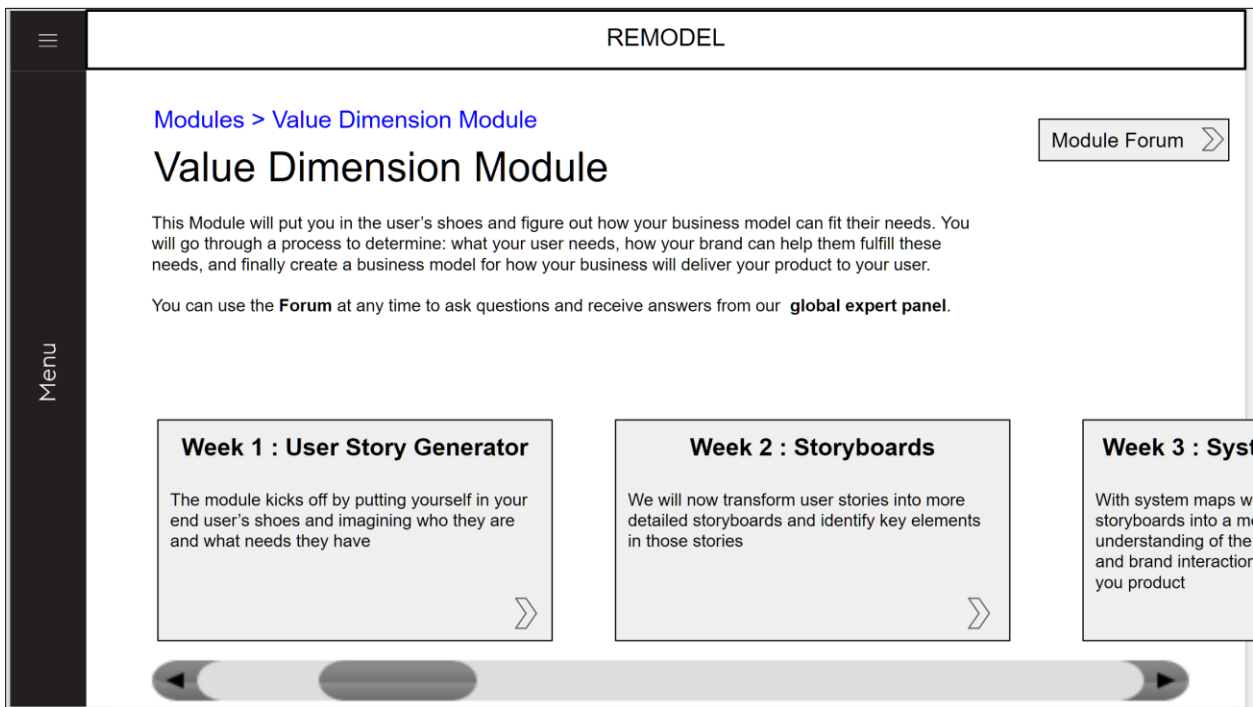
Another Article

*Appendix B. 10: Articles Page*





*Appendix B. 11: Central Learning Modules Page*



*Appendix B. 12: Value Dimension Module page*

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[Modules > Value Dimension Module > Week 1 : User Story Generator](#)

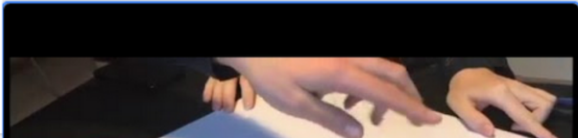
## Week 1 : User Story Generator

**What is the purpose of this exercise?**  
 The story of the user - the customer - is an essential part of any new business model. Understanding the needs of the user and what the user is trying to achieve as well as the desired outcome for the user is at the core of all business.

**Instructions**  
 Using the user story template, you can produce lots of stories in order to pin down the many different target groups your product could potentially have.

Download Materials

To get started, download the content and read through the **Guide to 1st Phase.pdf**. For more help, see the video below.



Menu

*Appendix B. 13: Individual Week of Value Dimension Module*

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[Discussion Forums](#)

## Week 1: User Story Generator

Discuss any questions you have on the user story boards. Feel free to post your sample user stories for feedback.

Sort by: latest ▾

Search:

New Thread

<b>FAQ for Week 1</b> Expert Created	<div style="border: 1px solid gray; padding: 2px;">110</div> <small>Views</small>	<div style="border: 1px solid gray; padding: 2px;">4</div> <small>Comments</small>
Is there a user story creation tool? dani@arduino.io	<div style="border: 1px solid gray; padding: 2px;">25</div> <small>Views</small>	<div style="border: 1px solid gray; padding: 2px;">7</div> <small>Comments</small>
Lorem Ipsum? some@email.here	<div style="border: 1px solid gray; padding: 2px;">1</div> <small>Views</small>	<div style="border: 1px solid gray; padding: 2px;">1</div> <small>Comments</small>
Lorem Ipsum? some@email.here	<div style="border: 1px solid gray; padding: 2px;">1</div> <small>Views</small>	<div style="border: 1px solid gray; padding: 2px;">1</div> <small>Comments</small>

Need more personal help?

Reach out by email to one or more of our experts:

Christian Villum: [cvi@ddc.dk](mailto:cvi@ddc.dk)

Julie Hjort: [jhj@ddc.dk](mailto:jhj@ddc.dk)

Expert Panel: < Some Alias >

Menu

*Appendix B. 14: General Forum*

☰
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Menu

Discussion Forums

## ← Week 1: User Story Generator

FAQ for Week 1  
[cvi@ddc.dk](mailto:cvi@ddc.dk) 1 month ago

Q1) Can I get individual support?  
 .....

Q2) .....  
 .....

👍 10 👎 1
🔄

some@email.here  
 1 week ago

Who is on the expert panel? Can I answer questions as a user?

Need more personal help?

Reach out by email to one or more of our experts:

Christian Villum: [cvi@ddc.dk](mailto:cvi@ddc.dk)

Julie Hjort: [jhj@ddc.dk](mailto:jhj@ddc.dk)

Expert Panel: < Some Alias >

*Appendix B. 15: Week 1 of Value Dimension Module Forum*

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Menu

General Forms		
Meet and Greet	20 threads	➤
Introduce yourself to other open source enthusiasts!		
General Discussion		
Discuss open source news and events		
Module Forms		
Value Dimension Module		
Week 1: User Story Generator	8 threads	➤
Week 2: Storyboards	10 threads	➤
Week 2: Storyboards	8 threads	➤

Need more personal help?

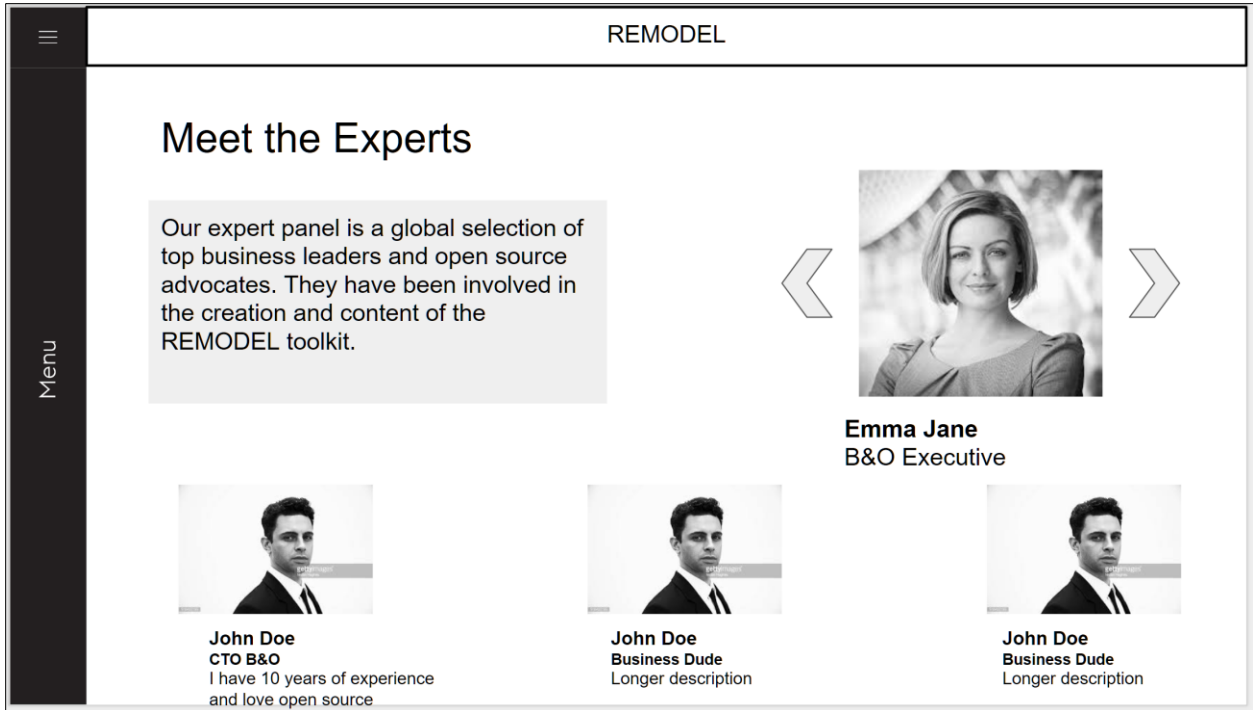
Reach out by email to one or more of our experts:

Christian Villum: [cvi@ddc.dk](mailto:cvi@ddc.dk)

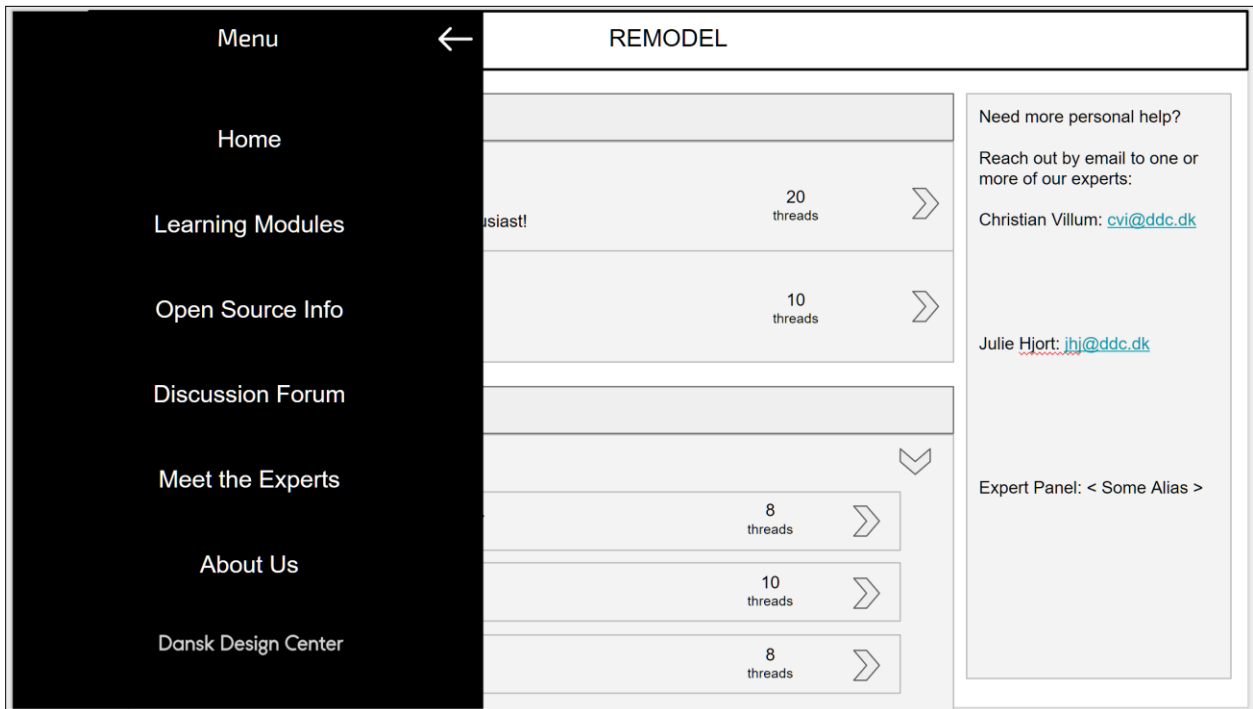
Julie Hjort: [jhj@ddc.dk](mailto:jhj@ddc.dk)

Expert Panel: < Some Alias >

*Appendix B. 16: Expanded Rows General Forum*



Appendix B. 17: Meet the Experts Page



Appendix B. 18: Side Bar Menu Display

# Appendix C: Case Studies

## Arduino – Community Through Open Source

Arduino is an open source electronic prototyping board that powers thousands of projects throughout the world. With an easy to user interface and a driven community, Arduino brings in millions of users monthly to find out how they can bring their ideas to life. Arduino’s community hub [Hackster.io](http://Hackster.io) (hosted by the community) has **over 91648 hardware developers!** Ideas ranging from as simple as an automatic toaster to prototypes of companies newly developed products.

### Open Source: Creating Community

The Arduino board is licensed under [Creative Commons license](https://creativecommons.org/licenses/by-sa/4.0/), allowing anyone to **produce, modify, and redistribute** their own Arduino boards as they see fit. This has let the Arduino product fill an enormous number of niches created by the creative community. This has lead Arduino compatible hardware and software to be created by the community such as the [Teensy Microcontroller](https://www.pcbay.com/teensy-microcontroller/), and even [Microsoft Windows Drivers](https://www.microsoft.com/windows/drivers/) created by Microsoft themselves. All of this is possible because Arduino *shared* their work and encouraged everyone to contribute to their platform. Arduino even allows other manufacturers to make their own clones of the Arduino board.

Arduino stay competitive by adopting a consultant role for the Arduino product; rather than making money from board sales themselves (which anyone can make and produce), **Arduino sells the corporate support for their product.** This allows them to freely benefit from their open model while still creating revenue.

### How can this help you?

If you product is small enough for anyone to buy, let anyone contribute. You can gain a **free and enthusiastic crowd** of supporters that will find ways to use your product that you never would have thought of. Furthermore, this community can alleviate the need for you to provide individual support for every consumer. Rather, **the community can teach themselves**, alleviating the need for you to spend as many resources coaching your consumer on your product.

### Further Reading

[10 Kick ass Arduino projects](#)

[Arduino Create](#)

[Why Arduino won and why its here to stay](#)

## FarmBot – Humanity’s First Open-Source CNC Farming Machine

Farmbot is a precision automated farming machine that is an open source project that aims to “Create an open and accessible technology aiding everyone to grow food and to grow food for everyone”. All Documentation, Design Files, and Software Source Code is **freely available** to be viewed and modified if need be.

### Open Source: Generate Revenue

While all the resources to create the machine is available, it is often the case that the average consumer will not have the manufacturing equipment to produce the machine. In this case the business model that FarmBot has developed is similar to the traditional business model. **They created a product and sell it**

**to a consumer.** However the benefit of having an open sourced design is it allows the user to look behind the curtain of the product they are buying and are given the opportunity to optimize it for their needs. This not only creates a more satisfied customer but also comes at **no additional cost to the company.**

Precision Farming is an industry that was often too costly for people to buy products from, however Rory Anderson, FarmBot founder, has developed a product that everyday consumers can purchase. Through the open source design of the product FarmBot was able to **reduce the overall cost** of the machine opening up them to a market of local farmers and agricultural enthusiasts opposed to only large industrial farms

### How can this help you?

Farmbot is an example of how an open source company is not that different from a traditional manufacturing company. There is the possibility for **gradual transition between a closed and open sourced model.** They also demonstrate that as an open source company you can still create a product and sell it to select consumer groups. The benefit that open sourcing the product creates is that they may now be more consumer groups available since it can be modified to fit anyone's needs if they put in the work.

### Further Reading

#### Farmbot

#### Description of Farmbot's product

#### FarmBot gives everyone a green thumb

## IBM – Creating a Standard through Open Architecture

*“Even a company the size of IBM couldn't develop all of the hardware and software to make the personal computer a success”*

- Dave Bradley, IBM Engineer

When the IBM personal computer (PC) was released in the 1980s, it was the the most popular and successful personal computer of the era making as much as 4 billion USD in revenue each year. So, how did the IBM PC dominate the market so thoroughly? The answer is **Open Architecture.** Open Architecture function very similarly to open source; rather than keeping your product design a secret, you publish all of the documentation another designer needs to create components for your product.

### Open Architecture: Shared Development Cost

The IBM PC was able to undercut the price of the competing Apple II computer and provide a larger platform by *not* developing everything internally. Rather, IBM developed their PC with an **Open Architecture;** IBM released the specifications for their computer and invited third party companies to develop **software and hardware.** This reduced the cost of the PC, and created a huge amount of third party contributions to the PC platform. In fact, because the everyone could develop software and hardware for the IBM platform, the IBM PC became the **defacto standard.** IBM was able to take over a huge majority of the PC market with the free help of the third-party contributors. All of this was possible because IBM had an **open architecture** and **shared** their knowledge.

### How can this help you?

You can rapidly spread your platform in a new market by adopting open source architecture by allowing other companies to contribute to your platform. And, if your platform grows large enough, this will allow you to define the standard for any company that comes after you. This will ensure that *anyone* who enters your market will also benefit your original product.

### Further Reading

#### Why the IBM PC Had an Open Architecture

## RedHat – Selling Open Source

“You could say it’s a neat trick to sell \$2 billion of something that’s technically free”

- Red Hat CEO Jim Whitehurst

Red Hat is one of the world’s most prolific open source software companies. Red Hat works by selling enterprise support for their Red Hat Enterprise Linux distribution of Linux. They now sell different services from cloud computing to desktop operating system support. All of these technologies are still completely open source and free, so how does Red Hat profit?

### Open Source: Generating Revenue

It may not seem possible to profit off of a completely free product, and yet Red Hat was able to generate over one billion USD in a single year in 2012 off of their open source products. So, why did people purchase this ‘free’ software? The answer is service.

Red Hat operates on a Software as a Service (SaaS) business model. In this model, the company or provider charges for the *support* in addition to the actual software. For example, when a Red Hat customer purchases Red Hat Enterprise Linux (RHEL), the customer is actually purchasing *support* from Red Hat in hosting or managing their software solutions.

This allows Red Hat to stay competitive; another company cannot simply *steal* RHEL from Red Hat as that is only one aspect of their product. Rather, Red Hat’s product is unique because of the service they provide along with RHEL. Thus Red Hat can gain all of the collaborative benefits of open source software while still keeping a competitive edge on competitors.

### How can this help you (in the manufacturing industry)?

One of the major concerns newcomers have with open source is *theft*; what is to stop a new company from ripping off your product? To solve this issue, you need to rethink how you conduct business. Rather than thinking of why someone should buy your *product*, focus on why someone would buy your product *from you*. By selling your expertise as a company, you can ensure that you always stay competitive in an open source market and still benefit from a collaborative and innovative community.

Further Reading

- [Red Hat](#)
- [How Red Hat killed its core product—and became a billion-dollar business](#)
- [Red Hat CEO Helps Turn Open Source Software Into \\$2 Billion Business](#)

## RepRap – The Self-Replicating 3-D Printer

Robots printing copies of themselves sounds like something from a Sci-Fi movie, however England based company, RepRap, has made this a reality. RepRap, which is short for **replicating rapid prototype**, is an open source 3-D printing company that focuses on being able to 3-D print the components of other 3-D printers for as cheap as possible. While components such as motors and other electrical components will still need to be purchased, the software and designs for the printers are freely open for others to download and create.

### Open Source: Increased Innovation

The 3-D printer **opens the possibility for a maker** to create virtually any item they can envision. The more users that have a 3-D printer available to them, means the more possibilities for an inventor to create something to change the world **without the need of a large manufacturing plant for prototyping**. RepRap has a [wiki style website](#) that allows users to add their own 3-D printer designs or modify others. RepRap has not only allowed for increased innovation by **decreasing the cost** to begin prototyping, but also have improved on the designs and functionalities of 3-D printers themselves. There are currently **more than 50 different printer designs** available to download or purchase.

### How Can This Help You?

RepRap demonstrates the true capability of open sourcing the designs of products. Not only are the 3-D printers **open to anyone to modify**, but the tool itself is a major gateway into the open source community. It allows for the capability to prototype your own products as well as test out the plans of others open sourced designs. RepRap's mentality is what can be most used by other companies. Open source allows for not only yourself to benefit from an invention but anyone who is interested.

#### Further Reading

[The RepRap Project](#)

[The Advantages of 3-D Printing](#)

## Riversimple – The Hydrogen Fueled Car of the Future

Riversimple is a UK based car company that has the goal to “offer customers the first affordable, hassle free, fun-to-drive eco car, delivered as a complete and cost-transparent service”. Through the use of an **open design community**, Riversimple has created a product that is not only better for the consumer, but also better for the environment.

#### Open Source: Increased Innovation

Riversimple's open source design allowed them to create a product that **gets rid of the trade off between a strong competitive business at the cost of environmental impact**. The network of collaborators working on the project strive to improve both the effectiveness of the car as well as reduce its impact on the earth. The Rasa is an eco-friendly car powered by a hydrogen fuel cell that produces zero emissions at the tailpipe and has achieved an equivalent to 250 miles per gallon.

When developing the Rasa they began with a “clean slate” as they call it. Simply starting with a hydrogen fuel cell, they developed a car with the help of anyone interested. The tires, the motors, the chassis are **all developed by separate companies** and Riversimple proudly displays this on their [website](#).

#### How can this help you?

Along with having an interesting car design, Riversimple has also an **innovative business plan** that is often used in the software industry. It focuses on the “sale of service” model. Instead of consumers paying for the car as a whole. Their simple pricing structure enables customers to pay a monthly fee which includes all services, access to the car, maintenance, insurance, and fuel. Even though there is no initial sales cost, Riversimple is still able to **generate monthly revenue**.

#### Further Reading

[Riversimple](#)

[Software as Service](#)

## Tesla – The Future of Infrastructure

“Yesterday, there was a wall of Tesla patents in the lobby of our Palo Alto headquarters. That is no longer the case. They have been removed, in the spirit of the open source movement, for the advancement of electric vehicle technology.” -Elon Musk



Tesla Motors is an American automaker that was created to **accelerate the creation of more sustainable transportation**. CEO Elon Musk is seen as a visionary for many industries, with a large focus on sustainability and clean energy. Tesla is one of the leading companies in electric cars and with the new development of the cheaper priced Model 3 they will only continue to grow. In 2014 Elon Musk announced that "Tesla will not initiate patent lawsuits against anyone who, in good faith, wants to use our technology".

### **Open Source: Shared Cost of Development**

Musk believed that their vision of wanting to accelerate the advancement of electric cars was severely inhibited by "intellectual property landmines". The electric car is only one aspect of the industry that is supported by this change. Electric charging stations and mechanics capable of working on electric cars are all **equally important for the entirety of the electric car industry to be supported**. Tesla's patents availability to the public allows for other companies to utilize aspects of their design and **encourages the shared development of the infrastructure** needed for these cars to be supported. The goal would be to have electric charging stations widely available and not only ones created and installed by Tesla.

### **How Can This Help You?**

Tesla released their initial concerns to opening their patents in a press release saying that they were worried that big car companies would copy their technology with their immense resources to overwhelm Tesla. This is often the case for many companies that are hesitant to open source some of their designs. However, the fact that Tesla themselves were the ones who created the technology and knew exactly how each component works meant that they **still maintained the expertise over other companies**. While it may also seem as if creating further competition in the same market can limit the potential of a company, the increased infrastructure created due to the competition **makes the initial product more appealing**. In this case the increased amount of charging stations encourages more potential buyers to purchase a Tesla since they know they will not be as limited on where to charge their car.

### **Further Reading**

["All our patents are belong to you"](#)

[Tesla's hopes to increase sustainability](#)

[Tesla wiki](#)

# Appendix D: Danish Design Center Branding Manual



Appendix D. 1: Color Pallet



Appendix D. 2 : Color Gradients over Images Example

**We celebrate** the difference  
**design** can make

We celebrate **THE DIFFERENCE**  
**DESIGN CAN MAKE**

Appendix D. 3: Boldface and Capitals Example

**TYPOGRAFI PRIMÆR FONT** November '16

Euclid Flex består i alt af 10 vægte:

- Bold**
- Bold italic*
- Medium
- Medium italic*
- Regular
- Regular italic*
- Light
- Light italic*
- Ultralight
- Ultralight italic*

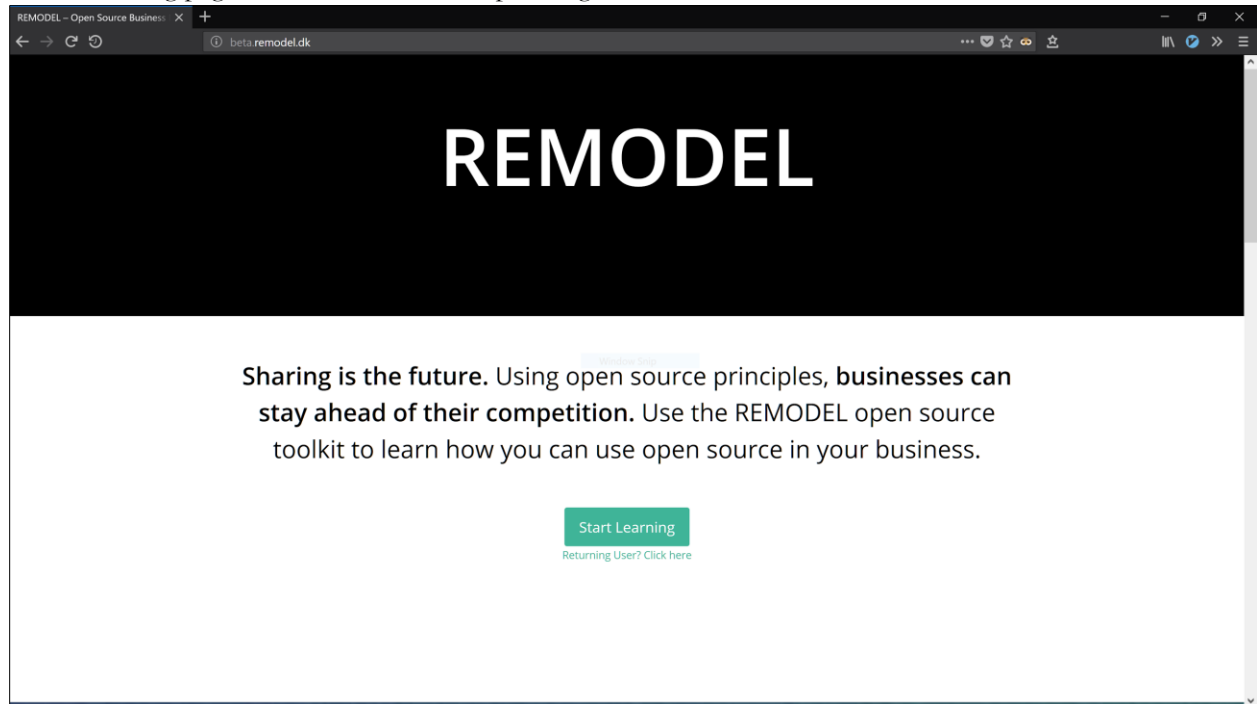
<p><b>Aa Bb Cc Dd Ee Ff Gg Hh Ii Jj Kk Ll Mm Nn</b> <b>Oo Pp Qq Rr Ss Tt Uu Vv Ww Xx Yy Zz Ææ</b> <b>Øø Åå 0123456789!?,.,;:-/()*" # &lt; &gt;</b></p> <p><b>Aa Bb Cc Dd Ee Ff Gg Hh Ii Jj Kk Ll Mm Nn</b> <b>Oo Pp Qq Rr Ss Tt Uu Vv Ww Xx Yy Zz Ææ</b> <b>Øø Åå 0123456789!?,.,;:-/()*" # &lt; &gt;</b></p> <p><b>Aa Bb Cc Dd Ee Ff Gg Hh Ii Jj Kk Ll Mm Nn</b> <b>Oo Pp Qq Rr Ss Tt Uu Vv Ww Xx Yy Zz Ææ</b> <b>Øø Åå 0123456789!?,.,;:-/()*" # &lt; &gt;</b></p> <p><b>Aa Bb Cc Dd Ee Ff Gg Hh Ii Jj Kk Ll Mm Nn</b> <b>Oo Pp Qq Rr Ss Tt Uu Vv Ww Xx Yy Zz Ææ</b> <b>Øø Åå 0123456789!?,.,;:-/()*" # &lt; &gt;</b></p> <p><b>Aa Bb Cc Dd Ee Ff Gg Hh Ii Jj Kk Ll Mm Nn</b> <b>Oo Pp Qq Rr Ss Tt Uu Vv Ww Xx Yy Zz Ææ</b> <b>Øø Åå 0123456789!?,.,;:-/()*" # &lt; &gt;</b></p>	<p><b>Aa Bb Cc Dd Ee Ff Gg Hh Ii Jj Kk Ll Mm Nn</b> <b>Oo Pp Qq Rr Ss Tt Uu Vv Ww Xx Yy Zz Ææ</b> <b>Øø Åå 0123456789!?,.,;:-/()*" # &lt; &gt;</b></p> <p><b>Aa Bb Cc Dd Ee Ff Gg Hh Ii Jj Kk Ll Mm Nn</b> <b>Oo Pp Qq Rr Ss Tt Uu Vv Ww Xx Yy Zz Ææ</b> <b>Øø Åå 0123456789!?,.,;:-/()*" # &lt; &gt;</b></p> <p><b>Aa Bb Cc Dd Ee Ff Gg Hh Ii Jj Kk Ll Mm Nn</b> <b>Oo Pp Qq Rr Ss Tt Uu Vv Ww Xx Yy Zz Ææ</b> <b>Øø Åå 0123456789!?,.,;:-/()*" # &lt; &gt;</b></p> <p><b>Aa Bb Cc Dd Ee Ff Gg Hh Ii Jj Kk Ll Mm Nn</b> <b>Oo Pp Qq Rr Ss Tt Uu Vv Ww Xx Yy Zz Ææ</b> <b>Øø Åå 0123456789!?,.,;:-/()*" # &lt; &gt;</b></p> <p><b>Aa Bb Cc Dd Ee Ff Gg Hh Ii Jj Kk Ll Mm Nn</b> <b>Oo Pp Qq Rr Ss Tt Uu Vv Ww Xx Yy Zz Ææ</b> <b>Øø Åå 0123456789!?,.,;:-/()*" # &lt; &gt;</b></p>
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Dansk Design Center Side 13/99

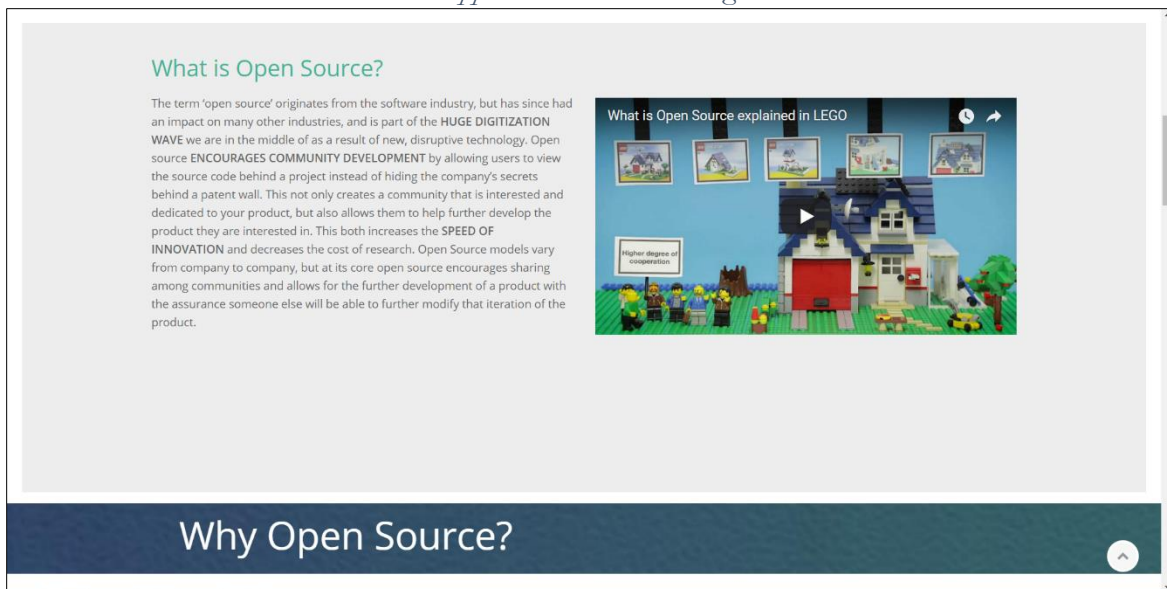
Appendix D. 4: Euclid Flex Font

# Appendix E: Toolkit Website Screenshots

Note: Scrolling pages are shown over multiple images.



*Appendix E. 1: Home Page*



*Appendix E. 2: Guided Tour part 1*

# Why Open Source?

Learn what is open source is as well as how it can help your business. Continue scrolling through the page or click on the buttons below to continue to a specific section.

Generate Revenue

Increase Innovation

Create a Community

Share Cost of Development

## Generate Revenue



Open Source is 'free', so how can you make money? Just because part of a company is open to be accessed and modified does not mean that you can not **SELL PRODUCTS** or **PROVIDE A SERVICE**. A common business model for open source companies is the service that comes with a product, professional consulting from the people with the **EXPERTISE** that created the product is often

### Appendix E. 3: Guided Tour Part 2



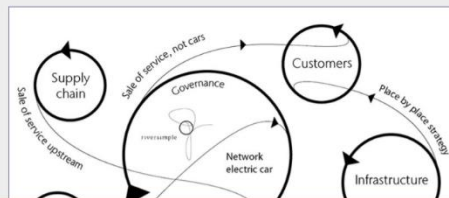
#### FarmBot - Humanity's First Open-Source CNC Farming Machine

Farmbot is a precision automated farming machine that is an open source project that aims to "Create an open and accessible technology aiding everyone to grow food and to grow food for everyone".

with the **EXPERTISE** that created the product is often desired by consumers. Similarly open source companies can still create a product and sell it to buyers at a cost which often does not differ from a traditional closed source company.

## Increase Innovation

By adopting open source, you are **NO LONGER CONFINED** to ideas within your company. Open source businesses are able to adopt the hive mind of others interested in the same product as your company. Consumers are able to **PROVIDE FEEDBACK** and **FURTHER DEVELOP** on products they feel may be improved. This often leads to **NEW IDEAS AND IMPROVEMENTS** to current



### Appendix E. 4: Guided Tour Part 3

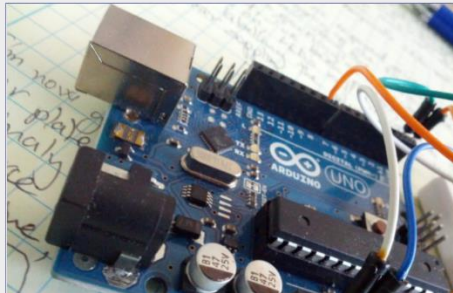
company has already used open source to increase the speed of innovation.



#### Riversimple - The Hydrogen Fueled Car of the Future

With the help of their open design community, Riversimple has created a hydrogen powered car that is not only better for the consumer, but also better for the environment.

## Create Community



Allowing anyone to contribute to an open source project allows a **COMMUNITY OF USERS** to contribute to your product. This community not only allows of a network of support that can assist with consumers questions but also makes the user **FEEL PART OF SOMETHING LARGER** than simply buying a product alone. The community aspect creates a welcoming aspect that **ENCOURAGES NEW USERS TO GET INVOLVED**.

### Appendix E. 5: Guided Tour Part 4

#### Arduino - Community Through Open Source

Arduino uses the community **HIVE MIND** to grow their platform into countless niches. With the help of their active open source community, Arduino circuit boards have been used in hundreds of projects from smart toasters to gps tracking devices.

## Share Cost of Development

Starting a new company is expensive; by adopting open source you can **REUSE** existing components and **REDUCE** the startup cost. By having a hive mind of collaborators working around a single product. User contributions often require no financial payout to effective new ideas. Along with this an open source community allows for a **SHARED INFRASTRUCTURE** between competing companies.




#### IBM - Creating a Standard through Open Architecture

"Even a company the size of IBM couldn't develop all of the hardware and software to

### Appendix E. 6: Guided Tour Part 5

source you can REUSE existing components and REDUCE the startup cost. By having a hive mind of collaborators working around a single product. User contributions often require no financial payout to effective new ideas. Along with this an open source community allows for a SHARED INFRASTRUCTURE between competing companies.



**IBM - Creating a Standard through Open Architecture**  
 "Even a company the size of IBM couldn't develop all of the hardware and software to make the personal computer a success" - Dave Bradley, IBM Engineer

**DIVE IN AND CONTINUE LEARNING!**  
 Click on the banner to continue


*Appendix E. 7: Guided Tour Part 6*

**REMODEL**


## Understanding Open Source Manufacturing

Open source has been used effectively in the manufacturing industry to increase innovation and community. We have created a list of case studies that highlight successful companies using open source today in their businesses. Additionally, we have created a set of articles written by other organizations that help demonstrate the effectiveness of open source business models.

Once you have a solid background in open source, learn how you can use open source in your business by progressing to our learning modules.



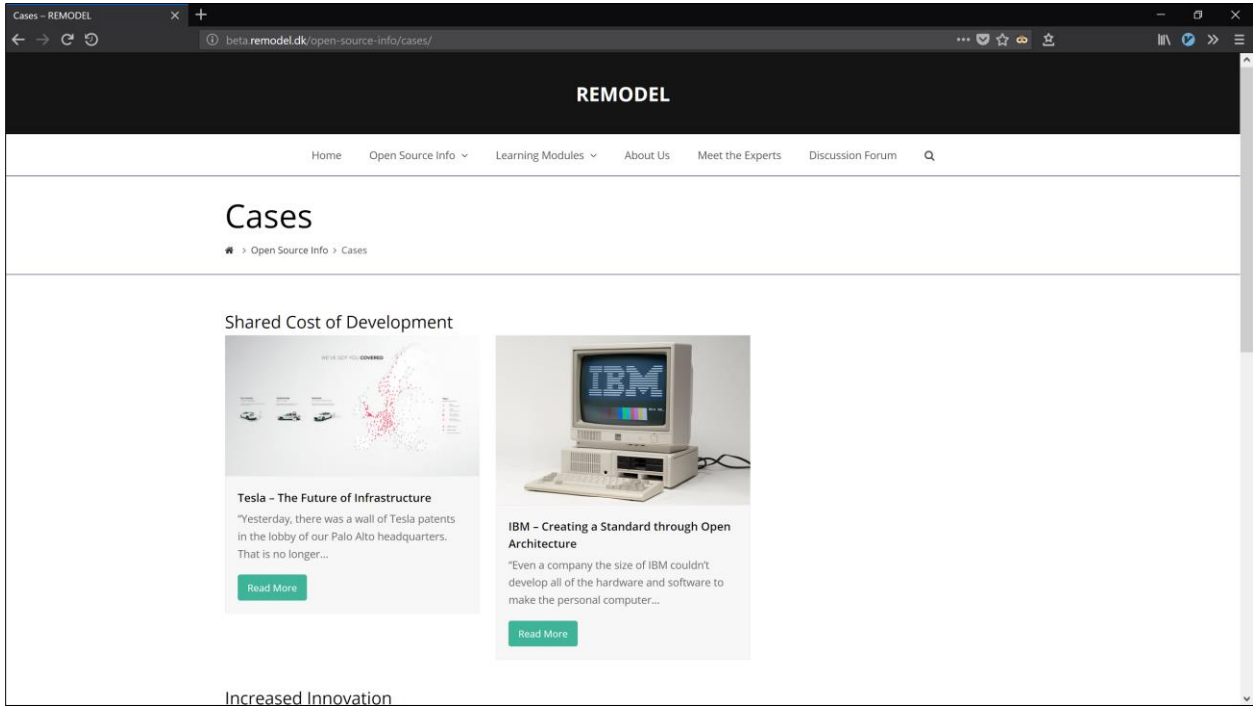
**Cases**  
 Explore cases of other companies that have used open source principles in their business model



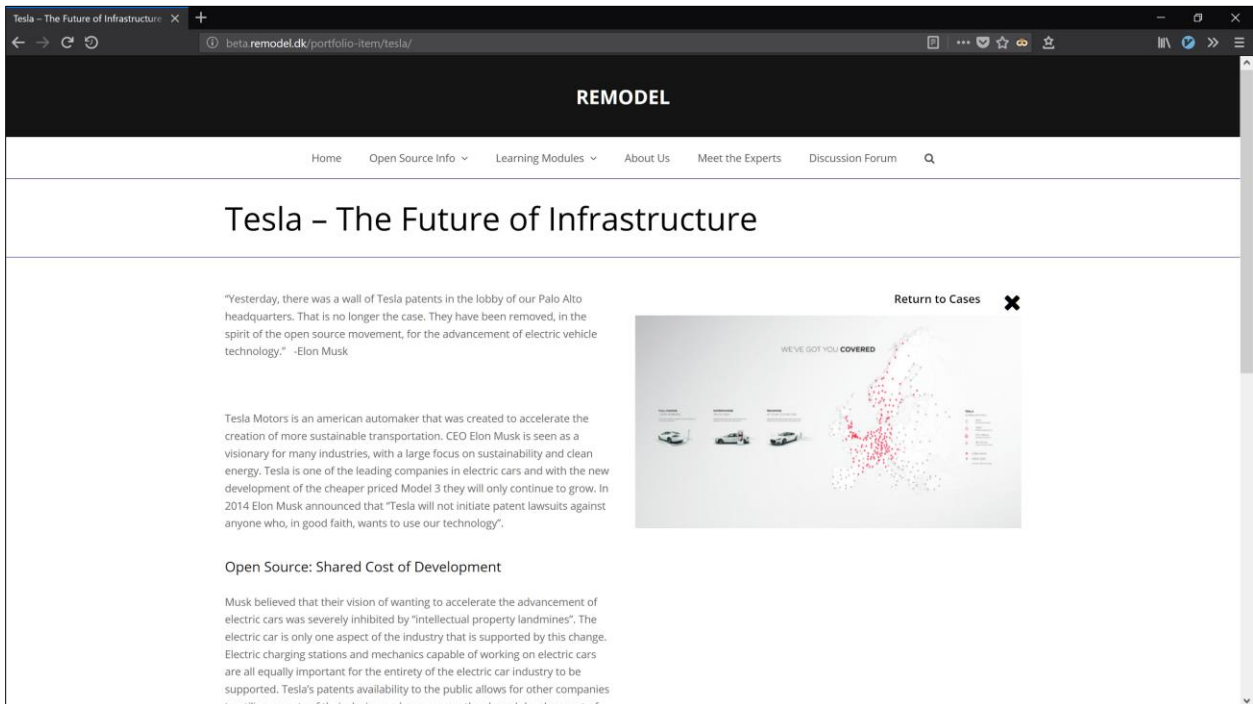
**Articles**  
 Explore useful articles to further your understanding of Open Source.

**CONTINUE TO LEARNING MODULES →**  
 After you finish reading about Open Source principles click here

*Appendix E. 8: Open Source Information Central Page*

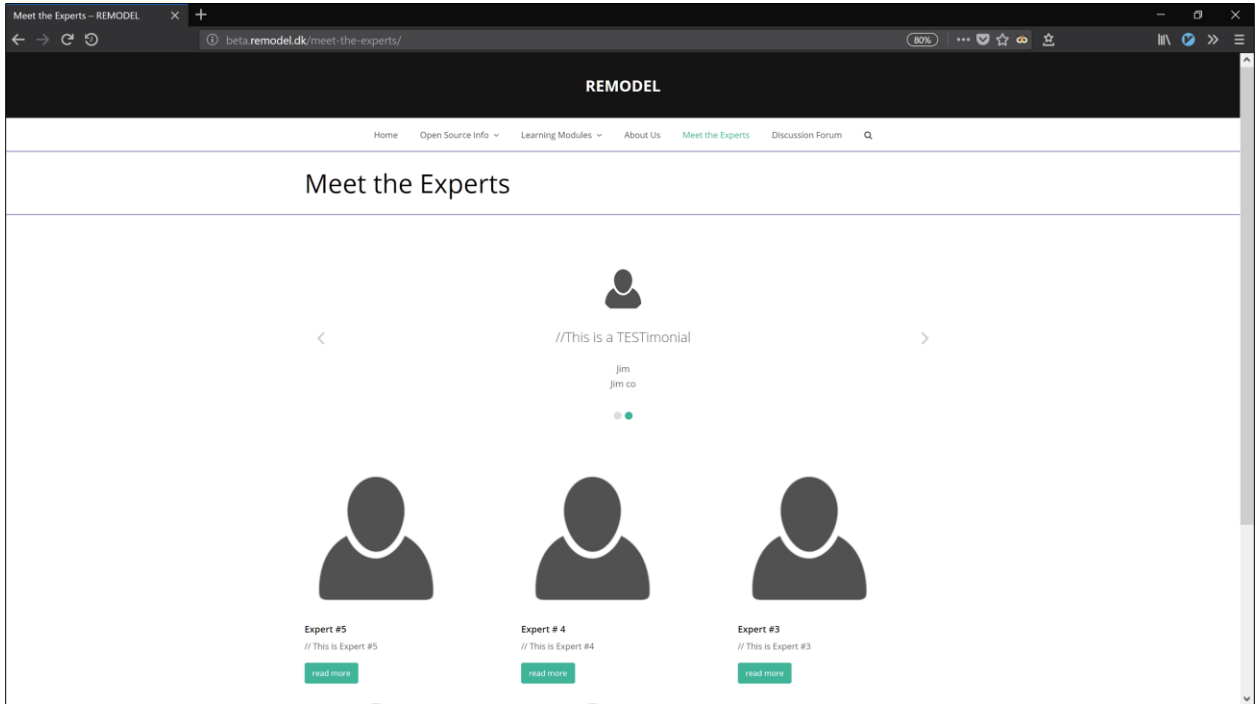


*Appendix E. 9: Cases Page (Filtered)*

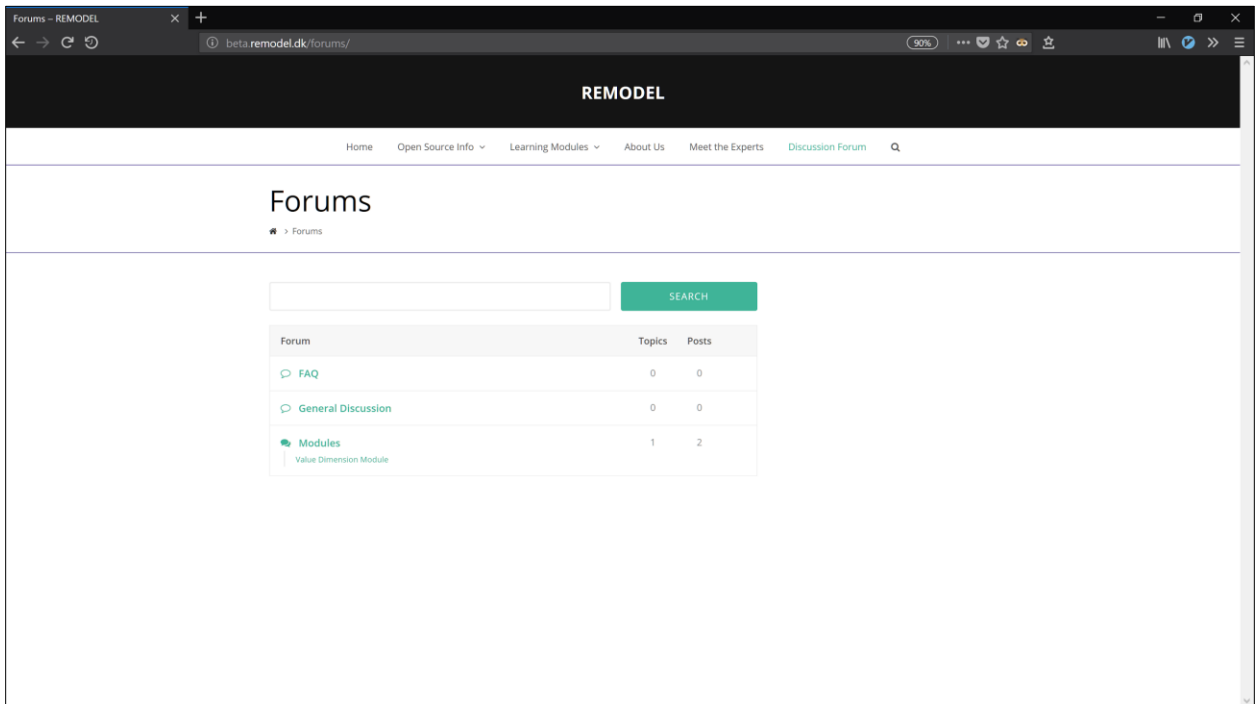


*Appendix E. 10: Individual Case Page (Tesla)*

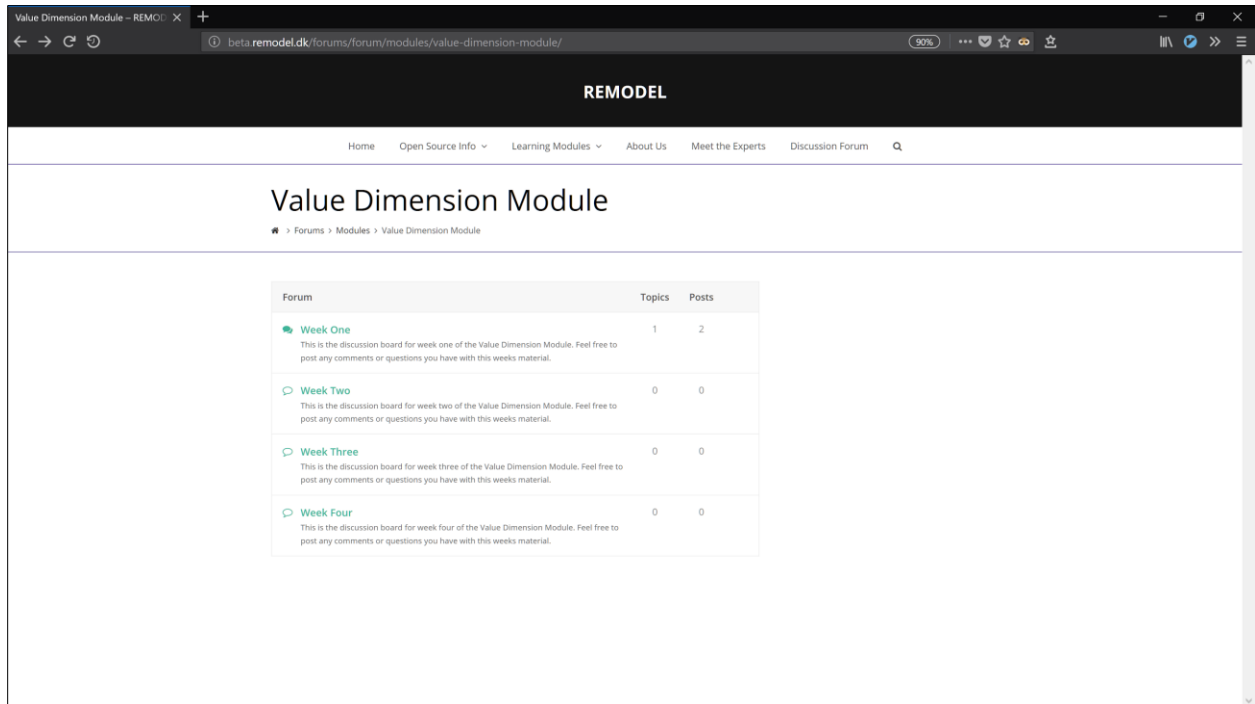




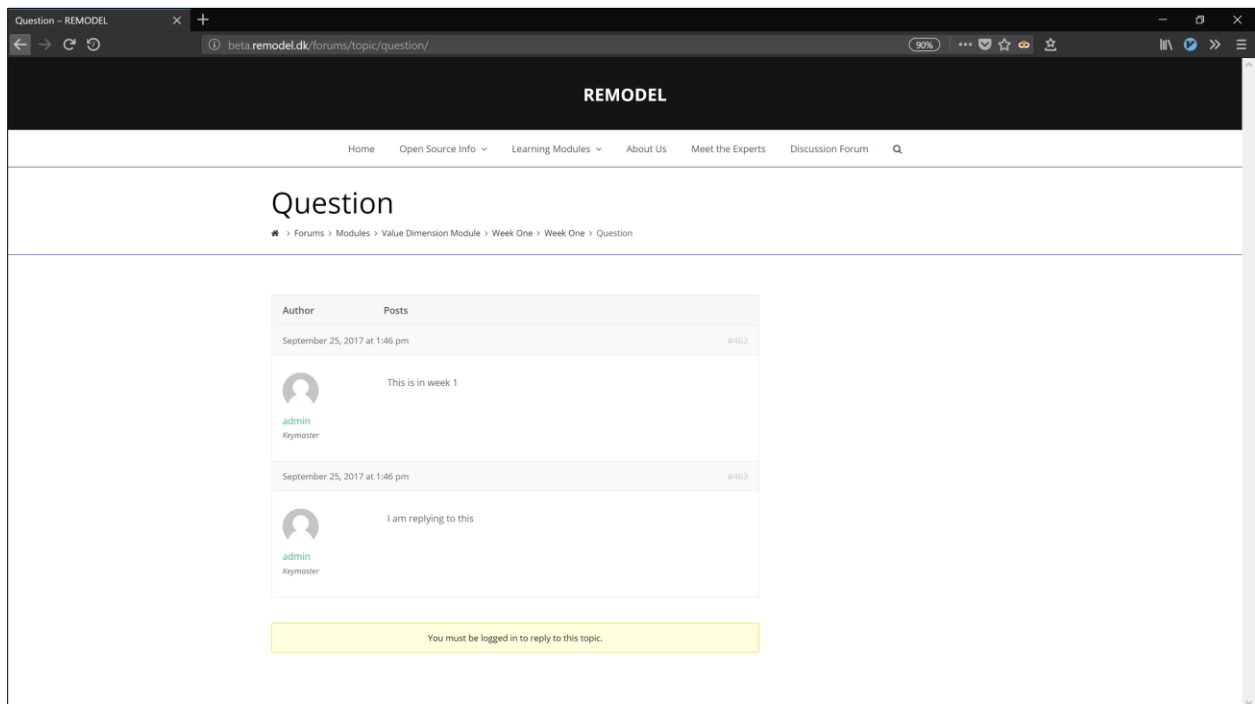
*Appendix E. 11: Meet the Expert Page*



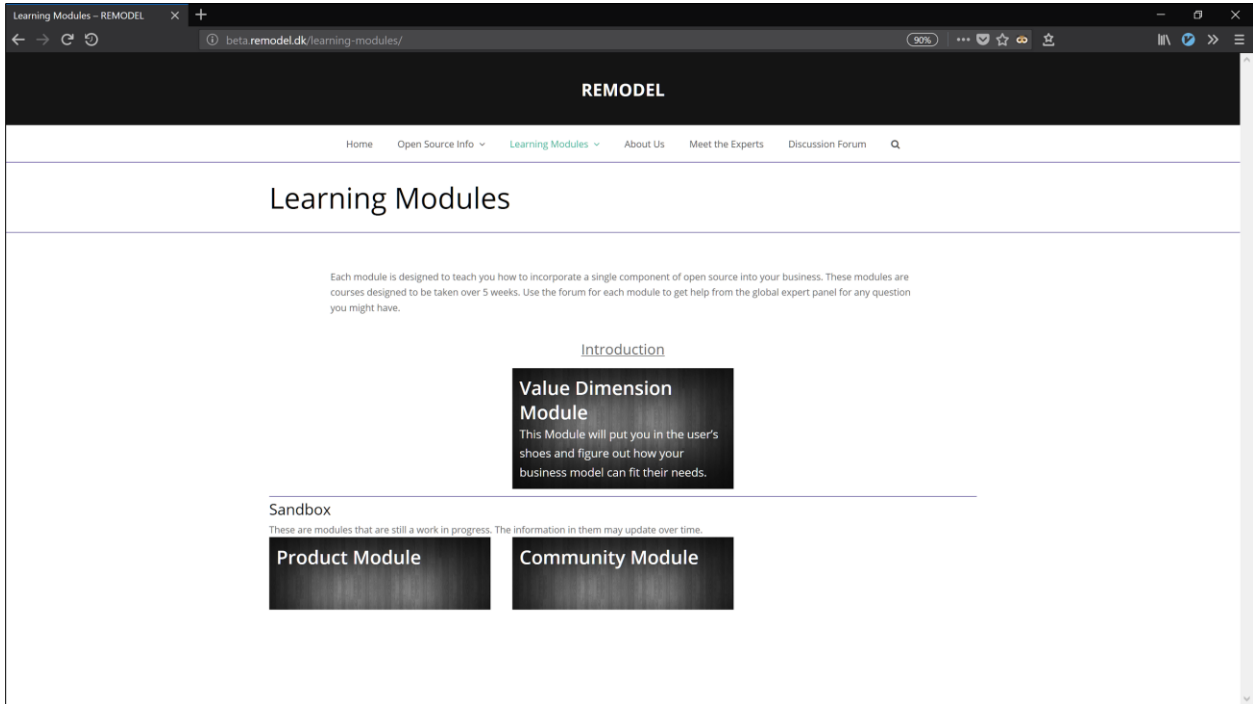
*Appendix E. 12: General Forum*



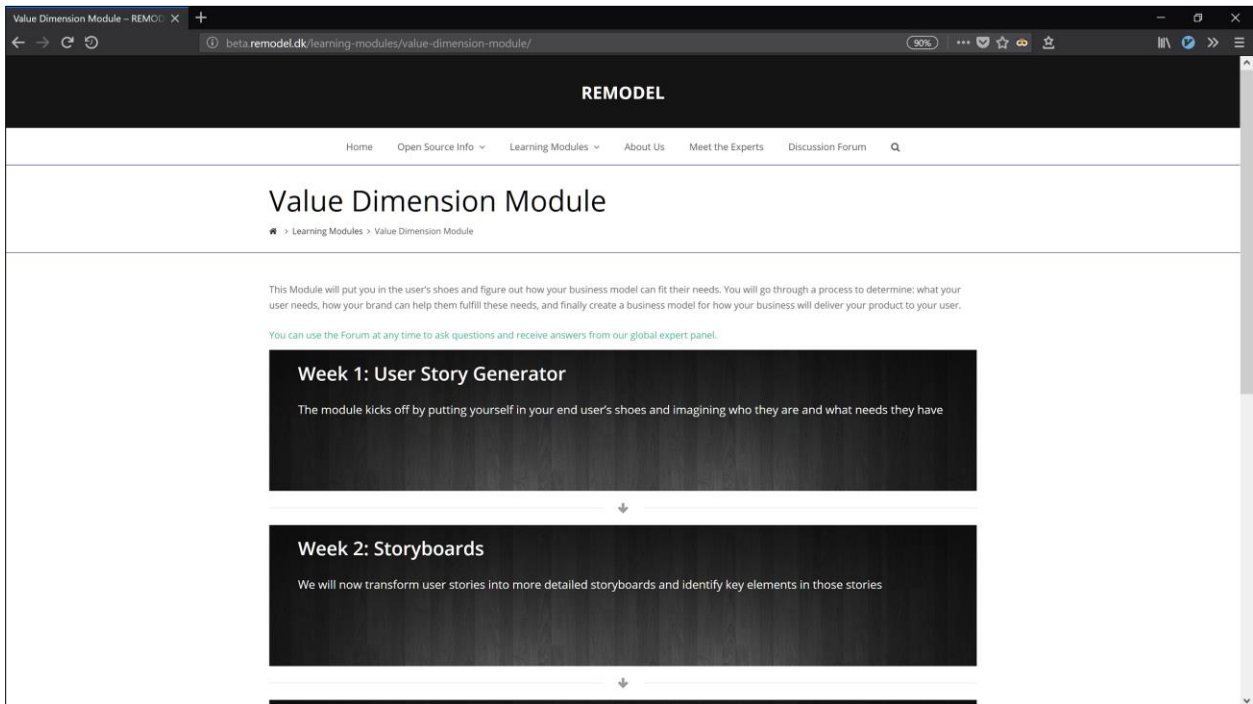
*Appendix E. 13: Value Dimension Module Forum*



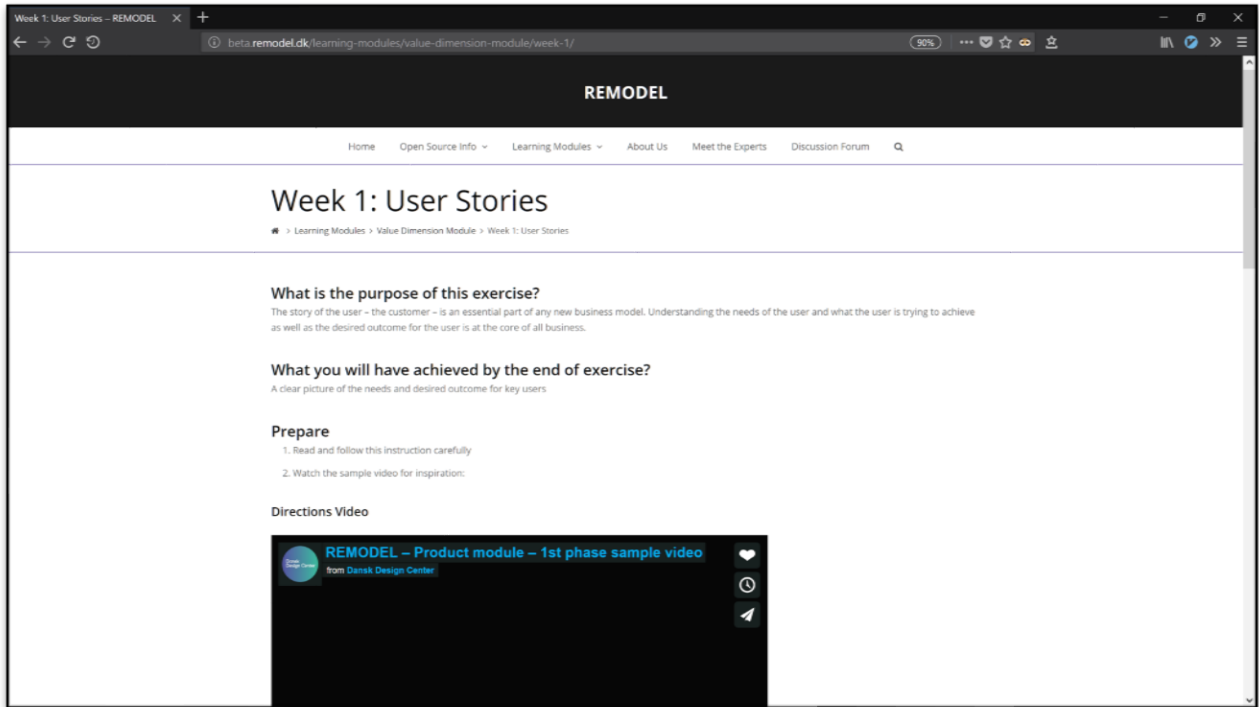
*Appendix E. 14: Value Dimension Module Week 1 Forum*



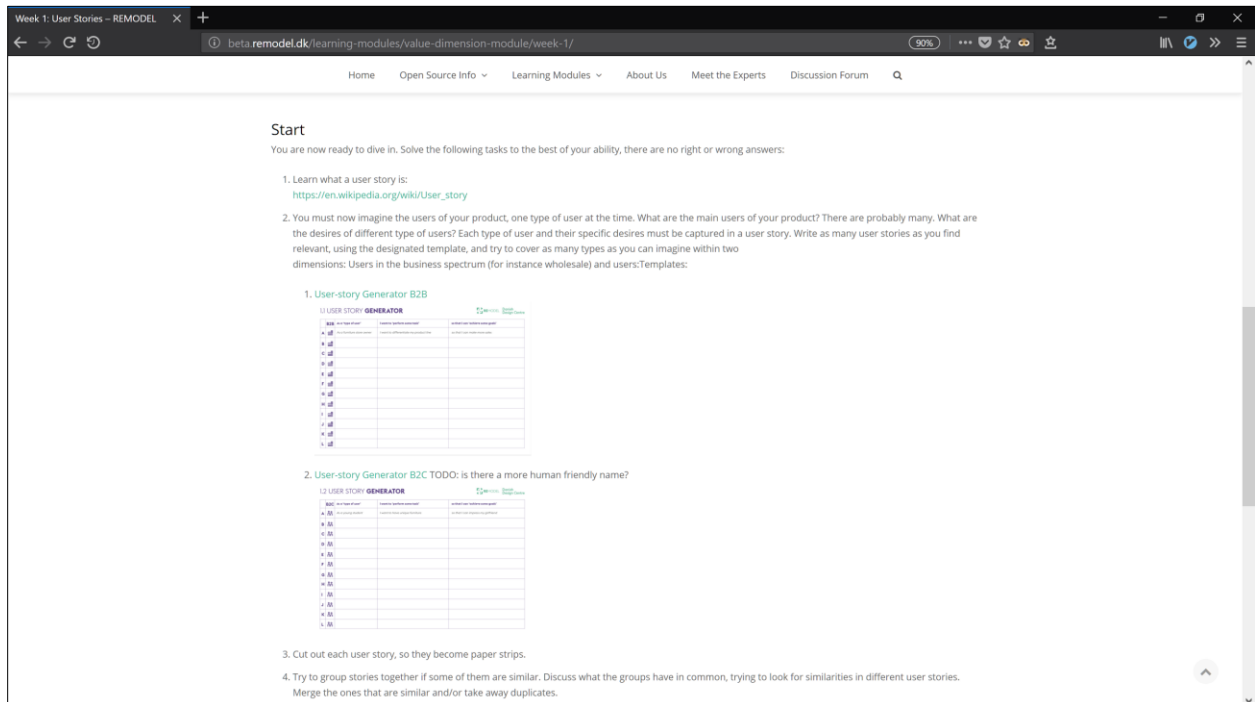
*Appendix E. 15: Learning Modules Central Page*



*Appendix E. 16: Value Dimension Module Page*



*Appendix E. 17: Value Dimension Module Week 1 Part 1*



*Appendix E. 18: Value Dimension Module Week 1 Part 2*

## Appendix F: Transition Manual

# REMODEL Toolkit Developer Guide

By: Saahil Claypool, Antonio Ferreira, Wentao Yuan & Sean Hunt

This user guide is meant to be used to help continue the development of the Toolkit website. This includes brief tutorials as well as our -- the WPI students -- vision for the final Toolkit. These suggestions may help in the continued development of the Toolkit.

This document provides a brief tutorial in Wordpress, especially focusing on the Total Theme and the Visual Composer plugin used to set up the website. The document then describes each of the major sections of the website: **Case Studies**, **Modules**, and the **Home Page**. In these sections, you are provided with information on how to extend each section. For example, the modules section go through the steps required to add a new module to the website.

Finally, the **Unfinished Pages** section provides an overview of the pages that have not yet been completed. Each subsection will provide an explanation of the direction we would take to finish these pages if we were to continue development. Most of these pages are structured on the website but lack real content, or were planned in the paper prototype but never implemented.

### Logistical Details:

**Site Url:** beta.remodel.dk

**Login Url:** beta.remodel.dk/wp-admin

**Login User Name:** admin

**Password:** Top10wordpress

□

### **Wordpress overview3**

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**Total Theme / Visual Composer AF** 4

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## Wordpress overview

To create the website, we used the content management system (CMS) Wordpress. Wordpress contains extensive documentation and there are a lot of guides and tutorials about it. The official Wordpress documentation can be found at <https://codex.wordpress.org/>.

Here are some aspects of working with Wordpress that we believe are important to highlight:

### Plugins

Below is a brief list of the plugins we used, as well as a description of what they are used for. These should be kept up to date to keep the site secure.

**Akismet Anti Spam:** (NOT ACTIVE) Used by millions, Akismet is quite possibly the best way in the world to protect your blog from spam. It keeps your site protected even while you sleep. To get started: activate the Akismet plugin and then go to your Akismet Settings page to set up your API key.

**bbPress:** bbPress is forum software with a twist from the creators of WordPress.

**Contact Form 7:** Just another contact form plugin. Simple but flexible.

**Duplicate Post:** Clone posts and pages

**Envato Market:** WordPress theme & plugin management for the Envato Market

**Google Analytics Dashboard for WP (GADWP):** Displays Google Analytics Reports and Real-Time Statistics in your Dashboard. Automatically inserts the tracking code in every page of your website.

**Slider Revolution:** Slider Revolution - Premium responsive slider

**Templatera:** Template manager for visual composer on Steroids

**WordPress database Reset:** A plugin that allows you to skip the 5 minute installation and reset the WordPress's database back to its original state

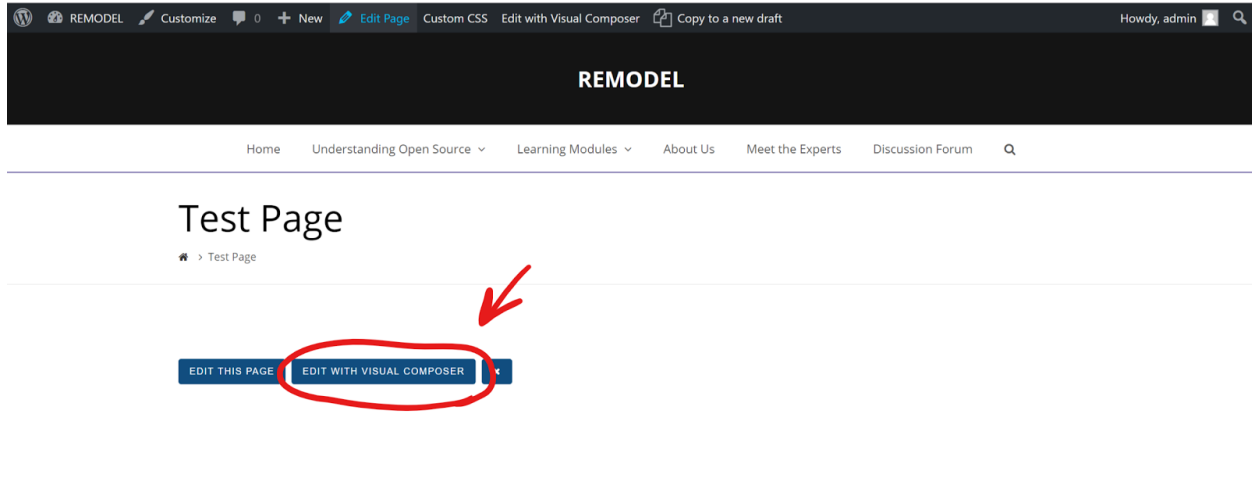
**WPBakery Visual Composer:** Drag and drop page builder for WordPress

## Total Theme / Visual Composer AF

When choosing a theme for the website, we took into consideration the fact that nobody had any relevant experience in web development that would aid us in implementing the website. Because of that, we ended up choosing the Total Theme for Wordpress.

Unlike most themes, that focus on providing one or more structural and visual templates, the Total Theme focus on providing customization tools that makes it easier to quickly set up a web-site with almost no web development knowledge required. This theme also has extensive documentation explaining how to use it. The documentation can be found at <https://wpexplorer-themes.com/total/docs-category/getting-started/>.

The main customization tool used by us was the Visual Composer plugin. It turns the page being customized in a drag-and-drop style page where you can add and move around buttons, text boxes, videos, etc. To use it, go to the page you want to customize and at the bottom of the page there should a button called “EDIT WITH VISUAL COMPOSER”.



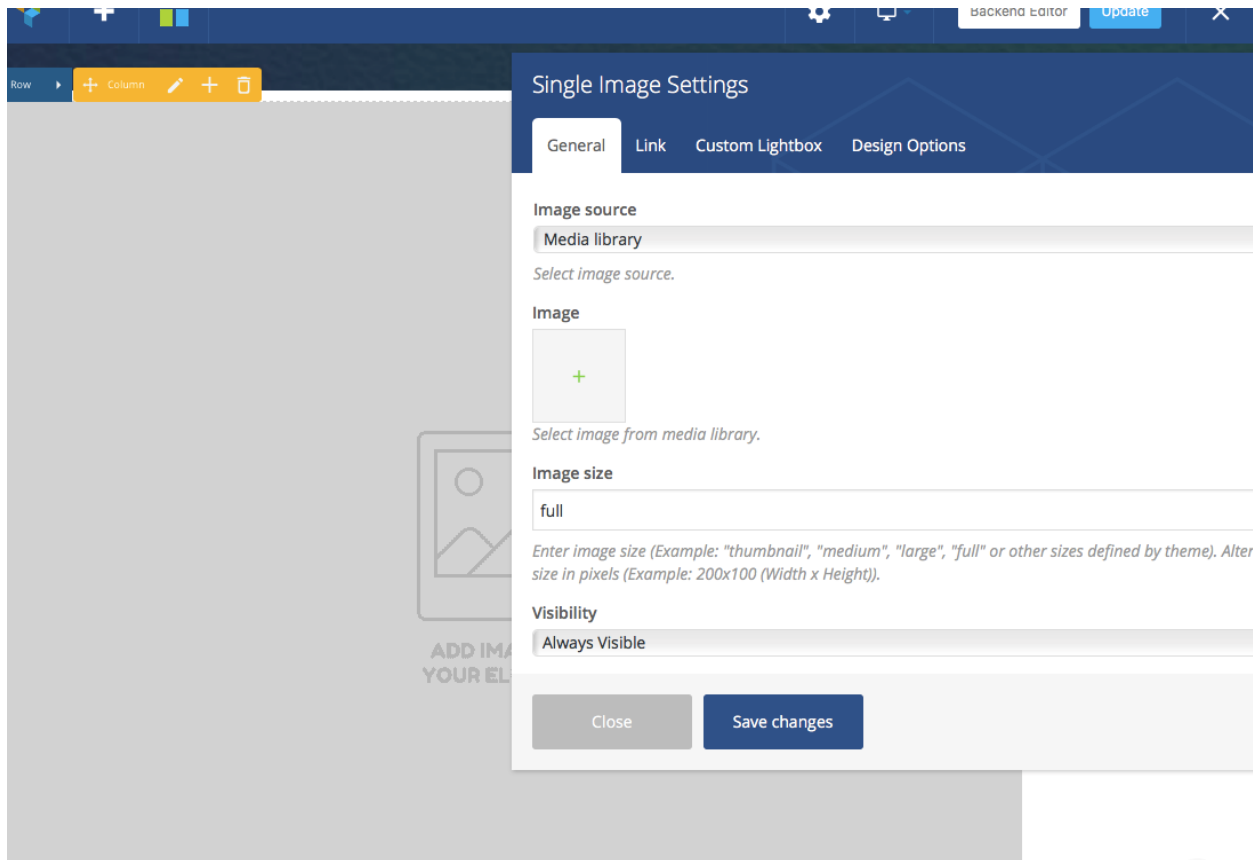
Once you click on the button, you will get the same page, but with Visual Composer’s options instead. If the page is blank, you will also be prompted to add an **Element**, a **Text Block** or a **Template**. An **element** can be a lot of things, such as buttons, images, text boxes, etc. A **text block** is just a standard text block if you want to start writing right away. A **template** is a page structure that was previously saved as a template. To save a page as a template click on the third button on the top left of the Visual Composer.

(insert image)

## Customizing Graphics / Look & Feel (Wentao)

### Adding images using Visual Composer

By hitting the + button on the top left when in the visual composer mode, you can simply add a single image (or a heading, a text block....). You can also add CSS animation for the image.



## Image Sizes When Using Visual Composer Modules

When you are using the Visual Composer modules many have their own cropping settings. For example if you insert the Total “Portfolio Grid” module you will see it’s own settings for defining the image sizes under the Media tab. If you select “Custom” you can enter your custom width, height and crop location for the specific module or you can select a custom image size as defined in the Image Sizes admin panel (as mentioned at the top of this post).

## Case Studies

The case studies section of the website includes each of the cases we wrote on companies that are or have used open source in their business model. The goals of these case studies are to do three things. First, these should provide a clear example of someone actually making use of open source. Second the case should focus on a *single* aspect of open source and dive deeper into that aspect. Third, the case study should connect back to the reader and help them understand how that single company’s experience could pertain to their personal situation. Each case study is meant to focus on one of four topics:

- Increased Innovation
- Creating a Community
- Generating Revenue
- Shared cost of Development

the *increased innovation* topic focuses on companies that are doing ‘next-gen’ technologies. the *generating community* case studies focus on companies that rely on contributions from their users. The *generating revenue* category focuses on actual business model of the company (usually very rich companies). Finally, the *shared cost of development* case studies focus on



companies that only develop part of their product and rely on community or other companies to get into higher priced markets.

## Structure

Each case study follows this general structure:

Title + Catchphrase

**Optional:** Motivating quote (usually from a CEO or other important figure)

Overview of the company – who are they? What do they do?

Their *specific* niche using open source

How can this help the reader?

Further reading (mostly sources used to write the article)

We recommend first creating a case study using the google drive template [here](#). This will make sure all the case studies are *roughly* the same structure.

## Publish a New Case Study

Make sure that you have created a case study with the appropriate structure before going through the publishing steps. All of the rendering is done by WordPress; you should just have to worry about adding the content and a single image to each case study. The rest will be taken care of by the templates.

To add a new case study in WordPress, do the following:

Go to the WordPress Dashboard

Select **Portfolio** from the left sidebar.

This will bring you to the dashboard for the case studies

Select **Add New**

This will open an editor

Enter a **title and content**

Use the appropriate headers & bolding inside this content box

Enter a short excerpt or summary

Located in the **Excerpt** box partway down the page.

Often, this can be the quote that is used at the top of the article

Add a **single category tag** based on the category of this case

The category tags are shown as a checkbox on the right sidebar

Add a **featured image**

This is found on the bottom of the right sidebar. The featured image will look best if it is roughly

3:2 in aspect ratio. But, all images will be rendered the same size based on the global style

sheet. To change the image size, change the a `img {}` rule in the global style sheet.

Remove **breadcrumbs** from the portfolio item.

Change the breadcrumbs setting from default to disabled in the Portfolio Item Settings.

Publish!

All of the rendering will be taken by the appropriate portfolio grids in the cases section. Filtering will be done by the category tag.

## Notes

### Portfolio grids

To display a portfolio category, use the *portfolio grid* widget. This widget has fields for including and excluding categories, or including a filter. This will take care of making arranging the portfolio items. Currently, this is being used on the **cases** page to display all of the case studies.

### Adding new categories

New categories can be added with the *add new* button in the category section on the right sidebar. But, on the cases page, the *portfolio grid* may need to be changed to include this new category.

### Changing all of the case study templates

In order to change the overall template that the case studies uses, go to the **WordPress Dashboard > Visual Composer > Templates** and edit the “Cases Portfolio Layout” template. The “Post Content” is the generic text widget that will take the text in the portfolio item editing page and display it. NOTE: This can only be used once per page it seems, it will show a duplication of the text if used twice. The post media widget uses the featured image of the portfolio item, the post media can be changed to display a video in the portfolio item page. The “icon box” widget is the back button for the cases since portfolio items are not considered pages which limits the use of breadcrumbs to return to the previous page.

If this template is changed it will change all case studies that use the layout (which by default is all of them) ensure that if the template is changed it will be capable to apply to each case study.

## Creating a new Module

Creating a new module on wordpress is similar to creating a new case study; there are templates on wordpress that should help structure the material.

### 1. Add a new module to the Modules page

This is simple. Copy one of the existing module icons and change the name, url, icon and content to point to the new module page.

### 2. Create a new module page

This will create an overview for a single module

To do this, do the following:

1. Click the **+ NEW** button on the top bar of wordpress.  
This will open a dropdown of possibly items to create
2. Click **page**  
This will open a page creation dialogue
3. Click **backend editor** option  
This will change the view to a visual composer view
4. Click **add template** on the bottom right of the page
5. Select **ModulePage** from the templates dropdown under *my templates*  
This will create all of the components for the module overview. All that needs to be done is change the text and links
6. For each element, change the text and the URL links

### 3. Create each individual phase or week page

This is where the actual directions for each module phase will be written

Do do this, complete the following:

1. Follow the same steps as above to create a new page.
2. Select the **module week** template.
3. Replace to the steps as needed
4. Change the **download worksheets** link

This is slightly involved.

1. Create a zip file on google drive
2. Right click and get a *shareable link* to the file

This should look like this:

<https://drive.google.com/open?id=1SfZbn4IXTDFFAeY4Mt5MDSqhHzpfBO36IDve0BdKX8A>

3. Copy all of the text after the **id=** in the url

In this case, it would be [1SfZbn4IXTDFFAeY4Mt5MDSqhHzpfBO36IDve0BdKX8A](https://drive.google.com/open?id=1SfZbn4IXTDFFAeY4Mt5MDSqhHzpfBO36IDve0BdKX8A)

4. Put the ID into this url : <https://drive.google.com/uc?export=download&id=<SOME ID>>

In this case, it would be <https://drive.google.com/uc?export=download&id=1SfZbn4IXTDFFAeY4Mt5MDSqhHzpfBO36IDve0BdKX8A>

Clicking this link will download the zip folder directly

5. For direction that requires a worksheet, simply click “add media” in the text box with the directions. Do the same steps as above to create a download link for that individual item.

Note: for pdfs, take a screenshot of that pdf to use as the media image. The link can still be directly to the pdf.

6. Change the discussion forum button to link to a new discussion forum for that week.

## Home Page

The Home Page is displayed as a single long scrolling page that contains local links on buttons allowing you to automatically scroll between sections with a single click. The top level banner is also modified from this page, which will eventually be modified to include the REMODEL logo.

### Main Banner

The main banner is created as an H1 tag and styled with CSS. This should *probably* be changed to an actual SVG logo.

### Featured Case Studies

Under each section of the benefits of Open Source is a featured Case Study that explains the section further. These displays are different than the set up in the full Case Study page as a portfolio grid would not be as logical here.

### Changing the Featured Case Study

Open the Visual Composer or Back end editor for the Home Page and find the section that you would like to edit. It is composed of a single image and a text box. In order to change the **Image and Link**:

Edit the **Single Image**

Under the **Image** section click the x to remove the previous image and the + to add a new one.

To change the **Link** navigate in the “Single image Settings” to **Link > Image Link** this should be the link to the url of the desired case study which can be found at **Dashboard > Portfolio > “Case Name”** at the top of the page. (Include everything after the /, beta.remodel.dk should not be added)

Make sure that the “New Window” is selected under the Link Target section

Click Save Changes

In order to change the text box below the case edit the **text box** in the page editor. This is manually changed to display the Case Title and Subtitle as well as an excerpt about the case. This information can simply be copied from the Portfolio item page.

## Still in Progress

### Forum

The Forum is currently set up with the plugin BBpress. It allows for the creation of topic threads for the structure of the forms and questions within designated topics. It also allows for users to

create an account on the site. This creates a wordpress account with the authorization level as a “subscriber” which will simply give them the possibility of creating question threads and responding to others.

## Creating a new topic thread

The overall structure for the forums is created by making “Forums” these are features that only an admin can create that will develop the structure of the forum such as Module forums as well as General discussion. In order to create a new topic you should:

On the dashboard of the website navigate to “**Forums**” this is where you can edit and create forums similar to the portfolio page.

In order to create a new forum click “**new Forum**” at the top of the page.

Add a **title and description** of the forum here.

Select any “Parent” forums which will make the new forum a subsection of the parent forum.

Make sure to publish the forum when complete.

Topics are the questions and posts within each forum that can be created by the user or the admin themselves. Any of these topics can be “stickied” at the top of a forum which will make them always appear first when viewing that forum

On the dashboard you are also able to view a list of all the replies which are the comments made within topics.

## Expert Panel

The expert panel contains all the information on each member of the expert panel. Similar to cases and modules there is a template that allows each expert to have a similar looking page if desired. Features that we intended to implement but were unable to at our finish time was categories and filtering for the Expert Grid which was supposed to filter Expert’s by Industry. As well as ordering of the Staff Grid so that more prominent Expert’s would be displayed at the top.

### 1. Add/Modify an Expert’s page

Experts are implemented into the website as “Staff Members”. These are created and modified similar to case studies. In order to modify an existing Expert’s page or create a new one:

From the Wordpress Dashboard click on **Staff** to view current “Staff Members”

In order to create a new expert click **Add New**

In order to modify an existing page click on the name of desired expert

The default setting is to use an existing template called “Expert Panel Layout”. (this template can be modified the same way as the case studies template. The current template includes a featured image and post content text.

### 2. Adding a Testimonial

The testimonials will be displayed at the top of the expert panel page on a slider. These are implemented as “Testimonials” separate from the Staff page. In order to add a testimonial:

From the WordPress Dashboard navigate to **Testimonials > Add new**

There is no default template for the Testimonials page but one can be added if desired.

The main content of the Testimonial goes in the large text box.

A **Featured Image** is added on the right sidebar which will appear above the text in the Testimonial Slider. We envisioned this to be the expert who the testimonial is from.

In **Testimonial Settings > Testimonial** the name of the expert as well as the company they are from can be added, along with other information.

Underneath **Testimonial Categories** on the right sidebar check “Expert Panel” to display it on the current Testimonial Slider

### 3. Editing the Testimonial Slider

The current layout of the expert panel page includes a testimonial slider page at the top which cycles through Testimonials. The current settings include all Testimonials with the “Expert

Panel” category with a limit of 5 Testimonials displayed. This number can be changed if the “Testimonial Slider” widget is edited when the page is being edited under “Slider Settings”

#### **4. Editing the Expert Panel Grid**

The grid of experts is a widget called “Staff Grid” which includes all staff members. The functionality of this grid works the same as the grid on the cases page. Due to this filtering can be added which was a desired feature but was limited by not knowing who the experts were. Staff Categories can be added to an Expert from the Dashboard by going to **Staff > Staff Categories**. Once a category is added here make sure to include the desired category to each expert in their personal staff page. These Categories will automatically be added to the filtering system in the Staff Grid if the Staff Category is included in the grid settings.

## **About Us**

This page is incomplete, likely will be similar to the main DDC webpage.