The Innovation Process

We have seen the different steps that make the creativity cycle and what frameworks provide further guidance when we talk about change within the organization. However, we often see that the digital tools that might help in several of these steps are not highlighted or not understood. My goal is to introduce these tools here and how they can help you in each step of the innovation cycle. These tools can help with the analysis of the data, so that we might better understand the problems we are dealing with in a clear manner, boost the idea generation process, testing of our solutions, up to the actual implementation.

It is time that we invite these techniques into the enterprise and make use of them in a positive manner. We should foster an environment where we really make use of the digital solutions that are now very common in the marketplace. Again, this doesn’t have to lead to a high cost but can significantly boost the change processes that are currently terrorizing modern enterprises. This is the final aspect that makes up the innovative organization, as depicted in Figure 8-1.
Step 1: Problem Definition

This first step is so often overlooked that it has become one of my main frustrations. Instead of considering what the real need of the organization might be, the only thing management really knows is that it needs innovation. Why? Because everyone else seems to be doing it, competitors are entering new markets and creating new products, customers are moving away, and our enterprise architecture consists of legacy systems that are woven together via a bunch of communication lines that are held together by hope and desperation. By throwing around the same buzzwords the competition is using, they believe they are keeping up with current trends, while their competitors might be just as stuck as they are. They are probably facing the same problems, and as such, we should spend our focus here, rather than trying to continuously throw around buzzwords out of some “need.” So we need innovation more than ever before. But what is really the problem you want to focus on? Whatever the case you put forward: a new platform, new service or product, new customer communication programs, or anything else, depending on who you ask, they will have a different view. Every department within the company consists of people that have problems of their own. However, this shouldn’t be stopping us but rather motivate us to do better.

The practical solutions put forward by most organizations are simple. Either we organize an innovation event, make a lot of noise about it, throw some people together in a room, and force them to come up with some new and challenging ideas in a couple of hours and hope something interesting comes out. The other possibility is that we invite a bunch of consultants. And when
we invite consultants, the objective is clear: one possibility is that management in all its wisdom has determined what the problem is and has put forward a solution themselves or they ask for some strategic insights and possibly a road map toward something new. While these ways of working might have proven their worth in the past, often they are counterproductive in the long run. Who remembers how the road map needs to be implemented once the consultants are gone?

Often the company is left with an expensive PowerPoint and nothing more. Or there has been a solution implementation, but the outcome of the project isn’t exactly what the company has been looking for; still there are some benefits. Perhaps the consultants need to stay on longer to try to realize some other improvements and the costs keep on piling up. And the internal innovation events? If we are lucky, something interesting comes out of the project and we can move forward, but it is more likely that we organized a teambuilding event where the participants didn’t really have any fun. And you could wonder why we might change the way of working as it has been the way things have always been done. Well, because we can do better and we deserve better. The core of the problem isn’t consultants or no consultants. The core of the problem isn’t that management doesn’t understand, their goal is to improve the organization as well. They don’t want to lose money on projects that don’t bring value. The core of the problem can be understood as the flow of information.

There is probably no worse place on earth when it comes to information flow than the modern enterprise. Management often likes to believe everything is going well and if there are problems, they receive the proper information and data to deal with it, but this is often not the case. And we can say that it is only the problem of management but it is rather the problem most human beings are facing. We like to think that we are smart and when we are faced with a problem, we understand it and like to solve it straight away. It is the way we are programmed to do things. However, if you show the same situation to ten different people, you can be sure as hell that there will be different perspectives and views which will lead to different problem statements and proposed solutions. And in that same room with ten people, how do you determine what the actual problem is? Well, you don’t. Even if you were to discuss it in such a room, it would probably be the person that holds the “highest” position in the company or the person that shouts the loudest.

When the decision is made, there is still a bunch of red tape to deal with within the company to convince everyone that the problem at hand needs to be solved and that we were able to identify the correct solution. What the impact on the organization will be, what value the project will bring, and what resources are needed? Only if we are somewhat able to make it through the huge minefield of decision makers can we hope to start the project. By this time the problem statement has probably already been changed, the solution
implementation minimized to the bare minimum, or we start with the minimum viable product or a proof of concept to see where we might land. The final product isn’t at all what was decided in the first place (even though that wasn’t the most effective decision to begin with), let alone that it solves anything really.

I might have painted a gloomy picture here when it comes to information flow and decision making within modern organizations. However, it is key that you understand that this isn’t some exaggerated story, this is what really happens nowadays in a lot of companies. Rather than bringing real innovation, decision makers rather look out of the window to see what competitors have been doing or like to be known for pragmatic decision making. This only makes the question here more pertinent: how do we help decision makers make the right choices and understand the problem at hand? How do we deliver them the information and data they need?

Well, we make use of the most important step in any data project: data collection. The information deficiency that modern organizations deal with nowadays is the main reason why decision makers keep on looking in the wrong direction or implement solutions that only treat the symptoms and not the real cause of the problem. Only by collecting as much information and data as we can, can we try to understand the problem we are trying to solve. However, to start data collection we must first have a problem statement that we can reasonably agree on and of which we know that it will probably change. Where do we have to focus on when we start collecting our data and information? It is a little bit the story of what came first: the chicken or the egg, the question or the data? It doesn’t matter if we want to solve an existing issue in the company, if we want to invent a new product or service or enter new markets.

First, there must be a reasonable understanding of the organization on what we would like to focus. You could say that top management is best suited to handle these decisions, but this isn’t always the case. As I stated before, information often remains hidden or locked in certain locations within the company. Even though sometimes we are very aware of some of these problems, sometimes they have become so common that we have learned to live with them, rather than question how we could possibly solve these problems once and for all.

A clear proposal can be made on how specific information and data can become more useful to the organization as a whole. First of all, we have to learn to centralize all data in one key location. Departments function too often as little principalities within the kingdom that is the enterprise. Instead of working together, a lot of information is simply locked away within the department, used to generate some small reports, and that is the end of it. I have seen the insides of several companies and always had to land on the same conclusion: if these organizations had actually been focusing on sharing their
knowledge and information, they would have known what problems they are dealing with in the first place. Many an employee complains about the fact that top management doesn’t understand their situation and they are right. Top management doesn’t understand because they simply don’t know. To step away from these issues of the past, we need to centralize all information and data within the company. Only by centralizing everything can the necessary information be offered to decision makers to make the right call and to define the problem we are currently focusing on. This doesn’t mean that all services need to be centralized. Large firms can still work with regional offices, different departments still focus on different jobs or clients, and so on. The only thing we should really do is to centralize all this data and information, and this in real time and up to date for every employee and client of the company.

Second, there is the fact that we need to focus on standardization. Too many companies make use of tens to hundreds of Excels, presentations, Word documents, and so on to share and present information. Once again, these often end up at some department head or manager and there it stops. Information is lost and the efficiency in sharing all of this information is very low. Centralized data repositories can help to standardize the data that is coming in by enforcing certain standards. This shouldn’t limit the data that can come in but can help us to optimize the information flow and allow us to aid further analysis. Third, very much linked with the previous two, is that of digitalization. Only by creating digital platforms and data lakes where we can have centralized access to all data can we hope to provide enough information so that the problem can be identified or that the problem statement can be refined. This way we can also collect much more information and at a higher speed. Even though this may seem straightforward, I can promise you that it is not. Many a company still makes use of paper archives, works based on paper contracts and documentation. The step to digitalization is often a difficult one as it involves major first investments and no organization wants to make a mistake when it is pumping large amounts of money in unknown technology. However, to allow for proper data and information flows, this step is a necessary one to make. Combined with this step toward digitalization, one can also make use of automation techniques. By automating information and data flows, you can remove the human error as much as possible from reporting and data input tasks so that we can rely better upon the data we receive. No more worrying if people are sick, on leave, or leave the company, as we can make sure that reports keep on coming in via these automated flows. Automation will of course not be able to solve all issues in the company but can sure as hell bring process improvements within the enterprise.

However, the most important aspect is the integration of stakeholders within these information flows. We need to have clear roles for all employees, with related responsibilities so that they can help manage the information flows. One aspect is that you can determine who has access to which data and what actions they can perform, so that security within the organization remains
maintained. More important is that these employees hold valuable information that needs to be unlocked toward the top management. It is these employees that talk to customers and hear their complaints that see where processes go wrong or where they are dealing with bottlenecks, where teams and departments run into issues, and so on. In the same manner, we know that external parties such as suppliers, sellers, customers, and more hold valuable information that we need so that we can determine where we should focus our innovation efforts on. What we think the customer needs might not be what the customer really needs. But how can we know? Only by implementing effective feedback loops can we hope to capture all of this information.

And let me stop you right there. No, you are probably not doing this in an effective manner. Having a conversation with your employees once a month or every couple of months doesn’t allow you to collect all of this data. Perhaps you are one of the few that has landed in a situation where you have a direct bond with your colleagues and you can trust them to provide this information honestly. More likely is that employees keep certain information hidden as they are afraid to share certain criticism or trust that someone else will do it. Of course, there are sometimes the obligatory questionnaires that are sent around where people can give their feedback “anonymously” and the company is able to present how good they are doing. Similarly, (semi-)external stakeholders don’t share their views, or at least not to the extent they should be doing, let alone the customers. We only scratch the surface when it comes to their ideas and what they imagine should be the next focus of the company.

In the next couple of pages, I am going to introduce some well-known (and less well-known) opportunities which can help improve this first crucial step in the innovation process. Thanks to the appearance of digital solutions, we can help this phase along the way and make sure that we extract as much data as we possibly can. Do not be mistaken, if this step fails, you can be certain that the next steps will fail as well, however good you are implementing them. I have mentioned it already a few times: information is the key to everything.

**Data Centralization**

I mentioned it already a few times, one of the key things we need to be successful is a centralized repository of all our data. By centralizing data, we can make sure that no information remains locked or hidden within any department. Even though access can be limited for employees depending on what their function is, people focusing on the data analysis can this way make use of all data that is available. Even data that remained hidden before now become available and open up a lot more possibilities, even outside the context of this book. Common advantages are that the data integrity is maximized as well when we make use of a single location. In the same manner
this means that it becomes easier to coordinate the data and make it as accurate and consistent as possible.¹

When we have to work on data cleaning, this helps us forward as well because we immediately have access to all the data. We can also reduce data redundancy by storing all data together instead of scattering it all over the organization. On top of that, we can increase the security measures we take on the data and reduce the possibilities for data leaks or corruption. We increase data portability, reduce costs, and have easy access to the data. Of course, this might bring disadvantages if not well implemented. These disadvantages can be linked to network latency as all employees have to access one location for their data. Also multiple users trying to make use of the same data and perform actions might lead to inconsistencies and problems. Finally, and this is an important one, if there are no database recovery measures in place, you can be sure that you are going to discover what hell is really like when the system fails because all data will simply be lost.

When it comes to such data centralization, you have several options. We are not going into the details of data flow mapping and so on here (many a book has been written on the topic), I am going to shortly introduce two of the major implementation types that organizations are currently choosing when embarking on such a journey. The first one is called the data warehouse which consists of historical data that has been structured so that it can fit a relational database schema.² It is mainly used for analytics of business decisions but can also be used for data and process mining. The data being stored is commonly limited to that which is relevant for data and business analysts. This type of structure can be interesting for different reasons. Certainly if the focus lies on auditing current processes and improving the current way of working, the data warehouse can be the key source we need to make use of. However, also a lot of information is lost. Unstructured data cannot be stored in the data warehouse, and all data that is currently deemed irrelevant isn't stored. When in the future we realize we do need the data, it is already too late as we never stored it to begin with. That is why there is a second option for those organizations that are a little bit more confident, immediately want to make the big jump, or already have experience with data warehouses.

The second type is called the data lake. The data lake consists of both structured and unstructured data from various company sources. The goal here is to store all data that might come into use by the company. We are trying to capture as much data as possible within the relevance of the company. While at the data warehouse we mainly focus on querying data from the database for our analysis, the data lake also stores data while at the same time we can perform some “big data” analytics, deep learning, and real-time

¹https://www.tutorialspoint.com/Centralized-Database-Management-System
²https://www.datacamp.com/community/blog/data-lakes-vs-data-warehouses
streaming and analytics. As you can see, you gain a much wider set of options when you make use of a data lake implementation. You don’t need to clean the data or immediately structure it before storing it, you can do this later when you actually need the data for future analysis. The data lake is also much more scalable as you can store any type of data without having to worry about data structures.

Whatever the choice is you make as an organization, the main idea is the more data you have, the better you can prepare your analysis. Whether it is to start an innovation process within the organization (and I can imagine that getting a data lake or warehouse might already be a huge innovation to start with) or perform any other type of data science project, you will certainly get value from the database.

Automated Data Flows

Well, it is highly linked to the previous topic, but the idea of automated data flows cannot be underestimated. The implementation of the data warehouse or data lake is the first important step toward being able to make use of the huge amounts of data your company is generating. Some of you might not realize this, but every organization has more information and data than they realize themselves. Sometimes departments don’t even try to get the data out of their systems because it costs too much time, is too expensive, or is too difficult.

With automated data flows we can help the ingestion of data in the centralized system you are making use of. This might put an initial strain on the way you are working in the company, but once implemented, you can focus on the part where you actually want to be focusing on. However, there are some things you need to take into account when thinking about such automated data flows. By processing data in parallel, you can process large amounts of data without creating a bottleneck by making use of a single server or edge node. The concept of parallel or distributed processing might sound strange, but it simply means that we can ingest data via several different and separate streams and hence optimize the way we are processing data.

Depending on the environment you are working on, it might become interesting to work with incremental data synchronization. This is certainly the case when the business needs continuous availability to recent source data and you are working with large datasets. If you keep on repeating a full load, you will impact the source systems which in turn will impact the other business work that needs to be performed. As our goal is to improve and innovate the current way of working, this would work against our goals. By working with incremental data synchronization, we limit the impact on the

3https://www.infoworks.io/automated-data-lake-ingestion-like-magic/
resource systems while at the same time we gain access to the most recent data. Everybody wins.

A final challenge where automation might lend a hand when we work with a centralized solution is that of schema changes in the source. Data warehouses typically cannot handle such changes very well and an intervention is needed of developers to adapt the schemas where necessary to allow the pipeline to continue working. In the case of the data lake, we can implement an automated solution which can detect the changes in the source schema, change the schema in the data lake, fill in the data, and notify consumers of the data about the change. Hence we can clearly improve the lives of decision makers and data scientists/engineers within the company by enhancing the overall flow.

**Stakeholder Engagement**

The second major part that we discussed is the idea of stakeholder engagement. How do we make sure that enough stakeholders are involved and remain involved in the process? Here we need to apply several strategies to gather all the information we actually need. And I will have to disappoint some of you, but this part cannot simply be solved by making use of digitalization or automation. They can be helpful tools but also nothing more than that. It remains key that the “human” remains central in the process and we need to realize that we will never have all the information we are looking for.

The first key factor is that we need to communicate clearly and openly with all the stakeholders. And this doesn’t mean sending an email when the project starts. This is just informing stakeholders without really engaging them. Instead of informing them, you should ask them to inform you. You could almost see it as an RFI, or request for information, where you request from your stakeholders what they think about your intention to start a project. By turning the table you could clearly show that you take their opinion seriously. A second important aspect here is that you can make use of emails but you should have more options open. People don’t tend to respond to mails as it takes up time in already very tight schedules or the mails end up in the spam folder. I am not saying you shouldn’t make use of mails, it keeps people informed and engaged, but you should also make time to take their opinion. You need to organize sessions with teams both internal and external. Engage your customers directly and ask about their requirements.

When people are allowed to make time for the process, you will much easier receive feedback. The person leading the sessions should be either someone that is new or someone that is trusted within the organization. Only this way can you make sure that you gather the right information and not the “desired” information where people just say what they think you want to hear. An interesting approach here as well could be to keep managing employees out
of the sessions so that they don’t influence the information provided by all people participating. Even though there are many good managers out there which have a positive influence on the team, even in that case they influence how people respond to questions regarding the company as a whole. In the idea generation process, we will show several techniques on how we might further enhance the experience of all involved people and stakeholders. Removing the “fear” of management is a difficult step but certainly one we have to try.

Other ways of collecting initial information from stakeholders can include the use of questionnaires. Typically, the response rate is quite low and the answers don’t always have a high quality. We could improve the usefulness of the responses by making use of open questions and actually allowing people time to answer. By opening up time for employees to specifically focus on these questions, we can hope to enrich the information we gather from them. We should also make clear that we allow them to answer anonymously. Sometimes people are afraid of the possible reactions from their team or manager, so they don’t provide the truth.

A third possibility consists of making phone calls from a dedicated team to employees and stakeholders, but also here we can only see limited success. Certainly external stakeholders such as customers are often bothered by these calls and tend not to answer or completely disregard them. From internal stakeholders we typically see higher success rates, but this really differs from organization to organization. A better approach is directly asking customers feedback at the end of the process they have been engaged in. Chances that they will actually answer increase. Similarly, you can directly ask for feedback or information in case customers are contacting you. Why did they contact you? Was their problem resolved? And are there other things that are bothering them?

Finally, you can actually enter the work of another stakeholder yourself. If your innovation focuses on internal improvement, the best way to know where frustrations might exist is by performing the work yourself. Put yourself in the shoes of the people you want to help and not just for 5 minutes. A couple of days focusing on the way they are doing things might really show you the existing problems. An added advantage is that the team you try to help will see that you make the effort of understanding the work they have to perform and this in turn might create strong foundations for the work you want to do. Similarly, you can act as a customer and really consider what parts of the process frustrate you or what you would like to do differently. This way you don’t have to rely on other people, but you can directly gather the information yourself. Even though this is still a very limited sample, it can give an indication in what direction you should be looking for a solution.
IT and Operational Capability

A final consideration we need to make is the IT capacity and capability of the organization. We can dream of the newest applications, but if we are dealing with a lot of legacy systems, this is not something that we can immediately introduce. Other possible problems might be the fact that we have to deal with limited resources as IT professionals are a scarce source on the market and finding adequate time of the IT teams in the organization might be a daunting task. Budget is another constraint as we certainly can see in times of crisis. The first budgets to go are those that focus on IT.

However, we can already make a first assessment of the capability of enterprise IT by making use of the IT-CMF (IT Capability Maturity Framework) maturity levels.4 It is a model that offers us some guidelines on where we can currently find ourselves and what gaps we are currently dealing with. We can make use of a standardized assessment tool to benchmark ourselves against similar organizations and as such collect information that we can immediately use in the company. The framework focuses on four core macro-capabilities which embrace certain critical capabilities which in turn lead to agility, innovation, and value:

- **Manage IT like a business**: We want to make sure that the contributions of the IT department optimize the organization as a whole. An increased focus on business and the customer is key to success.

- **Manage the IT budget**: Keeping the IT budget under control is an important challenge. We are dealing with scarce resources, expensive legacy systems, unplanned cost escalations, and at the same time the unwillingness of management to make further investments.

- **Manage IT capability**: We need to move from the idea that IT offers one-off solutions and rather is a function that is continuously involved in the innovation process. On the one hand we need to effectively and efficiently maintain the existing services while we develop new solutions.

- **Manage IT for business value**: Investments made in IT should benefit the entire business function. Therefore, they are no longer “IT projects” but rather generic projects focused on generating value across the organization.

4https://cio-wiki.org/wiki/IT_Capability_Maturity_Framework_(IT-CMF)
These four main cornerstones can be divided further into 36 critical capabilities. These capabilities include processes such as accounting, business planning, and process management, but also strategic planning and risk management. It continues with capabilities such as budget management, project portfolio management, program management, and relationship management. Don’t hesitate to have a closer look at this framework as it can really help you to better understand which capabilities we require in our organization.

Based on the improvements we can make across these capabilities, we end up in a certain maturity level:

- **Initial**: In this stage we have no formal processes in place and IT is managed “ad hoc.”
- **Basic**: Here we have started with the delivery of basic IT services across the organization, and we have started to formalize some IT/business interactions.
- **Intermediate**: When we have formalized all the IT/business interactions for the critical processes in the company and when we make transparent investment decisions in IT, we have landed at the third stage.
- **Advanced**: Here we have passed our competitors, and the use of best practices allows us to perform well above the industry average. Here we also quantify and communicate IT investments in a transparent manner.
- **Optimizing**: This is the final stage where we have value-centric IT management and we make use of “state-of-the-art” practices and outcomes.

Performing a thorough assessment of our organization allows us to see where we still need to grow and how we can capture value if we really want to start innovating ourselves.

Still, nobody can deny that the future of almost every industry is digital and that we have to move along with the digital revolution if we want to stay ahead of our competitors. It is this very contradiction that makes it often a struggle to implement new solutions, let alone truly allow innovation to become materialized.

In a similar manner we have to look into the operational capabilities of the organization. If the company has already been pushed to the very edge due to cost-cutting measures, driving changes and new implementations might actually have a devastating impact. Operational capacity must be able to carry the new load brought by the innovation you would like to bring. Even when you don’t have an idea yet, or you are still early in the process, it might be
good to have an idea where you are currently at with the entire operational capacity. This in turn can give you a clear idea of what extra costs you might run into when you wish to develop a new product or service. Of course, there will always be costs when you try to develop something new, these costs can easily run out of control if you don’t have a clear view of what capacity you have available currently. Experienced people that can work on the project, who know the company and at the same time have worked on similar projects or have been performing work on other products and services, can bring in their ideas as well. They might be able to steer the project toward success and can help the innovation to grow.

However, the opposite is also true. If you don’t have the operational capacity, this doesn’t mean you should simply stop and innovation is no longer possible for you. Every organization should have some elasticity on their capacity as employees go on vacation or get sick, sometimes we need to increase production, customers start to visit our website in huge numbers, and so on. Only by having some backup are we able to deal with these sudden spikes. If your organization doesn’t have the capability to deal with any type of change project, you might be running in much deeper problems. Still, catching such issues early on is key if you want the innovation to push beyond the “proof of concept” phase. By highlighting this problem, you can show your dedication for the project, while at the same time the decision makers are immediately aware of the possible bottlenecks they have to deal with both in the short term and in the long term. Larger organizations often have a dedicated function to innovation projects which can help the process along. This can help you to direct all change from one team. At the same time there can be a dedicated budget that is allocated specifically at innovation, the creation of proof of concepts, and more. The dedicated team can introduce new concepts, monitor changes on the market, and help the organization to think out of the box. Continued education is very important in this regard, just as conferences, monitoring of digital news, and more.

**Step 2: Analysis**

When you are able to push through the first step, you land at the second step where we focus on the analysis of data. Only when we have all the data which is applicable to our organization and our problem can we hope to move to the next steps. The importance of analysis and data collection cannot be underestimated. That is why we are going to spend some time on this step and introduce some concepts that might help you to discover some information you never knew was actually there.
Data and Process Mining

Once everything is in place, we can start with data and process mining. These techniques can help us to uncover information which we didn’t see before. With data mining (which finds itself on the intersection of machine learning, statistics, and database systems) we try to uncover patterns in large datasets which we simply cannot make with the naked eye. Not to be confused with other techniques that focus on modeling or analysis, with data mining we really want to uncover what patterns we might not know of and which can have a huge impact on the decisions that we make, certainly if we look at idea generation.

Before we can start with this uncover, we need to do some preprocessing and selection first. What data are we going to use for our project, and where do we believe might we find valuable information? The problem with data mining is the following: the data should be rich and large enough so that we can uncover these patterns while at the same time it should be focused on the problem we are trying to target. Data mining efforts often rely upon data warehouses or data lakes which contain huge datasets. However, there is still work to be done before we can start applying our techniques. We should make sure that we have an idea of what outliers can be found in the data, what missing data we have, and, if we have unstructured data, how we are going to prepare it for processing. These are fundamental tasks that take up a lot of time before we can move to the next steps. Anyone that has ever worked on such a project knows that these steps are not the most exciting ones and can even prove to be frustrating, but only if we do it right here can we make sure that the next steps are successful.

Once the dataset is ready for analysis, we have a set of techniques which we can use to uncover patterns and information from our data. The first one is called “anomaly detection.” Even though preprocessing often already focuses on outliers and deviations in the data, these might hold valuable information. Why do certain customers buy such huge amounts of our products? Why are there certain months we don’t sell at all? Why are only certain aspects of our platform popular? These are questions that we can only start asking when we have identified the outliers in the data and might lead to discoveries which can change the entire direction of the company. Also the absence of data might in itself provide us with information. Why don’t we see the actions logged from our customers on the order page? Why don’t we have information on customers from Western Europe? Why do we see certain errors in the data? Again, all questions we can only start asking when we discover them in the data and which might heavily impact the organization. Some of these can be attributed to human errors, data flows that don’t function as they should, or simply because the data isn’t there. But they might also help us to uncover key information.
Next, there is association rule learning, also known as dependency modeling. Here we try to uncover relationships between variables and make decisions based on these relationships. Web shops and supermarkets might make use of these techniques to discover what products are often ordered together. This information can be used for marketing campaigns but also to determine what products should be stored together. This can optimize the order flow of a web shop as it becomes easier for an employee to collect all the ordered products. It can also help us with the development of new products and services based on the relationships we see to improve the customer experience.

One unsupervised learning technique that is popular here is called “clustering.” You provide the data to the algorithms and try to uncover clusters, groups, and structures in the data that are in some way similar to one another. This can help us uncover what groups of customers we generally service and at the same time which groups don’t like us. What main groups of questions in customer center feedback do we see? Is there a way we can reduce these questions based on the groups we have uncovered? Clustering helps us to understand what structures are out there, even though it might not be “logical” for us at first.

Another technique is called “classification” which can help to further define your variables. Many supervised machine learning techniques focus on the task of classification, and based on these classifiers we can determine appropriate actions. This can help us to develop further strategies based on the results of the previous clustering tasks or with customer segments we are already comfortable working with. Regression is also a technique which we quite commonly find in supervised learning techniques and allows us to model data in such a way that we reduce the error and have the best possible outcome when defining the relationship between variables and entire datasets. These relationships can help us understand what the effects might be when we take certain actions and how we can optimize the outcome. Also negative effects can become clear so that we better understand the risk and downside of the changes that we are trying to introduce.

Finally, there is summarization where we generate descriptions of our datasets. Important here is that we should make use of a combination of techniques, including visualizations. A famous example is Anscombe’s quartet where four different datasets have nearly identical descriptive statistics, while when you visualize them, you realize they are completely different (as depicted in Figure 8-2).
The lesson here is that we should never blindly trust on summary statistics but we should rather combine it with other analysis and the knowledge that we have to make the proper decisions. Together with all this information we can go to the next step in a confident manner where we can trust on the data to make proper proposals. Only when we properly combine all of the techniques known to us can we come up with an analysis which carries true value to our organization. Another important aspect here is the use of peer review as more eyes often have different insights and ideas on how we might approach the data we have at hand.

Figure 8-2. Anscombe’s quartet
Unsupervised Learning

Another set of techniques that deserve some highlighting here fall under the term “unsupervised learning” where we focus on the discovery of patterns in the data without having prior knowledge of these patterns. We already shortly focused on clustering as it is part of data mining but unsupervised learning offers a wide range of specific algorithms and tools that you can use to really uncover all information that remain hidden in your data.

The first group of clustering techniques can be divided in several methods such as the following:

- **Hierarchical clustering**: The goal of this method is to create a hierarchy of clusters where we have the “agglomerative” or bottom-up approach where each observation is used to start a cluster and pairs of clusters are merged as we make use of the hierarchy, while the “divisive” or top-down approach starts from one cluster with all observations and moves down and splits into more clusters as we move down in the hierarchy. The results help us define the relationships between the variables in the dataset and what groups we are dealing with. We can also determine what the relations between these groups might be.

- **K-means clustering**: Here we see each column of the data as a quantitative characteristic or a clustering variable. This is a strategy that is often used when we want to determine the groups of customers with similar needs (market segmentation research). Here we need to determine the number of clusters (k), and this is also the reason why k-means analysis is performed multiple times. Next, you can combine this with hierarchical clustering to determine where you are going to assign the right objects to the right clusters or you assign the objects at random. We follow up with determining the cluster means we see and reassigning objects to the cluster mean that is closest to themselves. During our analysis we will often find extra clusters when we continue to improve our model and discover new groups that we were unaware of before.

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5 https://www.displayr.com/what-is-k-means-cluster-analysis/
• **Gaussian mixture models (as you can see in Figure 8-3):** Mixture models try to solve in part a problem that we have with the previous techniques. K-means, for example, assigns each data point to one cluster and only one cluster (also known as hard clustering), while in reality there is often only a probability that a certain data point is associated with a certain cluster while at the same time there might also be a connection with one or more clusters (soft clustering).6

![Figure 8-3. Gaussian mixture models (Source: https://towardsdatascience.com/gaussian-mixture-models-explained-6986aaf5a95, Oscar Contreras Carrasco)](image)

• **DBSCAN (as depicted in Figure 8-4):** DBSCAN, or density-based spatial clustering of applications with noise, is a technique developed by Martin Ester and some co-authors where they wanted to be able to deal with large spatial databases which might contain spatial clusters with different density, size, and shape while at the same time there might be noise and outliers.7 Some advantages offered by the technique are that it requires minimum domain knowledge, it can discover clusters of

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6 https://towardsdatascience.com/gaussian-mixture-models-explained-6986aaf5a95
7https://www.aaai.org/Papers/KDD/1996/KDD96-037.pdf
arbitrary shape, and it works efficiently for large databases. How does the technique work? Well basically it tries to separate several regions with a high density of data points from other regions with a high density as they are separated by a region of low density.

As you can see in Figure 8-3, there are border points and core points which define the clusters we are dealing with. Without going in all the details on the mathematical front, the algorithm starts with a random point and retrieves its neighborhood information based on the $\epsilon$ parameter (which defines the radius around the chosen point). Only if this neighborhood contains a minimum number of other points is it defined as a dense region and cluster information is collected. Based on the information collected from the other points, the algorithm determines what the core point of the cluster is. Only when a cluster is completely defined will the algorithm start with researching new points and looking for new clusters in the data. Some drawbacks of the technique are based on the parameters used to determine a cluster (the radius and the minimum number of points) which can greatly differ based on the cluster size. You cannot adapt the size based on the clusters you expect to find which can work as a strain during your research. A second drawback might be that if you really don’t have any domain expertise, it can be very difficult to determine these parameters. If you choose them at random, you will certainly miss information and you might have to repeat the process time and again just to make sure that you have all the information covered. Still, it can be a good technique to use to discover more information in your database and define clusters on the data you have available.

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Figure 8-4. DBSCAN (Source: https://towardsdatascience.com/dbscan-algorithm-complete-guide-and-application-with-python-scikit-learn-d690cb3ae4c5d, Saptashwa Bhattacharyya)

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https://towardsdatascience.com/dbscan-algorithm-complete-guide-and-application-with-python-scikit-learn-d690cb3ae4c5d
• **OPTICS algorithm**: OPTICS, or ordering points to identify cluster structure, uses a different approach when compared to DBSCAN. On top of what you already know from DBSCAN, it adds the concepts of core distance and reachability distance. The first is the minimum value of radius required to classify a given point as a core point. If it is not a core point, then its core distance is undefined. The second is defined with respect to another data point \( q \). The reachability distance between a point \( p \) and \( q \) is the maximum of the core distance of \( p \) and the Euclidean distance between \( p \) and \( q \). However, the reachability distance is not defined if \( q \) is not a core point. This technique visualizes the reachability distance to cluster the data together. Some other differences with the DBSCAN technique are that OPTICS requires more memory as it maintains a priority queue to determine the next point which is closest to the point currently being processed in terms of the reachability distance. On top of that, it requires more computational power as well. The OPTICS algorithm also requires fewer parameters, but the main difference might be that this algorithm doesn’t actually cluster the data but only provides you a visualization of the reachability distances.

The second major method is called principal component analysis (PCA). It is a technique which is often used when we are dealing with a huge amount of variables. When we have such a large set, it is often difficult to determine on which features we should focus. PCA can help to determine which dimensions we should actually be focusing on. The name actually says it all: we want to extract the principal components of the data. PCA allows us to reduce the dimensions in the data and plot the data with lesser dimensions than the original data.

With these reduced dimensions we can determine what the key components are which we should be focusing on in our dataset. This can help us to determine which the core dimensions are and how we should adapt to maximize the outcome that we are looking for. Unsupervised machine learning is gaining more and more traction in the business world. It can really help organizations to make the right decisions whether it is in the innovation process or any other data-related project.

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9 [https://towardsdatascience.com/clustering-using-optics-cac1d10ed7a7](https://towardsdatascience.com/clustering-using-optics-cac1d10ed7a7)
10 [https://www.geeksforgeeks.org/ml-optics-clustering-explanation/](https://www.geeksforgeeks.org/ml-optics-clustering-explanation/)
11 [https://medium.com/@raghavan990/principal-component-analysis-pca-explained-and-implemented-eeab7cb73b72](https://medium.com/@raghavan990/principal-component-analysis-pca-explained-and-implemented-eeab7cb73b72)
Autoencoders

Autoencoders (AEs) are a type of neural networks that try to copy their inputs to their outputs.\(^1\)\(^2\) They work by compressing the input into a latent-space representation and then reconstructing the output from this representation as you can see in Figure 8-5. To do this, the network makes use of an encoder which compresses the input and a decoder that tries to reconstruct the input.

![Figure 8-5. Architecture of an autoencoder](Figure 8-5)

So far the usefulness of the network doesn’t seem to be very great. If we just copy the input to the output, however interesting the achievement, it doesn’t seem to bring us any value. The reason why autoencoders might be interesting for us is that we can use it for both data denoising and dimensionality reduction. How? We might actually force the network to make a copy of the input based on only the most useful features. Similar to PCA, we can deduce the most important features here based on the model. However, research has shown that the projections made by AEs can be more interesting than those made by PCA.

So once again you can start creating models which allow you to quickly analyze your data. You can learn which features are the most important and even gain new insights in the dataset you provide. There used to be a lot of noise and popularity surrounding autoencoders. They were used in the past for object detection and image recognition features, but other types of networks were quickly able to surpass them and people even regard autoencoders as “failed.” However, this doesn’t mean that there is still use for these networks when applied in the right situation. Sparse and denoising autoencoders have capabilities which are useful in our situation here. Another concept you might hear from time to time is called the “variational autoencoder.”\(^1\)\(^3\)

\(^1\)https://towardsdatascience.com/deep-inside-autoencoders-7e41f319999f
\(^2\)http://paulrubenstein.co.uk/variational-autoencoders-are-not-autoencoders/
Data Scraping

Another popular way of collecting data is via scraping or by making use of APIs. Several providers out there offer APIs which you can use to collect data for your analysis. This way you can streamline your data pipelines and use the data for your pre-analysis. In the same line you can use web scraping to collect data from websites where you can even focus specifically on certain product or service information.

However, sometimes there are questions relating to the legal aspect of web scraping.14 If you are scraping for personal reasons or in light of academic research, there is no problem when you are making use of public data. Commercial applications of web scraping have to be more careful. By making use of automated data collection, you can actually put huge stress on websites and applications of other organizations. In some cases (i.e., supermarkets) these organizations have even put measures in place to prevent automated web scraping by others. This is to prevent competitors from using this information in their advantage. However, as long as you don’t pressure another organization their website and make use of public information, you should be in safe waters. From the second you start touching upon personal or private information, you should become more careful. The scandal surrounding Cambridge Analytica which made use of Facebook data to manipulate elections is still fresh in the mind while at the same time data protection regulations such as GDPR are more and more on the rise to protect people from possible abuse.

Many tools are available on the market to help you with your data collection measures so that you can perform analysis directly on your data. Whether it is data related to stock markets, product information, railway times, or anything else, you can greatly enhance your analysis efforts this way. Before even starting to jump into the idea generation part of your analysis, you can already collect significant information on how competitors are working and on how the current market looks like. While we already might have an idea based on the data from our own organization, we might have been locked out from certain aspects of the market without realizing it. With web and data scraping we can quickly collect data and make use of it.

Of course, I already mentioned that there are also APIs we can integrate in our applications. Whether you want to use scraping or APIs, the main idea is that we can make use of data external to our organization to enrich our analysis.

14https://www.tijd.be/tech-media/media-marketing/data-scapen-van-het-internet-mag-dat-wel/9999434.html
Step 3: Idea Generation

If you have been able to go through the data analysis phase, we can move to the most challenging one for most organizations: the actual idea generation. As we have already highlighted since the very beginning of this book, this phase often challenges people. Sometimes we are afraid to express our ideas, or we simply run into a block where we don’t seem to be able to come up with new and exciting innovations. Depending on the business we are in, we shouldn’t be in it alone. With AI algorithms we can help the process along so that we can come up with the next solution. Where artificial intelligence can come up with completely insane concepts, it can also free up people to share their own crazy ideas. I am going to introduce some key concepts here before we go into more detail and examples which you could use in practice as well.

Generative Adversarial Networks

Generative adversarial networks, or “GANs,” are algorithmic architectures consisting of two neural networks. The technique was first proposed by Ian Goodfellow and his colleagues in 2014. These neural networks are pitted against each other (the adversarial component) in a game where, based on a training set, new data is generated which has the same statistics as the training set. This means that (i.e., based on photographs in a training dataset) new photos can be generated which look authentic.

How does it work? Basically the two neural networks in the structure take up two different roles: the discriminator and the generator. These are two adversaries in a constant game during the training process. The generator tries to generate data where the discriminator determines the data it receives is real data (data from the training dataset) or fake data (data generated by the generator). When the generator is able to fool the discriminator, we know it can generate data which is not real but will seem real to the human eye. An important point to make here is that both the generator and the discriminator need to be sufficiently good. If the generator isn’t good, it will never be able to fool the discriminator, and if the discriminator isn’t acceptable, the output data from the generator will not make sense to human observers (i.e., photos that don’t make sense).

Over the next couple of pages we want to introduce some impressive examples where GANs are used and which might help the innovation process within your organization significantly. Everything depends on the industry you are in and the use case you are working on. Whatever the personal case you

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15 https://pathmind.com/wiki/generative-adversarial-network-gan
16 https://arxiv.org/abs/1406.2661
17 https://towardsdatascience.com/generative-adversarial-networks-explained-34472718707a
are dealing with, I am quite sure that the following examples might inspire you to help your company in its innovation efforts as well. A first example I would like to introduce here comes directly from the paper titled “Unsupervised Representation Learning with Deep Convolutional Generative Adversarial Networks” by Alec Radford et al. from 2015.¹⁸ In this paper the researchers introduced DCGAN where they demonstrated how to train stable GANs at scale and the example they used showed generated new examples of bedrooms.

The example of generated bedrooms can easily be transferred to any type of architectural environment. As you can see in the preceding examples, these generated rooms look very realistic. Of course, you cannot always promise to receive very realistic examples, but the exercise shows that they can allow you to receive a wide range of new examples quickly. The innovation? Based on these examples you might create new ideas or receive the new ideas directly from the GAN.

A second example is related to the generation of human faces. Based on a set of existing pictures of real humans, pictures can be generated which seem realistic, while at the same time these people don’t really exist! Imagine making use of photos for your marketing and photo-efforts without having to worry about the infringement of people their privacy? Of course, your original database should be rich enough to make sure that people don’t recognize the original people in the new pictures.

You still want to work with models? No worries, GANs might actually be able to help you here as well. Imagine you have a range of photos from a session with a model and all of a sudden you see a picture of another model in a pose you were looking for. You want the first model but the pose of the second model? No problem! Liqian Ma et al. showed an example in their paper “Pose Guided Person Image Generation” back in 2017 where they did exactly that! This same method can be used to generate any number of products you want to focus on. This can prove very useful in the thought process. What kind of smartphones and devices can be conceived if we allow a GAN to process and produce numerous examples? There was a paper in 2018 titled “Large Scale GAN Training for High Fidelity Natural Image Synthesis” which demonstrated the way new and realistic photographs could be generated.¹⁹ However, there is a wide range of image-to-image translation GANs which you can make use of and which have proven to be interesting in the past. Images can be changed from day to nighttime, or sketches can be translated to real-life pictures! It is a common problem that people have an idea and draw a sketch but others don’t grasp the entire story. Well, now you can actually have a GAN translate

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¹⁸[https://arxiv.org/abs/1511.06434](https://arxiv.org/abs/1511.06434)
¹⁹[https://arxiv.org/abs/1809.11096](https://arxiv.org/abs/1809.11096)
your sketch in a more lifelike image, which in turn could help you communicate your ideas to colleagues.

And for those of you that think (or believe) that the options are limited here, human faces can also be generated from basic sketches or vice versa as proven in “Towards Realistic Face Photo-Sketch Synthesis via Composition-Aided GANs” by Jun Yu et al.

We have now already introduced several ways to introduce new photographs, but you can also use the same techniques to update existing photos with specific features. In “Invertible Conditional GANs for Image Editing,” Guim Perarnau et al. showed in 2016. It can easily be used to change any kind of picture just the way you want. In our case the focus lies on innovation, but you can easily see how this could be used for malicious intents. These pictures are nowadays known as “deep fakes” where people appear in photographs doing things they never did or, even more scary, in videos saying and doing things they never did!

Of course, people have also started to look in other fields, and some fun examples are the generation of anime and Pokémon by making use of GANs. Even though I can imagine that newly generated Pokémon might not have real value for you or your organization, I think the idea here is clear. Whether you want to generate new logos, marketing images, or anything else, GANs can aid you in the process to offer you new and perhaps even crazy ideas.

Some other great implementations of GANs cover photo blending, where two photos are blended to one photo containing features of both, super resolution of pictures where you can give original pictures a much higher pixel resolution, photo inpainting so that holes in pictures can be filled and clothing translation from models wearing clothes to how the clothes would look like in a catalog.

So far we have seen some examples where GANs are used on images but they can be used on much more. An example is the text-to-image translation introduced in the paper titled “StackGAN: Text to Photo-realistic Image Synthesis with Stacked Generative Adversarial Networks” by Han Zhang et al. in their 2016 paper. Here they prove how textual descriptions can actually be used to generate realistic photographs!

As you can see, this is not only a very exciting implementation but when properly implemented, it could also help with the idea generation process at your organization. With the right description and while making use of a properly trained GAN, we could help the innovation process along and change description to a photograph which could properly be understood by the public you are addressing.

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20[https://arxiv.org/abs/1612.03242](https://arxiv.org/abs/1612.03242)
All of the examples given show how GANs and deep learning might positively impact the way you are generating ideas in the innovation process. Idea generation based on the information you have of existing systems, products, and services is no longer limited to human beings but can now be aided by making use of AI. I am not going to promise you that the examples generated by these networks will solve all your problems and are going to come up with the next big thing, but they will have an impact on the way you are doing things and might just push you in the right direction.

**Music Generation**

Can’t get enough of AI for the generation of something new? Well, there are other interesting implementations you might check out which might just help you jump up the right ideas. Not all of the solutions presented here are based on the GAN structure we introduced earlier (or other common structures are LSTM, or long short-term memory, and RNN, or recurrent neural net). These have been used to generate music at the push of a button. Exciting isn’t it? And you might think that it will sound like nothing or complete madness but the opposite is true. Even though voice is still difficult to generate, it has been proven that beautiful music can be created by making use of these implementations. Examples which can help you are Jukebox or MuseNet of OpenAI and AIVA.

However, this also steers us in the direction of music during the sessions of our innovation process. It has been proven in the past that classical music stimulates the brain and the thinking process. On top of that, a 2017 study has shown that upbeat classical music helped people better on tasks which required divergent thinking. The reason why is still unclear, but it could be due to lowered anxiety, improved mood, and a better ability to concentrate on the problem at hand. Whatever the case, if you really want to stimulate thinking and creativity in the innovation process at your organization, you should certainly consider implementing music in the process. Where the music generated by the AI can certainly give a “wow” factor and stimulate thinking out of the box, the classical music itself might just give you that extra edge when really thinking about the problem.

**Other Techniques Which Might Improve Creativity**

You might already have a notion of how your environment might influence the innovation process, and you are right. There are several other common techniques which you can use to help the innovation process as a whole to

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21[https://time.com/5626958/music-creative-thinking/#:~:text=A%202017%20study%20in%20the,a%20core%20component%20of%20creativity]
move forward. One such example is the use of color where you change up the environment the stakeholders meet in. With new colors and a comfortable environment, you can stimulate thinking to move in the right direction. Changes in the environment in a positive direction help the mind to relax and focus. In a similar sense you might want to make use of flowers. It might seem strange or even unprofessional, but flowers have relaxing effect and the smell often has a soothing influence on people. This can help you to get in a better mood and go through the idea generation process with less stress.

A second aspect is the food you are consuming. Healthy food seems to have a positive impact on how you are able to think and certainly if you are required to help in innovation matters. By consuming more fruit and vegetables, individuals are stimulated and become more creative. Some examples of food which might actually help you are eggs (they contain choline which in turn can help increase cognitive ability), bananas (which contain potassium), salmon (high omega fatty acids), green tea, wine (resveratrol), dark chocolate (high concentrations of flavanols), and nuts. These are no magical solutions of course, but they do seem to have a positive impact on brain activity.

A third possibility is walking. Yes, it might sound very strange, but a study at Stanford has shown that walking actually improves the creativity and thinking process. Both Steve Jobs and Albert Einstein were known for making use of walking to improve their thinking, certainly when they were faced with difficult issues. According to studies, even people walking inside in a boring room on a treadmill were able to produce more creative responses (about double!). This clearly means that we cannot underestimate the power and influence of physical activity in the creativity process. I am not going to ask you to run through the office every day, but if you consider that even a good walk might jump-start some original ideas, I think it is certainly worth a try.

The final suggestion is not going to surprise any of you: performing a new activity. By trying out something new, you are forced to think outside of the box and hence are triggered to come up with new ways of doing things. These new ideas might help you in the innovation process as well. Thinking out of the box is therefore something that you can learn (at least in part).
Influencing the Senses

As you might have already noticed, several of the suggestions here focus on influencing your senses. A classic example is that of the old classroom. Getting in in the morning was already difficult, but the smell after a couple of hours was killing, let alone the air quality. It's not surprising that studies have shown that pupils are not able to concentrate longer than 20 minutes. Well, if you want to stimulate the creativity process, you need to stimulate the cognitive function. Classical music, physical activity, and healthy food are all clear examples of how we can positively influence people to make the right decisions. So another aspect which we might use to influence decision making is by providing an environment with fresh air and even with the soothing smell of fresh flowers. These flower plants in general can provide a soothing environment which might calm people and give them a sense of belonging. A relaxed environment can become stimulating for groups to start really working together and generating ideas.

The Modern Age

However, recent events have shown that we need to be able to adapt ourselves to changing situations. Covid-19 has forced many people to quarantine and start working from home, and this for a longer period of time. This doesn't mean that we can simply stop with the innovation cycle and are forced to take a couple of steps back. Many organizations have proven that they were able to deal with this sudden change and adapted in only a couple of weeks, where change normally can take up to years to take place. It has even become a running joke that the innovation factor for companies hasn't been the CIO, CTO, regulation, or anything else, but Covid-19.

When we think on how people are able to meet now in these times, while making use of masks, distance measures, and so on, we might not be able to achieve the environment we are looking for to stimulate fresh and new ideas. Well, if working from home has become the new standard for the time being, we should also be able to adapt the process to support innovation as well. It can have one major advantage that cannot be offered by the workplace. In general, people feel nowhere as relaxed as when they are home in their trusted environment. People tend to decorate their houses as they want to, which relaxes them just so. Also pets tend to have a positive impact on people to work in general, and in this case it might just help as well to stimulate people to perform better.

Now how do we communicate our ideas? While we can actually make use of Teams, Skype, or, for those of you that don't care about privacy, Zoom, this can sometimes be stressful. People tend to start speaking at the same time, Internet connection can drop, and sometimes there are annoying background
noises. It also tends to be an environment where a couple of people could highjack the meeting while other, more introvert, colleagues willingly drop to the background. Even though this can also happen during a physical meeting, in a physical environment you are able to stimulate people to participate and speak up to express their ideas.

The digital age did bring us with an entire set of more possibilities and we should play into these new trends and ways of doing things. What is the first thing you see when you see people on the street or even when they are bored during a meeting? They are on their phones. It has become so common that we almost don’t notice it any more. Even though there are a lot of people that see it as a nuisance, we could actually use it in our advantage. Mobile apps and native applications can be used to actually help us to collect ideas and communicate with everyone in a constructive manner. As with brainstorming sessions, we can actually use it to collect information at any moment. Combine this with alerts to the other involved participants so we can work together and build on top of each other’s ideas.

We can use those same apps to make the entire process even more interactive. Over the course of a couple of days, we can actually plan several moments where participants are stimulated to share and think about the problem statement. The app can have small pieces of text, music, or a chat environment where we allow the participants to share and discuss specific ideas. We can even do this by installing small games.

Gamification is a general trend that is often used in the field of corporate training. At the same time we can actually use it to stimulate people to think about the problem. We can confront people with the problem statement at hand in an interactive manner and have them figure out a way around the problem. Digital solutions don’t always have to be a nuisance but can actually help us to become creative by actually jumping outside of the box. By making use of such an app, we can actually make the idea generation a longer process, instead of forced brainstorming sessions which are not productive at all and can even work counterproductive, we can allow people to spend more time on the problem.

Selecting Ideas

We have now spent ample time on the generation of ideas to solve our problem. After these sessions, we need to actually start the second part: the selection of new ideas. There will be ideas that are simply too crazy, things we tried already in the past, or even ideas that are not a solution but might even introduce more problems. Important here is that we actually perform the selection process with respect for all the involved participants. I have seen it happen too often that ideas are dismissed immediately and even laughed out of the room. This is often followed by the question “Can’t you come up with
anything else?” or “Why are you not giving more ideas?” Well, it is not because you are the loudest person in the room, that you have presented the best way to approach the problem.

Even when we are collecting ideas via an app or an online dashboard, we need to consider the selection process. This will not be the only time you want to collect solutions for problems within your organization, and if you don’t want to harm the innovation process in the future, you always need to have an open mind toward all the ideas we have collected. Again, you might be one of those people that think that others will forget the remarks that were made toward them or that you need to be moving fast and don’t have to consider people their feelings when considering ideas. Well, if this is the case, please stop.

The selection process must be performed with respect toward all participants. When an idea is removed from the list of possible solutions, we should do so by giving constructive reasons why we want to remove the idea. Is it too expensive? Is the technology not ready yet? Is it an idea that failed in the past? What were the outcomes of these ideas at other organizations?

As you can see, some of these questions can only be answered by collecting information and data once again. We can evaluate each of the ideas based on what has happened in the past. Even though we like to think that all of our ideas are new and have never been done before, the reality teaches us that most of the ideas people come up with have already been tried out in one form or another. Even in case the idea is completely out of the box, we can in fact check what the impact could be on our organization. This doesn’t mean that you need to deeply evaluate each and every idea but collecting more data and information based can help us determine on a high level which ideas do have potential, even when they look completely insane at first glance. This also helps us to dismiss ideas based on clear feedback.

Selection Criteria

We already spend some time on the selection of ideas when we were going through the different frameworks and tools that are available to help you develop an innovation strategy for the company. Whether you make use of a classic go/no-go design or a selection matrix doesn’t matter; important here is that this is done in a way that is generally accepted by all the involved stakeholders and isn’t done seemingly at random. The more you are able to streamline this process, the better you will be able to select those ideas that show promise and which deserve a deeper analysis.
Design Thinking

A final concept that deserves to be mentioned here is called “design thinking.” It is a methodology which makes use of a couple of aspects that are key to solve complex problems. The first one is the importance of empathy. You should leave all of your judgment and ideas that you have of all others involved in the process behind as well as your perception of the problem. By making use of empathy, you can better understand all the other involved stakeholders, how they perceive a problem, and more importantly why. This we can achieve by performing interviews and really going in depth why people have a certain perception of the problem at hand. This immediately leads to the second aspect which is the proper definition of the problem. Only when it is clear for all involved stakeholders that we are focusing on the same problem can we hope to be successful in the next steps of the process. The next step is called “ideas,” where the generation of ideas (and the focus of this step as well) is important. Only by generating as much ideas as we possibly can might we be able to create great solutions. The next steps of design thinking are equal to the next steps that I defined here: prototyping (testing) and proving that something also really works as a solution.

Step 4: Testing

Once we have selected an idea for possible improvement for the organization, we don’t immediately jump to the implementation. Once we have gone through the first decision step, we need to make sure that we made the right choice. This we can do several ways, depending on the solutions we have picked out of the previous steps. When we are thinking about process improvements, a pilot project can quickly prove whether the changes in the process actually also deliver the improvements you are looking for.

This is a lot more difficult if the innovation concerns you making use of a new digital platform or machine learning solutions. How do you prove the value you are going to bring to the organization? Well, in part you can do this by providing the analysis you have done earlier and offer insight from similar project implementations at other companies. Of course, this offers no guarantee of what success you might achieve, but it can offer you some grounds on which you can build your business case for the project. It shouldn’t surprise you that organizations are often not very willing to try out something completely new without having at least some proof of what the value of the investment might be. Sometimes decision makers like to go for a first proof to see what they could actually get out of the solution without developing the entire platform immediately. This is sometimes referred to as the minimum viable product. While we might be developing the minimum viable product, or

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25 https://designthinkingworkshop.nl/design-thinking-methode/
MVP, we have to take several advantages and disadvantages into account. The first advantage of an MVP is clear: it is often a lot cheaper than immediately developing the entire solution. If we discover that the product is nothing for us, we can reduce the loss to the absolute minimum. At the same time we are able to learn the maximum of the solution so that in case we want to develop something further, we can use these lessons learned to streamline the process.

If our innovation focuses on an external product or service, the MVP can allow us to feel the market, and in case the market responds positively to it, we can actually see how we can develop the solution in the future. An important example we can show here is the popular video game called “Fortnite” which has more than 250 million registered players and more than $2.5 billion revenue since 2018. Epic games came up with the idea for the game back in 2011 and already teased a first view of the game only 3 weeks later! In 2017 the game was released in beta and tested by 50,000 players to see how the world responded to the game. What only a few know was that the game format looked a bit different than and some of the people responsible for the game even tried to have it cancelled! It was only based on the feedback of some early fans and changing the approach (taking on some ideas of another game called PUBG), the game still became a success. Even though the company already spends a significant amount of time on the development of the product, it does show the importance of showing an MVP to your public, use the feedback of your fans and the popularity of other products to develop something great.

Another major advantage of the MVP approach is that you use the minimum amount of work to solve the end-user problem. This again minimizes the cost and forces everyone to focus on the core of the problem rather than all the extra features which might improve the customer experience even though it doesn’t have a positive impact on the solution itself. For a startup environment this certainly allows for a minimum cost to solve the customer problems as it is still unclear at this first stage on how the customer will react to the new product.

However, there are also disadvantages we should take into account when we start thinking about the MVP. Certainly when we are trying to get the hopes up of our customers, we could in fact come back with negative feedback as we weren’t able to deliver on all the promises we made. To cover the demands of the customer, we might in fact require several product releases and revisions based on customer feedback which might actually take away the entire idea of the MVP. However, choosing the minimum requirements of the product can be hard thing to do. Ever been in a room where people tried to look at the minimum features they would like to see? Everyone wants something else,

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26https://www.businessinsider.com/fortnite-was-nearly-cancelled-in-development-process-2019-6?r=US&IR=T
and they always have a very good reason as to why they want it. These discussions can significantly slow down the process, and if there is no one able to make the hard choices, we no longer end up with a minimum viable product but go through the standard development process.\(^{27}\) It is better to create a product that is too simple as you can add features based on customer demand. Creating a product that is way too complex and contains features that users are never going to use is something completely different. In the same line, decision makers are often distracted by the bells and whistles that make it extra attractive to specific customers. Again, losing focus on what really matters can damage the product in the long run if you are going for an “MVP” approach. Finally, a real danger that lies waiting under the surface is that sometimes the minimum viable product is seen as enough. When it starts selling and customers buy the product, the underlying company sometimes loses the incentive to further optimize and change the product. Even though this isn’t a problem in the short run, this can become a significant problem in the long run. Customer expectations aren’t met and eventually go looking for different solutions which do offer the extra features they are eventually looking for.

**VR/AR**

Even though the minimum viable product is a beautiful option we might want to make use of, we do have some other options available that might help us to get an idea of what the innovation might look like. A lot of people still like to say that virtual and augmented reality is still in “its early stages” and therefore choose to ignore it as a viable option. Even though this statement might be true, the advances made over the last couple of years have been significant. With the tools that are currently available, we are able to perceive a virtual world in magnificent detail. On top of that, we are able to “sense” the virtual world by making use of haptic feedback. You can literally feel what is happening if you want to by making use of gloves and body suits. Body tracking allows you to move and even move your fingers in a completely different dimension. And for those of you that still aren’t convinced: now you are already capable of smelling VR. You can also get a sense of hot/cold and even when it is raining.

All of those features might not be useful for you and your product development, but it does show that there have been significant changes and that VR might actually be an option this time. Some major companies (i.e., Facebook with the Oculus glasses) have invested in the development of head displays and as such have given great advancement to the world. By making use of Unity or Unreal Engine, developers are capable of creating quickly virtual situations that might be tested by users. We could actually start training people in the

\(^{27}\)https://threewill.com/minimum-viable-product-pros-and-cons/
virtual and take corrective action even there based on their feedback. No longer would we have the need to test everything immediately out in the real world and even though it still has a cost, this cost can be significantly less than what we can expect when testing out innovations straight away in real life.

Therefore, I would really like to highlight the use of VR here as still too few organizations dare to look at it as a viable option for their use cases, while the time has come to test out the possibilities of what VR has to offer and actively deploy it in the innovation process. Certainly if what we are proposing would come at a significant cost, VR can act as the first line of defense. It could even be used to have some first customer feedback on what we want to do. If we notice that the overall response is negative, we know as a company not to go down this road. I can imagine that there are numerous organizations that wish they were able to do so in the past. Well, you are now capable of doing so, so don’t make the mistake that so many other people made.

The high cost of development? Well, you will have to pay for a developer of course, but the actual cost of the software itself can be very low. You can make use of some of the most important development environments completely for free (such as Unity and Unreal Engine). Even though they are also known as game engines, we can easily use them to develop any type of virtual experience. The cost of the hardware itself has also become much more limited, where you can buy a great headset between 500 and a thousand USD. Keeping in mind the costs related to actually creating everything end to end, this cost is very limited compared to the value it could actually create. Virtual experiences are becoming part of the customer experience as well. An example here is a kitchen builder that actually makes use of a VR headset to allow prospects to see how their kitchen could look like if all of their choices are implemented. Here we are able to move away from classic designs and actually allow customers to get a real idea of what their kitchen could be. Architects could give immediate insight in how their designs would look like once created, operators could be trained along a new process line, and new machinery could be tested. In virtual reality you are able to create exactly the same environment as we are used to in the real world (think gravity, weight, and more) so that the effects of our design choices could become immediately clear in the virtual world.

3D Modeling

Strongly related to the concept of VR and AR is the use of 3D modeling. It allows people to step somewhere in between these advanced concepts and still show stakeholders the extra value they are looking for. There are several companies all over the world that actually specialize in 3D prototyping and as such give a better idea of what the future might bring. Related to the concept of 3D modeling is the development of hologram displays. Even though these
developments are still very early days when we are thinking about customer applications, this doesn’t mean we should dismiss them altogether.

With these displays, we can actually see the designs become part of the real world around us without having to wear a headset. Again, the technology is still being developed, but the displays we are able to buy right now already give a great feel of what will be possible in the coming years. It is all about the visual representation of what we have been developing. The better we are able to visually represent what we are trying to create, the easier it will be for the involved stakeholders to understand what we are trying to do and how we wish to create a new innovation. A great example here is the Looking Glass Factory which specializes in holographic displays of 3D models.

Prototyping: 3D Printing

With the rise of 3D printing it has become very cheap to create a first model of anything. Many different companies have specialized in printing for you so that you can actually make a design yourself and have created it for you. No need to actually buy a 3D printer yourself and as such reap all the benefits. If you are still interested in buying a 3D printer, you will also see that there is a wide variety of printers you can choose from depending on the size of the products you want to print and the material you would like to use.

Still, this can once again allow you to create a very quick prototype and analyze if there are certain flaws in your design. Based on first feedback and test, you can adapt your designs appropriately before presenting it at any type of decision makers.

IoT

The world of IoT, or “the Internet of Things,” has allowed us as well to develop new and interesting use cases which can be created at low cost. With small board computers such as Raspberry Pi and Arduino, we can build small tools which in turn can be produced in high volumes once we have proven the use case in a testing environment. Certainly projects related to the automation of the physical environment or projects that rely upon data collected by an array of sensors, I would certainly advise the use of IoT devices.

Certainly with the idea of smart cities, farms, and houses, we can make use of these tools to quickly implement new solutions. We can quickly adjust anything from lighting and temperature to watering of plants and sound based on the sensors we have in place. This allows us to automate a lot of the work that traditionally is being done manually. It brings with it not only some very interesting cost reduction measures but also the promise of even better control and, because of this, even better results.
Evaluating Test Results

Based on the examples I have given here, it should be clear to any professional that you have many options when it comes to creating a first test case of an innovative idea. No longer are you bound to taking major risks as you can trust on a range of techniques to create a first proof of concept which in turn can immediately make clear to all stakeholders why the idea you are proposing will bring real value to the firm. Some of these techniques pose an innovation in themselves as well as they force people to think out of the box and trust new solutions to bring the value they are looking for. Even though they are often already tried and proven, the reality teaches us that it often takes a lot of effort for organizations to take this step. Nevertheless, I hope I was able to show you the possible value of making use of these technologies and as such the possibilities of taking the next step.

Depending on the results of the test we implemented, we will have to determine whether we will go and take the next step and actually move to production. How do we make this decisions? A classic answer is the business case, where we look into the costs associated to going to production and the value we expect to create with the new tool or process. It isn’t always easy to do so, and often we will have to rely on assumptions to determine the final outcome. It is important that we make use of a business case so that we get an idea of what the future holds while at the same time we shouldn’t pin ourselves to the outcome. As we are making use of assumptions, we aren’t certain if we are actually going to be able to achieve the outcome we desire. This is why we should also implement the “worst possible outcome” case and the “best possible outcome.” By adding these bounds, we can get a better idea of what the outcome might be.

Of course, the reason you are looking into new solutions stretches beyond the business case alone, and we should carefully take in the feedback we receive from stakeholders and potential customers alike. The business case might make sense, but if the customer isn’t happy with the final product, you can be sure as hell that your business case will fail as well. Customer experience, whether these are internal or external customers, has become more important than ever. We should make proper use of their feedback to create a product they really like and want to work with in the future. This also requires us to adapt our solutions based on the needs and wants of that same customer. We can collect this feedback by making use of direct testing sessions with customers, beta releases of software, surveys, calls, and more. The better we understand the problem, the better we will be able to create an adequate answer that will actually be used.

A final aspect of testing is the resilience of the tool we are creating. If we have developed a new application or process that breaks from the second it has to deal with even a little amount of stress, we know we have created something
that can only deliver value in the short term and this brings a strategy that will certainly fail in the long run. Therefore, proper testing of security, risk, and resilience is needed before we can move forward to the next step: implementation.

Step 5: Implementation
When one of our innovations has made it through the testing phase, comes one of the most exciting phases of all: the actual implementation of our creation. Whether it is a new process, tool, application, or instrument, the production phase is when our creativity becomes reality and we are able to say we have created value for the organization as a whole. The reason you are moving toward production is because you had an idea which made sense, had a strong business case, and was able to convince stakeholders.

Market Introduction
The market introduction of a new solution is a crucial moment as the improper representation of a great solution might still lead to failure. That is why companies sometimes like to make use of an iterative approach where at the very beginning only a small set of customers are allowed to make use of new features or a new product and based on their feedback the solution is adapted to fit the customers just as they want. We also run into the “minimum viable product” which is tested out at a group of customers to see how they feel about the solution and as such the organization is able to adapt the proposed product to the customer needs. However, this approach does come with a huge risk, as sometimes the product starts to gain popularity while still being an MVP and some companies choose in this case to leave the product an MVP. This can come with security risks or can lead to short-term popularity, after which the solution falls out of grace, and even when there are new and improved features, it can take years before the solution once again gains prominence among customers.

The market introduction is a careful process on itself, which falls out of the scope of this book, but cannot be underestimated. Marketing materials and the way the product or service is presented will help create the first impression of the product. Remember the presentation of the Cybertruck by Tesla? The design was already something new and strange for many of the interested fans watching the presentation. However, when the focus moved to the strength of the windows, and Elon Musk wanted to prove it by swinging a hammer at the windows, they crashed. Even though it didn’t stop the popularity of the product launch, it still led to a lot of laughter across the world. The wrong presentation or even a small mistake can destroy an entire franchise.
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A second example here is the movie “John Carter” by Disney. The movie was meant to be the start of an entire franchise but flopped at the box office. Several reasons can be thought of (I liked the movie) such as the title of the movie which wasn’t really inspiring, but even more importantly the marketing of the product. It should have been the first movie of a series, based on a series of books which were classics to say the least. The public was far from aware what the movie was about, what it was based on, and what they should expect. Hence, the first movie failed and the franchise was killed.

This is why even the best solutions depend upon the right market introduction if we are looking for both short-term and long-term success. As we said before, turning around a bad first impression takes time and you might simply not have time to do so.

Why Do We Still Fail?

Even when you did everything right, you might still fail. About 30 to 45% of new products fail to deliver any meaningful financial returns. Why? A bad market introduction might lie at the basis here but there are also other possible issues we might run into. A classic one is that the solution doesn’t actually solve a problem the customer is currently dealing with. If we don’t properly understand the problem of the customer, we will fail to provide an appropriate solution. Closely related to this mistake is the second one: solving a nonexistent problem. You can create great products and services, but if there is no clear value for the customer, why would they spend money on it? Again, there are numerous examples in the past where this mistake was made by companies who eventually had to abandon their solutions. A third possibility is that you are targeting the wrong market. If you are creating a product which is in essence a copy of a competitor’s product, why should the customer change to your solution? Or why would users in a certain market make use of a solution simply because you think it so? An example is the dual sim phone. Very popular in certain Asian countries, it hasn’t found any real market in Europe. One should respect the differences between certain markets and tailor their solutions based on the characteristics of the market. At the same time we shouldn’t simply try to copy the solution of a competitor but rather come with a unique value proposition. The fourth killer on the list is pricing. If products become too expensive compared with the value we expect from the product, why would a customer have to spend their money on the solution? This can kill products or ensure that there is only very slow adoption on the market. An example here is many AR glasses which haven’t seen mass adoption because of (among other reasons) the steep price that is often attached to solutions. Next on the list are the internal capabilities.

https://community.uservoice.com/blog/why-products-fail/#:%7E:text=The%20TL%3BDR,a%20lack%20of%20internal%20capabilities
The company needs to understand its strengths and, even more importantly, its weaknesses. Only when it is able to do so can you prevent from a weak team or a team that has the wrong capabilities from screwing up a new innovation. Other possible killers can be poor execution of the new solution, not respecting the timeline (so that customers have to keep on waiting for the product), bad marketing (as mentioned before), and so on.

It is easy to point the finger at the innovation team when an idea fails, while in reality there are much more capabilities we should take into account when introducing an innovation to the market.

**Step 6: Monitoring**

Once we have a new solution implemented, we need to start monitoring the progress that we are making with the innovation. Are we achieving what we want to achieve or not at all? And if so, why is that? It is not because we have made a bad start, that all is lost. In this case we should change the approach and we could still save the product or service. We might have misread the customer or have been too optimistic on the timeline. Perhaps we didn’t take into account some of the solutions our competitors came up with and so on. Monitoring allows us to follow up on the perception and reception of our solution and how we might further adapt it for our customers.

**Dashboards and Reporting**

Classic examples of monitoring are dashboards and reporting lines. Here we focus on the returns from a product or service. The better we streamline this reporting lines, the better all decision makers and stakeholders will be aware of how an innovation is actually doing in practice. If we fail, we can do so in due time and limit the loss as much as we can, and if we succeed, we might further influence and push the way we are succeeding. Sometimes a product becomes a success but not in the market we originally wanted to target. By clearly monitoring our solution, we can align ourselves with the actual market we are targeting.

**User Feedback**

With user feedback we can even better understand how the solution is working for our customer and what aspects deserve a closer look. Is the solution focusing on the right problem but aren’t we there yet? Well, only by listening to the customer can we truly understand what they are looking for and what they require from us. Customer feedback is crucial and not only receiving the feedback but actually listening to what they are looking for is crucial. Ignoring negative feedback can kill a product and might even threaten
the existence of your organization. By making use of customer feedback, we can aim at better understanding the problems we still have to work on.29

There are several ways how you can focus on collecting this feedback:

- **Surveys**: Not the most popular tool ever invented and sometimes even seen as a nuisance, they can be useful if we want to reach a large customer base and collect a general idea of how the solution is doing. Open-ended questions might help us come up with ideas.

- **Customer contact forms**: By making use of contact forms that can easily be reached by the customer, we will be much easier contacted, and this way we will be able to focus on the active feedback we receive.

- **Personalized responses**: If we are working with a smaller set of customers or with a few bit organizations, we can work with personalized responses and might even dig deeper into what they like and, more importantly, don’t like of our solution.

- **User testing**: As it is already a part of the testing phase, this doesn’t mean we cannot keep on continuously testing out new features and aspects of the solution.

- **Customer interviews**: The best way to go into the depth of solution reviews is by making use of workshops and customer interviews. Here we are able to ask all the questions we would like to see answered but we also provide a platform where customers can actually give their honest opinion of a solution.

- **Social media**: Social media has proved to be a rich ground for people to let out their opinions and criticism. It is used by corporations to have a presence as well on most of these open platforms, and as such it can be a great point of contact.

- **Tool analytics**: Finally, there can be analytics in the tool or website itself which in turn can be used to have a better understanding of how the customer is using the tool. Of course, here you might have to consider the data privacy implications of collecting such data.

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29[https://www.helpscout.com/blog/customer-feedback/](https://www.helpscout.com/blog/customer-feedback/)
Protect Intellectual Property

Important as well during the monitoring phase is the rise of new solutions developed by competitors. As we try to protect the intellectual property that is part of the design, we need to make sure that our efforts haven’t been in vain and/or that competitors don’t break our patents. At the same time, we should take into consideration the rise of open source solutions and tools (as we already focused on in the section regarding technology and trends). These come with their own set of licenses which in turn might have an impact on how we develop future solutions or how we might bring a new product or service to the market. Changes in these licenses might directly affect some of the solutions we have in place, and as such we should be able to respond in a timely manner if this would be the case.

The Innovation Life Cycle

Another important aspect we have to understand here is the life cycle of an innovation.30 When we start with a new product or service, the first actors that will be interested are the innovators and early adopters which only make up about 15% of the entire market we are trying to reach. Only if these early movers have the sense that this is a solution that might be successful will we approach what is commonly called the “golden era” where we gain the early majority by reaching another 35% of the market. The reason why this is called the golden era is because we are dealing with a lot of growth and success in the market. The investments we made earlier pay off during this period, and we have little competition to deal with in this time. However, this time of growth and expansion cannot last and is followed by a period called “the squeeze.” Here we reach another 35% of the market which is also called the late majority. We are still growing and the market is reaching saturation when it comes to the product or service that we have put into place. It now no longer is a new solution but rather becomes a standard practice, and other competitors now start to fight over market share. Solutions are now compared based on pricing, features, and user experience so that new investments and marketing become crucial to keep the leading market position or take over from one or more competitors. We end up with the consolidation phase where the final 15% of laggards also start to take over the solution now that it has become a standard practice and customers are expecting this to be standard in the services they receive.

30https://pt.slideshare.net/nealcabage/the-6-market-dynamics/15-Innovation_Life_Cycle_TIMING_CRITERIA
Understanding what phase you are in when you are in the market with your solution is also important so that you might better understand the results of your sales so far of the service and/or product. It also gives you an indicator how you should respond when you reach a new phase, based on the customer feedback and increased competition.

**Improvement upon Improvement**

Most important here is that a new innovation doesn’t simply stand on its own. We need to continuously try to improve upon the features that we already offer to our customers. The work is never done and we can always streamline the way things that are done. This is why we should consider during our monitoring if anything seems out of shape. An example can be the processing time, time of delivery, cost of running an application, the time it takes for a user to learn and understand the solution, and so on.

**Step 7: Repeat**

Here we end up with the final step: repetition. There will always be other fields where we can apply our innovation process to come up with new services, products, approaches toward customers, and so on. We might re-innovate a solution that was once an innovation itself. The world doesn’t stop turning because you want it to. Society keeps on changing, new trends hit the world, and technological advances never stop. At the same time our industry keeps on changing as well, with regulation having a major impact on how organizations react to new ways of doing things. This is why innovation has to become a cornerstone of any modern enterprise as we can only ensure future performance if we keep on focusing on improving upon the current state of affairs. Every problem can be solved, it is only a matter of time before you find a new way of doing so.