Artifacts is a human-centered framework for growing ideas. It is built around documents that are units of meaning rather than units of data, enabling the expression of thoughts grounded in the way humans think. It organizes these documents loosely enough to aid the making of associations while retaining enough structure for users to navigate their collections seamlessly. It is built for humans to continuously develop ideas over longer periods of time and emphasizes collaboration as part of the system.

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Artifacts is a human-centered framework for growing ideas.

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Introduction

»The snap judgements of intuition [...] are rarities in the history of world-changing ideas. Most hunches that turn into important innovations unfold over much longer time frames. They start with a vague, hard-to-describe sense that there's an interesting solution to a problem that hasn't yet been proposed, and they linger in the shadows of the mind, sometimes for decades, assembling new connections and gaining strength. And then one day they emerge into the light of day: sometimes jolted out by some newly discovered trove of information, or by another hunch lingering in another mind, or by some internal association that finally completes the thought.«

JOHNSON, 2013, P. 75

The objective of this project is to devise a digital framework that supports the process of developing ideas: From collecting information, expressing thoughts, developing them further, putting them into connection with each other, to collaborating on them and finally sharing them with other people.

The framework is to be designed in a human-centered way, putting the way humans think and their creative process first, rather than being rooted in technical limitations or the legacy of previous computer systems.

Digital tools can have a great impact on the way humans think. Based on Douglas Engelbart's vision of »Augmenting Human Intellect« (ENGELBART, 1962) the goal is to offer humans a tool that augments their mental capabilities by opening up new ways of thinking and enables them to solve more and more complex problems, which they could not have solved before.

Part 01

State of Science and Practice

01 Models of the Process of Ideation in Context

02 Interviews

03 Supporting Creativity

Through literature research and interviews we got an overview of the current research into the creative process, how practitioners understand and perceive this process, as well as what can be done to support it.

Chapter 01

Models of the Process of Ideation in Context

The creative process is complex and non-linear. It includes several phases and possible barriers. While there is no agreed-upon definition of the process, we looked at different scientific models and combined them into one overarching model that covers all phases.

Models of the Creative Process

Within the area of creativity research various models of creative process have emerged.

Dr. Klaus Linneweh
(1942 – 2013) was a German psychologist and founder of the »Institut für Systematische Innovation«.

Linneweh: The Six Creative Stages

Linneweh (1994) separates the creative process into six stages. First, there is the »Stage of Information«, where all information available is collected to get an overview over the field in question and understand other people's previous ideas in the same field. This is necessary, because »only things known to [the creator] [...] can be thought« (P. 60). The second stage is the »Stage of Pondering«: During this stage it is not yet clear which pieces of information will be of value. It is necessary to »juggle with information« and reflect on it. Third, there is the »Stage of Speculation« where even elements only known unconsciously have to be taken into consideration. In this stage speculation is necessary, because simple consideration is not enough. Fourth, there is the »Stage of Maturing«: When an idea is really new, often there is a phase of frustration. It is necessary to gain some distance and not consider the idea for a while, to let it »ripe«. Then comes the »Stage of Insight« – in this stage it is important to recognize a good idea and realize its potential. The hard part is not just having good ideas, but also recognising them. Last, there is the »Stage of Testing«, where the idea is validated and improved. In this stage it is necessary to find out whether the idea actually solves the problem.

Alex F. Osborn
(1888 – 1966) created the »Brainstorming« technique and wrote the book »Applied Imagination«.

Osborn: Facts – Ideas – Solutions

Osborn argued that three components are necessary for successful creativity: Facts, ideas and solutions. Each of these needs to be considered and none can be left out. Fact finding is about collecting data and information on the field. Idea finding is about exploring different possibilities while using some of the facts gathered before. In the last stage, solution finding, the most promising ideas are developed into solutions, which can actually be applied (BERKUN, 2007, PP. 90 – 91).

Boon: Preparation – Incubation – Verification

Boon (2014) separates the creative process into three stages. During »Preparation« information is gathered and the rules of a domain are learned. This is »a very rational, laborious and often even frustrating part of the creative process« (BOON, 2014, P. 92). The stage of »Incubation« happens unconsciously, usually when the creator takes her mind off of the area. New combinations of the information are made, until »the unconscious brain connects with our conscious brain to share an insight« (BOON, 2014, P. 99). With this the phase of »Verification« starts, where the insight is compared to available knowledge and developed.

Barriers

Certain factors that can negatively influence the creative process are called »Barriers«.

Barriers obstruct the flow of creativity and prevent the generation, development or communication of new ideas. There are both conscious and unconscious, as well as internal and external barriers. Ideas, especially in their early stages, are very susceptible to these barriers:

»The problem with new ideas is that they are by their very nature often ill formed, sketchy and with contradictions. In their nascent state, like a newborn baby, they are extremely vulnerable. They are easy to destroy – they even invite it«

GURTEEN, 1998, P. 11

Linneweh: The Censor

Linneweh (1994) describes the »Censor« that stands between the unconscious and the conscious mind. The censor decides which information is passed on to the conscious mind. It is shaped by environmental influences, education and experience (LINNEWEH, 1994, P. 26). Because of this, established ideas have an easier time getting through, while new ideas often get blocked.

Steiner: Barriers

Steiner (2011) defines groups of the most common barriers.

BLOCKADES BY HABIT AND EXPERIENCE

Through education and society we learn several »patterns« that we tend to follow. Within the family, the school and the job environment we train routines through continuous repetition. This makes it hard to support new perspectives on known problems, a skill that is important in order to enable the creation of new solutions (STEINER, 2011, P. 41).

BLOCKADES BY RULES AND TRADITIONS

Every organization is based on rules. This is necessary in order to enable smooth processes and minimize conflicts (STEINER, 2011, P. 42). In comparison to the »blockades by habit and experience« traditions and rules are not based on personal experiences and individual routines, but are given by the context. Rules and traditions are predefined boundaries in which an individual can act. If the creator is to focused on theses boundaries (for example by being scared to present an idea out of fear of rejection) or is not given the opportunity to try new ideas it can inhibit the creative process (STEINER, 2011, P. 42).

BLOCKADES BY RESOURCES

In the creative process there is a tendency to drop ideas, when it becomes clear that the needed capital, time, knowledge or people to lead the idea to success cannot be provided (STEINER, 2011, P. 42).

BLOCKADES BY PERCEPTION

»The human tendency to percept things in a specific way is called ›perception set‹, ›mental set‹ or ›functional fixation‹« (DAVIS, 1999, P. 167). Subjective knowledge, experiences, social values and interests block the creative process in different stages, like during the problem recognition or ideation phase. Schönwandt, Voermanek, Utz, Grunau and Hemberger (2013) state that »[p]roblems can't be objective, as a problem occurs from somebody's own understanding« (P. 22). The individual perception has a big impact on the problem definition phase and can inhibit the recognition of new ideas.

Gurteen: Paradigms & Mental Models

PARADIGMS

Gurteen (1998) writes: »The biggest block to creativity at any level is the paradigm« (P. 7). He defines a paradigm as a way of viewing and perceiving the world, that »works at the subconscious level« (P. 7), that we are not aware of.

»Paradigms include theories, principles, values, beliefs and doctrines. They can be thought of as a rigid tacit infrastructure of ideas that shape not only our thinking, but our whole perception of the world.«

GURTEEN, 1998, P. 7

According to Gurteen (1998) our paradigms block ideas, because often we reject ideas based on a subconscious reason, rather than conscious reasoning. Because of this they limit our thoughts and prevent us from developing new ideas.

MENTAL MODELS

Another barrier according to Gurteen (1998) are inappropriate mental models. In contrast to paradigms mental models are conscious. He names mental models and business models as examples and states that »[a] model is an approximation to reality. Models only work when certain parameters are fixed or certain influences are ignored« (GURTEEN, 1998, P. 8). Because of this certain models only work in some situations, but don't in others. People often make the mistake of mistaking the model for reality and therefore closing themselves off to thoughts that do not fit into their mental model, instead of accepting that the mental model could not be appropriate for the situation.

A Combined Model

We took elements from the different models of the creative process and fit them into one model that explains the process according to our understanding. We used this model as a base for all of our further work.

The numbers indicate the position of the various phases in →Figure 01.

→ **Figure 01** (P. 14)

The Process of Innovation (I)

The »Process of Innovation« (I) contains all necessary steps of both the problem-solving (II) and the ideation process (III), but differentiate itself in that the ideas are also put into practice (ROBINSON, 2011, P. 3) and validated by the market: After a successful validation from the inner problem-solving process (II) a main step of innovation is the application phase (10), in which the offered solution is realized, refined, produced and distributed. The timespan between application (10) and acceptance (11) varies depending on the individual solution, but it is a longer-lasting step. The process of acceptance (11) is the main gatekeeper, which can inhibit ideas or solutions from transforming into innovations. In this step the decision is based on external economic factors like market and competitors.

Innovation is defined the acceptance and widespread use of a new product, process, or service, conveys the notion of success and of perceived value from various economic actors, as well as differentiation from existing solutions (GABRIEL, 2016).

The Process of Problem Solving (II)

Much of creativity research is concerned with the problem solving process (II), that ideation is a part of: Regardless of whether we want to find the solution for a difficult equation, are unsatisfied with a situation, or try to improve a process, we are often searching for the solution to a problem.

According to Roland Arbinger a **problem** occurs, when an individual has a target in mind, but doesn't know how to achieve it (DUNCKER, 1974, P. 1).

PROBLEM DEFINITION (3)

Every problem consists of three components: »Predicament initial state«, »necessary measures« and the »target state«. Problem Definition (3) is an important step, because the way in which a problem is described has a huge impact on the solution: »The determination of the unfortunate initial state is a central component of the problem definition« (SCHÖNWANDT ET AL., 2013, P. 25). »Necessary measures« describe how the »target state« can be achieve. The »target state« is the aim, which should be achieved through specific measures: »By setting a goal, we are dictating the direction of march« (SCHÖNWANDT ET AL., 2013, P. 28).

When describing the problem solving process (II), problems can be classified as one of the following: Transformation problems are problems that have a clear initial state, target state and measures to achieve the goal. When talking about synthetic problems initial and target states are clear, but the required measures are unclear. The last class are called dialectic problems, where the target state is unclear, but all the other aspects are known (ARBINGER, 1997, PP. 9–11).

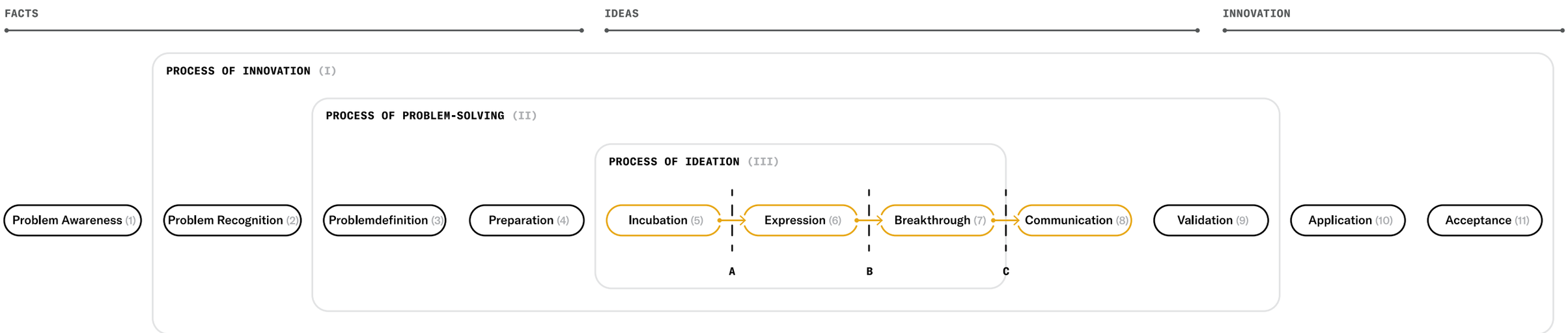


Figure 01: **A Combined Model of the Creative Process**

Horst Rittel (1992) stated that there are two core types of problems: »tame« and »wicked problems«. A »tame« problem is a problem which can be easily solved by applying the right algorithm, pattern or method. The process for a »tame problem« is linear starting from initial to the target state. In contrast »wicked problems« are nearly impossible to solve, because of their complexity and relation to the symptomatic of other problems. The process of solving »wicked problems« are almost infinite loops of solutions generating new problems, in which we investigate again to find new solutions.

PREPARATION (4)

Before the »Ideation process« (III) starts, there is a phase of preparation (4), where information, related ideas and suggestion are collected. This research is »a very rational, laborious and often even frustrating part of the creative process« (BOON, 2014, P. 92) as »no scientific, inventive, conceptual, or artistic results are booked« (BOON, 2014, P. 92).

The preparation phase isn't something that is only executed when we try to solve a specific problem. In fact every information and idea we absorb throughout our lives can be seen as gaining insights in preparation for future problems (BOON, 2014, PP. 94–95).

COMMUNICATION (8)

After an idea has passed the self-censor and reached the breakthrough-state (7) of the ideation process (III), the idea has to pass the external-censors (C) as well. In the communication phase (8) the idea is shared with external shareholders, organizations or interest groups, which weren't involved in the ideation process (III). They analyze and criticize the idea in terms of practicability, economic aspects and effectiveness. As the quality of an idea is hard to measure, passing both censors – internal and external – can be an indicator of high-quality.

VALIDATION (9)

In the last phase of the problem-solving process (II) the idea is tested, analyzed and a decision is made whether the idea is actually a possible solution for the underlying problem (LINNEWEH, 1994, P. 60).

The Process of Ideation (III)

INCUBATION (5)

During the incubation stage (5) the brain connects different pieces of information. When two concepts from previously unrelated domains are connected, a new idea forms. This happen unconsciously and can only be stimulated, not controlled.

→ **Cognitive Processes: Bisociation** (P. 17)

EXPRESSION (6)

»The stage of incubation ends immediately when the unconscious brain connects with our conscious brain to share an insight« (BOON, 2014, P. 99). In the expression phase (6) thoughts are shaped and expressed. This

determines the starting point for conscious thought in the ideation process (III).

BREAKTHROUGH (7)

»Is my idea good or not? How might others think about it once I've shared my thoughts with them? Is this idea even helpful and goal-driven at all?« These questions often block progress within the ideation process (III).

→ **Barriers** (P. 11)

Between the step of expression (6) and the breakthrough (7) an expressed idea has to pass the self-censor (B). As »[n]ew ideas have a higher potential for danger, [...] we learn to be suspicious of them« (MAUZY, 2008, P. 9). Sticking to an idea and taking time to refine it is always a risk-taking endeavor, but it is crucial to the creative process. Often the self-censor is so distinctive that it blocks many thoughts or potential new ideas unconsciously (MAUZY, 2008, P. 9), as the self-censor validates the ideas regarding »self-esteem«, »self-image« and »self-punishment« (MAUZY, 2008, P. 7).

Once the idea has passed the individual self-censor it is important to lead the focus away from the actual problem and our possible solution and to revisit it with a fresh mind. Not every idea leads to a breakthrough immediately. This is called the maturation phase of an idea (LINNEWEH, 1994, P. 60). In this phase the mind has to be receptive and able to recognize new insights as breakthroughs. After an idea has matured one often experiences »Aha«-moments, which describe the outcome of breakthrough phase (7) (LINNEWEH, 1994, P. 60).

Cognitive Processes: Bisociation

A process that is consistently mentioned in the literature as being vital for the generation of new ideas – or even as the generation of new ideas itself – is »bisociation«. First mentioned by Arthur Koestler bisociation is the act of associating elements that are usually unrelated and thereby creating a new combination that did not exist before.

Arthur Koestler (1905 – 1983) was an author and a journalist. In his 1964 book »The Act of Creation« he attempted to create a »general theory of human creativity«.

»The term ›bisociation‹ is meant to point to the independent, autonomous character of the matrices which are brought into contact in the creative act, whereas associative thought operates among members of a single pre-existing matrix« (KOESTLER, 1964). This concept is also expressed in many of the →ways of thinking creatively by different authors: De Bono's »Lateral Thinking«, Getzels', Jackson's and Hudson's »Divergent Thinking«, Byrge's and Hansen's »Horizontal Thinking« and Stefik's and Stefik's »Beginner's Mind«.

→ **Ways of Thinking** (P. 19)

Bisociation is also why knowledge is relevant for creativity: It is clear that only knowledge that is in the mind can be combined in new ways by the mind. However how much knowledge is helpful and how it should be structured is a point of discussion: Hayes (1989) argues, that at least ten years of experience in a field are necessary, before truly new ideas can be produced. However Simonton (1984) says that too much knowledge about a problem area might inhibit creativity. In conclusion: »Knowledge may provide the basic elements, the building blocks out of which are constructed new idea, but in order for these building blocks to be available, the mortar holding the old ideas together must be not too strong« (WEISBERG, 1998, P. 226).

In general it is assumed to be good for creativity to have more and especially broader knowledge in the »mental library« (BYRGE & HANSEN, 2011) because more »building block« for the bisociation process are available. However too much reliance on existing knowledge can become a barrier, that is furthered by rigid structures and the rejection of variation.

Santanen, Briggs & Vreede: Cognitive Network Model of Creativity

The Cognitive Model of Creativity presented by Santanen, Briggs and Vreede (2004) expresses the cognitive process necessary for bisociation, as well as its barriers (→Figure 02). It considers bundles of associations in the mind as »frames«. These frames get combined in the working memory. New ideas develop when frames from different areas are combined: »[...] creativity emerges when two or more knowledge frames not previously associated with one another are activated together in the context of some new problem« (SANTANEN ET AL., 2004, P. 176). However the working memory is limited in its capacity, so while more stimuli (e.g. frames held in the mind) increase the likelihood of new combinations, they also increase the cognitive load – resulting in fewer associations. To lower the cognitive load, the mind groups similar frames into »chunks«. However this only works with

→ **Figure 02** (P. 18)

similar frames, which means that there is less diversity of frames held in the mind, which again results in fewer new bisosciations.

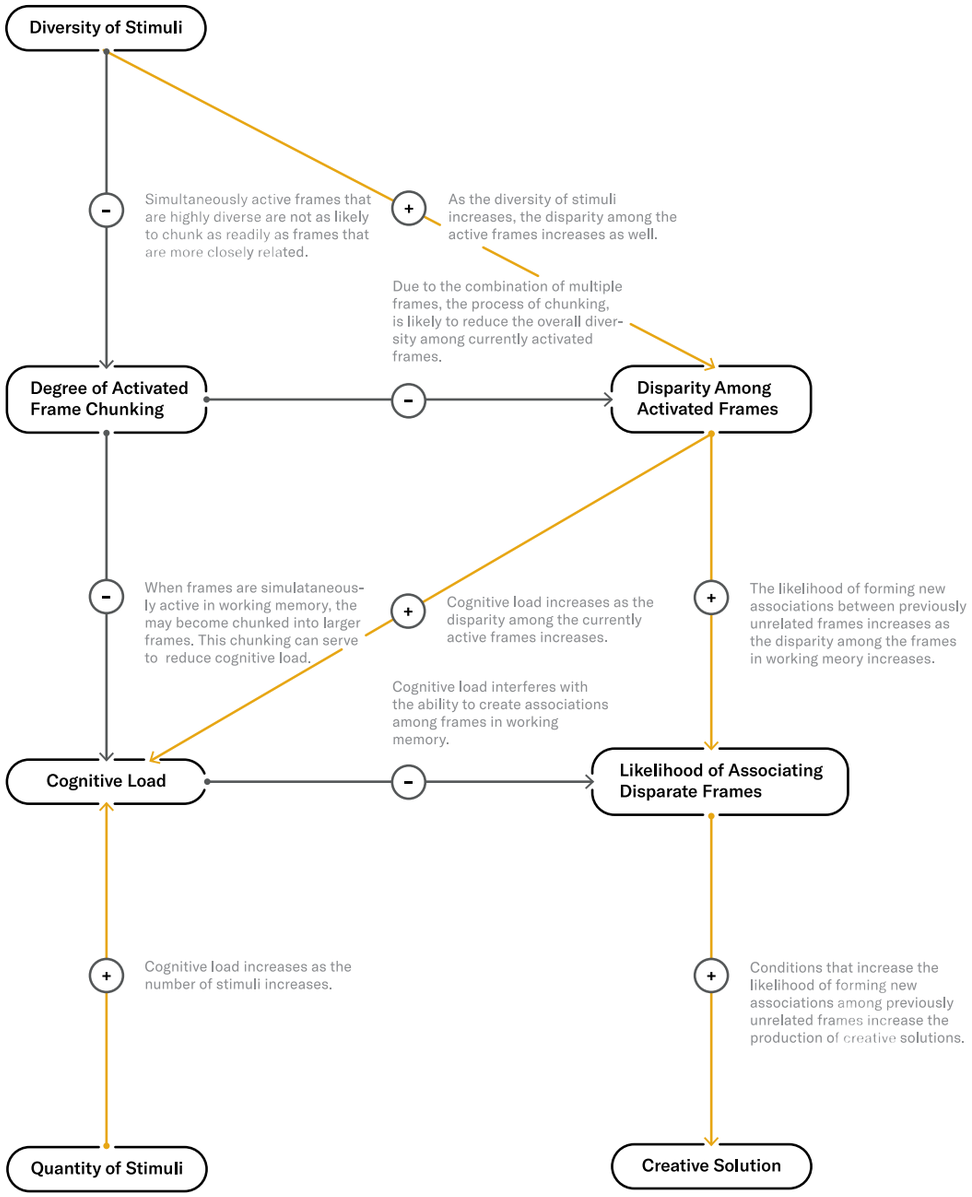


Figure 02: **Cognitive Network Model**

All of this results in a complex network of dependencies. For a successful creative process it is necessary to find a balance between the amount of stimuli and their diversity, and the cognitive load.

Ways of Thinking

The creative process requires different ways of thinking for different stages. Multiple ways of expressing this have been found by different authors. The different ways of thinking often happen unconsciously, but they also can be used knowingly to stimulate the process.

Traditional Thinking: Logic Reasoning

The fundamentals of how we think was defined more than 2400 years ago by the big three of Greek philosophy: Socrates, Platon and Aristoteles. Socrates developed the philosophical method of structured dialogs. Platon's aim was to find the absolute »truth«. Aristoteles established the idea of categorized thinking. The result of this is that in our culture logical thinking is often praised as the biggest achievement. However since the aim of creativity is to create new connections and combine knowledge in new ways, many ideas seem logical in retrospectively, but cannot be reached easily through logic reasoning (DE BONO, 2010).

De Bono: Lateral Thinking

De Bono (2010) introduced the term of »lateral thinking«, which describes problem solving through an indirect and creative approach. He states that is hard to come up with new ideas, because existing solutions create patterns in our mind. On a neurological level this is because links between neurons that are often activated together get stronger: »The end result of following these strong links serves to reinforce known patterns of thinking and the result can be a ›stuck in a rut‹ syndrome of not being able to find a creative solution« (SANTANEN ET AL., 2004, P. 177). Lateral thinking offers different techniques that help to view a problem from different perspectives that wouldn't be considered by a classical step-by-step logic. With the help of mental provocations the perception can be changed and patterns can be broken (STEINER, 2011, PP. 28–29).

Edward de Bono (*1933) is a British psychologist, who has written many influential books on creativity.

Getzels/Jackson/Hudson: Divergent and Convergent Thinking

According to Getzels, Jackson and Hudson the process of creative thinking is a sequential order of divergent and convergent thinking with a continuous repetition. Divergent thinking is responsible for the analysis and the redefinition of problems and the generation of new problem solutions, fostering a broad vision. Convergent thinking is about then finding the right problem solution and validating it (STEINER, 2011, PP. 32–33).

Byrge & Hansen: Vertical and Horizontal Thinking

Bryge and Hansen (2012) developed the model of horizontal and vertical thinking: »[V]ertical thinking is to use pre-existing knowledge from a specific section in the mental library in order to solve a particular problem from the very same section« (P. 6). Vertical thinking is used in most

everyday situations and helps navigate situations which have been dealt with before. However it cannot be used to generate new ideas (BRYGE AND HANSEN, 2012, P. 7). For this horizontal thinking is necessary: »Horizontal thinking is to cross the boundaries of the mental sections in order to develop a new idea that solves a particular problem related to one [other] mental section« (BRYGE AND HANSEN, 2012, P. 7). This cannot happen instantly: »Knowledge is not constructed as principles when found in a section in the mental library. The knowledge found is rather constructed in a system related to a particular situation or a particular proble« (BRYGE AND HANSEN, 2012, P. 9). So the practical problem at hand has to be turned into an abstract principle problem, which requires vertical thinking. Only then can the mental library be searched for a principle that might help solve the problem. Here too, practical situations have to be turned into abstract principles: »In horizontal thinking the principles need to be detached from the systems they are a part of« (BRYGE AND HANSEN, 2012, P. 9). Then the principle can be applied to the initial problem: »Having identified the idea principle in the horizontal section, horizontal transfer is to turn this principle into an idea that can solve the practical problem definition« (BRYGE AND HANSEN, 2012, P. 13).

Mauzy: Different Kinds of Ideas

Mauzy (2008) describes two different kinds of ideas: predictable and surprising ideas. Usually the predictable ideas are the ideas that form first (MAUZY, 2008, PP. 7–9). They are »the result of thinking according to our habitual patterns of thought« and are »usually very specific, very doable – and very safe« (MAUZY, 2008, P. 9). When starting to follow these predictable ideas, it is hard to go back and find surprising ideas, which are more vague, directional and seem more dangerous. Mauzy therefore suggests trying to move from surprising to predictable ideas instead. To foster surprising ideas is important to confront and overcome »self-censoring blocks«, more work and courage is required but they result in more innovations (MAUZY, 2008, P. 10).

Stefik & Stefik: Beginner's Mind vs. Prepared Mind

Stefik and Stefik (2005) describe two different mindsets: the prepared mind and the beginner's mind. The prepared mind consists of all existing knowledge and experiences. The beginner's mind on the other hand tries to discard the previous experience and be open for new ideas. »The prepared mind sets up the Aha! moment« (STEFIK & STEFIK, 2005, P. 18): Without it discoveries and ideas could be dismissed, because their potential is not recognized. It is also helpful during cross-disciplinary studies, when the expertise of multiple people can be combined in new ways. However the prepared mind on its own will not generate surprising and novel ideas. For this it is necessary to shift mindsets: The authors propose to »cultivate a beginner's mind« (STEFIK & STEFIK, 2005, P. 18) in order to facilitate creativity. This can be done by trying to the opposite of the usual solution, changing activities, talking it out or through testing ideas quickly and learning from failures.

Individual and Social Creativity

Most creativity research is focussed on the role of individuals within the ideation process. In reality the problem-solving process is rarely an individual, but rather a team accomplishment (STEINER, 2011, P. 88).

»Creativity builds rich knowledge structures and executes complex ideas through interaction between individuals« (BOON, 2014, P. 130). Therefore it is important to look at the similarities and differences between the individual and the collaborative process as well as to identify its main characteristics.

Advantages and Disadvantages

Collaboration is a crucial part of the modern →problem-solving process. The reasons for this are quite obvious, as a collaborative work style increases the motivation, the harmonization, the creativity and flexibility of all stakeholders. In collaborations people are more involved in the decision-making process and their need for self-realization is more satisfied. Collaborating leads to a uniform target and problem understanding and harmonizes the problem-solving process. The creative capability of a collaboration is higher as experiences and professions can be more diverse, which helps to foster the bisociation process. Smaller groups are also more flexible than the whole organization or company and can easily expand or shrink depending on the problem's scope (LINNEWEH, 1994, PP. 114–115).

→ **The Process of Problem Solving (II)** (P. 13)

Despite positive aspects collaborations can also cause negative experiences. Mostly because of a bad working atmosphere members can experience time-consuming decision-making, dominating personalities, who minimize diverse thinking and a competitive team spirit.

Collaborative Ideation Process

By taking a closer look at the creative process in the context of collaboration it is recognizable that the different phases and stages within the process are almost the same as in the individual process. The differentiating aspects are the actors participating in this process and the occurring internal dynamics, which bias the group.

Requirements

In order to create a successful collaboration many external factors and individual characteristics matter. Steiner's formula (2011) describes the external influences, which affect the creative potentials of problem solving groups. Factors like internal communications, the combination of individuals, the environment and the objectives have a huge impact on the success of a collaboration (STEINER, 2011, P. 90).

Every collaboration can only be as creative as the creative potential of its individuals. When choosing members for a problem solving group, it is

important to base the decision on their expertise, problem-solving style and their organizational relation (STEINER, 2011, P. 90–92). Despite the professional qualifications, personal goals and objectives have a huge impact on the agility of the project group (STEINER, 2011, P. 92).

The competence of a collaboration member is an important measure and can be described as »the ability to produce successful behaviors in non-standardized situations« (WESTERA, 2001, P. 82). For Steiner a diverse mixture of competences is crucial for a successful collaboration. The ability to act responsible in a professional context is called »action-competence« and plays a significant role during collaboration. It is defined by the system, the individual, the professional and the social competence of its actors (STEINER, 2011, PP. 93–94). The action-competence defines the area of possible interactions and behaviors within the collaborating group (STEINER, 2011, P. 98). In order to minimize status-oriented behavior, which can inhibit new and diverse ideas within the creative process, a problem-oriented behavior should be targeted with equal action-competence within the group (LINNEWEH, 1994, P. 117).

Shared Spaces

As collaboration is the process of shared creation, the main question is where these interactions and communications take place (SCHRAGE, 2008, P. 143). Traditional researchers state that improving the communication will also improve the way of collaborating with each other, as it is a simple bandwidth problem. Currently the technology industry is recreating conferencing tools in the virtual space – increasing the bandwidth – without facing the real issue: »creating a shared space that becomes a part of the ecology of communication« (SCHRAGE, 2008, P. 144).

Schrage (2008) defines a »shared space« as the summary of objects and artifacts people are using to communicate and to transform their thoughts into ideas (P. 142). Shared spaces can be anything ranging from a sketch on a napkin to a whiteboard. During the communication they become the center and an integral part of how we are communicating (SCHRAGE, 2008, P. 143). In order to improve collaborations, shared spaces have to be created, which easily create feedback loops and create democratic communication situations.

Chapter 02

Interviews

After getting an overview of the scientific view of the creative process, we tried to understand what this process looks like in practice. We conducted informal interviews with people from different fields of work – some traditionally considered creative, some not – and asked them about their processes and the tools they use. To get an even wider range of positions we created a survey with similar questions and sent it out to several interdisciplinary mailing lists.

Authors' Meetup

We visited a monthly meetup of the local authors' club of Schwäbisch Gmünd, where a small group of authors presented their recent work to each other and received feedback from the group.

Figure 03: **At Authors' Meetup of Schwäbisch Gmünd**

→ **A Combined Model** (P. 13)

We used the opportunity to ask them about their creative writing process in a casual, focus-group like setting. As guidance we prepared cards representing a simplified version of the creative process as shown above (Preparation, Idea Generation, Expression, and Discussion and Critique). We moderated group-discussions based on prepared questions on each of the steps, collecting notes and grouping them around the cards as we went along.

All of the attending authors focus on writing poetry. While their inspirations come from a lot of sources, they all agreed that when an idea is present they need to write it done, either as a note or as a first draft that is then iterated upon. They said that while writing thrillers or historical novels requires preparation and research, they work with bits of inspiration and based on feelings and impressions. They collect ideas, metaphors and sentences, sometimes to get back to them, sometimes just to get rid of them and let them go.

Realizing whether an idea is good or has been improved enough to be finished is a challenging task. Usually they focus on their gut feelings: When you have an emotional reaction to an idea you know that it might be worth pursuing: They described this as »images coming to you« or the feeling of »a door opening«. Sometimes it might take years to finish a project, because it doesn't feel right yet. They said that this »disharmony« in a text is not only sensible for the author, but others as well, and that a text can only be considered finished once it resolves.

They all mentioned methods to overcome creative barriers. For a lot of them it is important to let ideas rest and do something else and come back to them later. This helps them gain a new perspective and sometimes reach a breakthrough when their minds are somewhere else. One of them mentioned that in order to foster creativity she relies on a set of strict rules – she only writes Haiku poems that follow a strict scheme. Another method some of them use is »Écriture automatique« (Automatic Writing), where the author writes without stopping to think for a couple of pages. The result can then be cut down to a couple of sentences in a second step. This often helps to express feelings or ideas that seemed inexpressible before. One author mentioned consciously using boredom: Sometimes she just sits there and waits, fighting the urge to read a book or distract herself until an idea hits. She described it like this: »Some ideas want to be waited for«.

One author works as a journalist. She pointed out the fundamental difference between her personal writing and her work. She considers journalism as a craft: The challenge is to put a set of information into a text without sounding boring. For her this is not about expressing ideas, but about finding words.

They all agreed that outside feedback is necessary in their writing process. They use their meetups as a way of sharing ideas that might not be finished yet in a trustful setting where they feel comfortable sharing and are not afraid of the critique.

The process of editing plays an important role: By writing things down the ideas and thoughts get sorted and developed, but most of the content produced has to be cut down:

»For every twenty pages of text that you can print you have to throw away eighty pages you have written.«

This process was described as »painful«, because letting go of ideas is often hard. Because of this one author described that she collects the ideas that are thrown out, not to use them again but just because it is too difficult to let them go.

The conversation with the authors' club was very intersting for us, because it provided a perspective on a style of creative work that we have little experience with. Seeing how the authors balance structure and methodical approaches with their generally spontanious approach to creativity was insightful and provided ideas for stimulating creativity.

Hedwig Richter and Detlef Pollack

We interviewed Hedwig Richter and Detlef Pollack, who are both scientists and writers.

Hedwig Richter is a historian, lecturing at the university in Greifswald and occasionally writing articles for interregional newspapers »DIE ZEIT« and »Frankfurter Allgemeine Zeitung«.

Detlef Pollack is a sociologist focusing on religion, lecturing in Münster. He has written multiple books on this subject.

Both of them define themselves as »creative«: For them this is obvious, because they rearrange information and create new one based on existing thoughts and ideas. For Detlef, this is the central point of being creative: »Recognizing things that are new.« But they also recognized that being creative is only one part of their work: Working in archives to dive into files is not creative work, but necessary as preparation for the more creative steps later on. But collecting information for the project at hand is not the only preparation: They both consider the experience they collected over the years as a vital part of all of their works.

When asked to define what an idea is Hedwig's description stood out: »It's like a kaleidoscope: Everything is already there – then a new way of seeing opens up.« For her it is a sudden intuition at the end of a long process, when the parts that have already been there mix in a new way. But an idea is not the end, it often is just the starting point: Their creative process is hard work and »ideas need to be cut and polished like gemstones. This work can take years.« They have a similar approach to finding new ideas: They both create a base of knowledge through lots of reading and paying attention to the small details. They think it is important to »take yourself seriously«, but also being ready to discard ideas if they don't work out.

They collect their ideas and thoughts mostly digital, because it makes searching them later easier. A big part of their process is the filtering out of ideas not worth pursuing. Hedwig uses a large Microsoft Word document where every piece of information is collected and tagged. They consider ideas worth collecting when they are remotely connected to the topic they are working on. Although only 20% of those ideas get used in the end, they feel that it's necessary to collect the other 80% as well to get a broad view. For Detlef, this collection of ideas and thoughts is necessary to increase his creativity by condensing many smaller ideas into a large one:

»When I collect ideas and bring them into a logical order I notice that some of them contradict themselves. This exclusionary contrast has to be turned into a fruitful tension by finding higher or more abstract aspects.«

Recognizing a good idea can be tricky, but for Hedwig it is important that the idea is not only original but also stands after some trials and reviews. Detlef recognizes a good ideas when it »opens something up. When with it you can see more than before.«

Figure 04: **Hedwig Richter and Detlef Pollack**

They both argued that feedback from other people thoughout the whole process is necessary to evolve, nurture and grow the ideas. They look mostly for feedback from people from the same area of research, although an outside view can be helpful as well.

Hedwig told us about external barriers that made her life as a scientist harder because of prejudices against women in a male-dominated field. They both experience internal barriers like stress and anxiety. It's important for both of them to stay calm and take the time to let ideas rest: »Ideas have to be nurtured. Negligence towards ideas is dangerous.«

Thomas Reymann

Thomas Reymann, a young artist, considers ideas the basis for all his work – for him everything starts with an idea that is then enhanced and executed.

Thomas Reymann (*1986) is an artist living in Kassel.

Thomas was surprised to find how difficult it is to define creativity. For him it is just something he does, not something that he thinks about or analyzes. Ideas are the basis that all of his work, so naturally they are quite important to him. For him, the subtle fear of one day maybe not having any ideas anymore is a constant challenge, since every project requires coming up with something new.

While his process of coming up with ideas happens unconsciously he makes an effort in collecting ideas in order to be able to develop them and use them later. Thomas collects inspiration and ideas mostly in a visual way: as photos or screenshots on his smartphone. He also collects some written notes with ideas for installations or quotes, but not many. He doesn't use a sketchbook anymore, because he develops most ideas in his mind, using the images he collects as mere reminders. His visual collection is not structured or ordered: Thomas usually remembers the location where he took the photo and finds them in his collection via the map view of the photo app.

Figure 05: **Thomas Reymann**

He recognizes a good idea when it stays with him for a while. Using the first intuition is difficult, because »all ideas feel good at first«. He noted that in art, the value of an idea or work is usually determined not by the artists, but by outside authorities.

Thomas considers sharing his ideas with others an important part of the process, but usually does it when the execution idea is already close to being finished. Though he has been getting used to it sharing ideas is still challenging to him. He tries to share his ideas with people he trusts and whose work he values. For him it is difficult because he feels like people often try to bend his idea, pushing him to change it in ways he disagrees with. But he has learned to value this and stated that ideas improve even if he doesn't change them based on other people's feedback, simply because he has to defend his decisions, thereby making them more consciously.

The creative barriers that he struggles with have changed throughout his career: While at the beginning he was somewhat insecure about what other people would think of his work and wondered what he could share, he has learned to deal with this and is more confident. He has also gained

in knowledge making it easier to explain and »defend« his ideas. Nowadays his biggest challenges are economical and logistical: He selects the materials and sizes he uses for his works based on such factors as whether he will be able to transport the work easily and how difficult the material is to work with (e.g. oil paints can take weeks to dry).

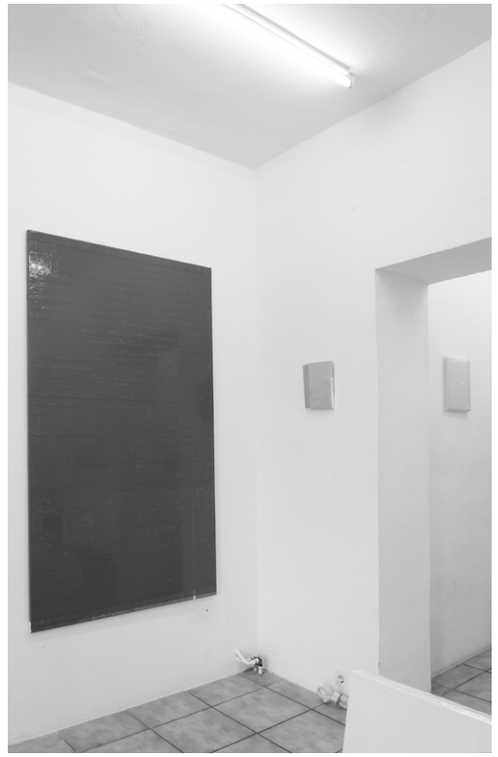


Figure 06: **Recent Work by Thomas Reymann**

Online Survey

To complete our understanding of the creative process in a variety of fields of study and work we created an online survey. We sent it out to multiple mailing lists of the »Studienstiftung des Deutschen Volkes« and the »Cusanuswerk«, as well as posting it online.

Sending the survey out to many people allowed us to tap into a pool of diverse fields of expertise, rather than just focusing on a single profession like designers. More than 140 people participated in the survey and in total spent over 38 hours answering the questions. The chart shows a diverse field of interest from Natural Sciences to Humanities and the answers reflect a broad range of approaches to manage and stimulate the creative process.

Area of Expertise

What is your main discipline?

Applied Science (e.g. Engineering, Design, Computer Science)	**27.97%**
Humanities (e.g. History, Literature, Philosophy)	**22.38%**
Social Sciences (e.g. Economics, Law, Psychology)	**16.78%**
Arts (e.g. Performing Arts, Visual Arts)	**13.29%**
Natural Sciences (e.g. Biology, Physics, Mathematics)	**11.89%**
Other	**7.69%**

Types of Information in the Collection

What types of information do you collect?

Written Notes (Text)	**94.89%**
Scribbles/Drawings/Sketch	**60.58%**
Photos/Videos	**54.01%**
Screenshots	**53.28%**
Audio	**37.23%**
Other	**5.11%**

Tools

Which tools do you use for collecting information or thoughts?

Notebook (Written Notes)	**72.26%**
Loose Sheets	**67.88%**
Notebook (Sketches)	**34.31%**
Word	**29.93%**
Dropbox Paper/Google Docs	**24.09%**
Other	**16.06%**
Pinterest	**13.87%**
Zotero/Citavi	**12.41%**
Evernote	**10.22%**
Apple Notes/Google Keep	**9.49%**
Microsoft One Note	**8.03%**

Sorting

How do you sort your collection?

Folders	**74.07%**
Creation / Edit Date	**48.89%**
Tags	**33.33%**
Location	**15.56%**
Other	**15.56%**

Scales

Where would you place your collection on the following scales?

Chaotic	**5.97%**	**14.93%**	**14.93%**	**15.67%**	**23.13%**	**19.40%**	**5.97%**	Structured
Small	**0%**	**5.11%**	**14.60%**	**27.74%**	**25.55%**	**11.68%**	**15.33%**	Large
Low Effort	**5.84%**	**22.63%**	**26.28%**	**16.06%**	**16.06%**	**8.76%**	**4.38%**	High Effort
General	**5.84%**	**7.30%**	**10.22%**	**30.66%**	**13.14%**	**20.44%**	**12.41%**	Specific

Quotes
The survey helped us to understand the potential users and get to know their problems in more detail. There are to many answers to print them all, but here are a few that we found particuallary insightful.

ADDING INFORMATION

APPLIED SCIENCE
»It’s a problem to find the right tool where my thoughts live in. Most of the time I forget where I added it.«

APPLIED SCIENCE
»Segregated information is a problem for me. It’s difficult to group in one single place what I saved in different tools.«

FINDING INFORMATION

HUMANITIES
»I love it when the found information points to other source which can be inspiration for further ideas.«

NATURAL SCIENCES
»If I had a magic wand I would love a system that reminds me when I already wrote or collected something related to my current thoughts.«

APPLIED SCIENCE
»I would like to have a machine sort the mess that I have right now and softly propose some changes to improve how I capture, save, view and curate my collected info.«

ARTS
»I need the space to collect a bunch of different kinds of information and the feeling that they are accessible at one place.«

ARTS
»Saving something is quick and easy. Adding tags or organising it so that you can search for it is time consuming. When you don’t (I never do) the only way you can find my sketches or thoughts is the equivalent of trying to find something I’m almost certain exists in someone else’s garage.«

SHARING AND COLLABORATION

HUMANITIES
»I often have the the subjective feeling that my work is not worthy enough. I let it grow for quite some time before showing it to anyone. I don’t want to make a bad impression through presenting unfinished work.«

SOCIAL SCIENCES
»I want to know each person’s thought process behind choosing ideas and how this can be articulated better in a team setting to improve how we make decisions.«

APPLIED SCIENCE
»That feeling when someone builds on my initial thought and makes it better. That’s the best about sharing ideas.«

Chapter 03

Supporting Creativity

Since our main goal is to support the creative process, we researched what the prerequisites are that make people creative and what current solutions exist to do just that. We specifically looked at »Creativity Support Systems« and »Knowledge Management Systems«.

Sources of Creativity

In order to support creativity in a general way it is necessary to look at where it comes from, which traits and circumstances facilitate it.

→ **Linneweh: The Six Creative Stages** (P. 10)

Linneweh: Characteristics of Creative People

Robinson (2011) stated that the »human intelligence is profoundly and uniquely creative« (P. XVI) and that the main »challenge is to develop [each individual potential]« (P. 4). As Linneweh described in his →creative stages, many people might have similar insights, but only the really creative person recognizes its potential. This leads to the question if any recognizable characteristics for creatives exist and whether creativity is just a matter of training or only based on the natural abilities.

Research on the characteristics of creative people like architects, scientists or artists have shown that there are five abilities which describe a highly creative person: high problem awareness, widespread knowledge, mental flexibility, critical judgment and strong perseverance (LINNEWEH, 1994, P. 40).

PROBLEM AWARENESS

People with high problem awareness are sensitive to perceive possible problem areas before others do. As we can only solve problems of which we are aware this an important characteristic. Theses characteristic can be strengthened by continuously reflecting new learnings and experiences (LINNEWEH, 1994, PP. 41–43).

WIDE-SPREAD KNOWLEDGE

A wide breadth of knowledge and experiences are the core of the creative process. In the ideation process only information that is memorized can be used. This doesn't necessarily mean that only intelligent people are creative, as a too detailed knowledge might block the ability to see the bigger picture (LINNEWEH, 1994, PP. 44–45).

MENTAL FLEXIBILITY

In order to successfully be creative people have to be able to easily combine information, to understand new situations fast and to question routines and trained habits (LINNEWEH, 1994, PP. 46–47) – this requires mental flexibility.

CRITICAL JUDGMENT

Linneweh also mentions the critical reflection of own thoughts and ideas as an important characteristic of a creative personality. The ability to judge your own ideas is as important as the ability to generate many: Divergent and convergent thinking have to supplement each other in order for new ideas to be developed. (LINNEWEH, 1994, P. 48).

STRONG PERSEVERANCE

Even the best idea needs someone who leads it to success by founded reasoning and profound arguments. This ability together with the critical judgment is in a strong connection to the peculiarity of one's individual self-censor (LINNEWEH, 1994, P. 49).

Rhodes: The Four P's of Creativity

Rhodes (1961) states that creativity is seen as an attribute of either a products, a person, a press or a process.

PRODUCT

Creativity can be considered an attribute of a product. Some products are more »creative« than others: They are »unusual when compared to other products in the same class« or are »novel and adaptive to reality« (SANTANEN ET AL., 2004, P. 169). In this case creativity is a property of the outcome of the creative process (SANTANEN ET AL., 2004, P. 169).

PERSON

It can also be considered an attribute of a person. In this case it is argued that certain personality traits make one person more creative than another one. Studies have found that some of these traits may be that creative persons are described as »capable, clever, confident, egoistical, humorous, individualistic, insightful, intelligence« and many more, but are less »affected, cautious, commonplace, conservative, conventional«, etc. (SANTANEN ET AL., 2004, P. 169). Santanen et al. (2004) however note that it is not clear, »whether creativity causes the traits, whether the traits cause creativity, or whether something else causes both« (P. 170).

PRESS (ENVIRONMENT)

The third way is seeing creativity as an attribute of press. This means that creativity is an interaction between people and their environments, and that certain environments encourage or discourage creativity. Creativity has been found to be encouraged by »social interactions, intrinsic and extrinsic motivation, the present of sufficient challenge, freedom and autonomy, access to required resources, and organizational support« (SANTANEN ET AL., 2004, P. 170), as well as encouragement of risk-taking and support when failures occur. It is discouraged by »threats of evaluation, surveillance, competition and time pressure« (SANTANEN ET AL., 2004, P. 170).

PROCESS

Last, creativity can be seen from the perspective of a process. »Stage models for creative problem solving aim to enhance human problem solving performance by formalizing a protocol for creative problem solving efforts« (SANTANEN ET AL., 2004, P. 170). Creativity methods, like Brainstorming or others approach creativity from this perspective.

Shneiderman: Schools of Creativity Support

Shneiderman (2007) sorts the literature on creativity support into three schools, depending on which component of creativity is their focus.

STRUCTURALISTS

The Structuralist school describes creativity as a process that can be improved using systematic methods or »an orderly method« (SHNEIDERMAN, 2007, P. 25).

INSPIRATIONALISTS

The Inspirationalist school focuses on stimuli: »They advocate working on unrelated problems, getting away to scenic locations, and viewing random photos or inkblots« (SHNEIDERMAN, 2007, P. 25). Typical methods proposed by this school are sketching out as many ideas as possible and concept mapping.

SITUATIONALISTS

The Situationalist school focuses on the creative person and their environment. They look at the characteristics of the creative person, social barriers (like fear of rejection), motivators (like rewards and recognition) and the role of social creativity (competition and collaboration).

Shneiderman argues that it is not one school versus the other, but that designers can take inspiration from all three of them: »Structuralist thinking encourages systematic tools that include progress indicators with reminders of what is still needed. The inspirationalist view supports development of image libraries, thesauri, sketching interfaces, and concept-mapping tools. Situationalists broaden the designer's view to include email and collaboration tools, as well as the e-science notebooks that guide users and coordinate groups through scientific processes over weeks, months, and years« (SHNEIDERMAN, 2007, P. 25)

Creativity Support Systems

Using digital technology to enhance creativity and support the creative process is an active research field. The solutions that are being developed are commonly referred to as »Creativity Support Systems« (CSS) and support the users during one or multiple phases of the creative process:

»Creativity support tools extend users' capability to make discoveries or inventions from early stages of gathering information, hypothesis generation, and initial production, through the later stages of refinement, validation, and dissemination« (SHNEIDERMAN, 2007, P. 22).

During our research into →existing solutions, Creativity Support Systems were one of the software categories that we focused on. Before looking into the applications though, it is helpful to look at some general assertions being made by researchers active in the field.

→ **Existing Solutions** (P. 47)

Lubart: Metaphorical Categories

Lubart (2005) uses metaphorical categories to describe »how computers can be partners in the creative process«. This is a helpful classification for different Creativity Support Systems.

COMPUTER AS NANNY

Since developing ideas is often a long-term process, perseverance is an important quality for creative people. Computers can support perseverance by helping the user set deadlines and monitor their progress, encouraging breaks and help with scheduling, or even making the expression of ideas more frictionless.

COMPUTER AS PEN-PAL

Computers can help teams with communicating and foster collaboration. Examples of this are communication softwares, such as email or chats, but also interactive systems that make in-person communication easier, such as interactive whiteboards or systems involving tangible artifacts.

COMPUTER AS COACH

Computers can function as expert-systems, proposing creativity-methods and supporting their use. This might help users that are not aware of all existing methods or are not sure how to apply them.

COMPUTER AS COLLEAGUE

According to Lubart this is »[t]he most ambitious vision of human-computer interaction for creativity« because it »involves a real partnership, in which humans and computers work hand in hand« (LUBART, 2005, P. 367). Computers can aid creativity by using artificial intelligence: They can

contribute new ideas or further developed ideas given by the users, thereby fostering a dialog in which they appear as a colleague in the creative process.

Shneiderman: Proposed Design Principles

Shneiderman (2005) proposes four design principles that he recommends for future Creativity Support Systems.

SUPPORT EXPLORATORY SEARCH

Because traditional search might not be enough for creativity support Shneiderman (2005) recommends that future tools support exploratory search and guide users to discover previous and related work. They should also offer »rich mechanisms for organizing search results by ranking, clustering, and partitioning with ample tools for annotation, tagging, and marking« (SHNEIDERMAN, 2005, P. 26).

ENABLE COLLABORATION

Since most breakthroughs are not achieved solitary, creative support systems should improve communication and enable collaboration. »Communications systems that let users expose their uncertainties in a safe environment could help build trust, and designs that record who said what can document contributions to emerging ideas. Trust, accurate records, and safe exchanges are also needed in the middle stages when information gathering, idea refinement, and knowledgeable partners are important« (SHNEIDERMAN, 2005, P. 26).

PROVIDE RICH HISTORY-KEEPING

No matter if working in a structured or free-form process, rich history-keeping offers benefits: »Users have a record of which alternatives they have tried, they can compare the many alternatives, and they can go back to earlier alternatives to make modifications« (SHNEIDERMAN, 2005, P. 27).

DESIGN WITH LOW THRESHOLDS, HIGH CEILINGS, AND WIDE WALLS

Shneiderman argues that tools »should be easy for novices to begin using, yet provide ambitious functionality that experts need« (SHNEIDERMAN, 2005, P. 27). The tool should offer a wide range of functions, reducing the friction and enabling the users to focus on being creative, rather than using different tools. He suggests that the software could be designed in layers, depending on the user's expertise.

Knowledge Management

Knowledge has been established as a fundamental component of creativity, as it is the base for the process of →bisociation. Using technology to improve the handling and use of knowledge can therefore be seen as a way to support creativity. The research field concerned with this topic is called »Knowledge Management«.

→ **Bisociation** (P. 17)

Knowledge Management is commonly defined as »the management process of creating, sharing and using organizational information and knowledge« (GIRARD & GIRARD, 2015, P. 14). While a lot of research focuses on the organizational aspects of Knowledge Management, there are is also Personal Knowledge Management, which puts the focus on individual use. When researching →existing solutions we focused on applications for Personal Knowledge Management and put a special focus on applications that are aimed at casual users. Before looking at these solutions, some general observations about the nature of knowledge should be made.

→ **Existing Solutions** (P. 47)

What is Knowledge?

The relationship between data, information and knowledge is often described using the »DIKW hierarchy«:

»The hierarchy is used to contextualize data, information, knowledge, and sometimes wisdom, with respect to one another and to identify and describe the processes involved in the transformation of an entity at a lower level in the hierarchy (e.g. data) to an entity at a higher level in the hierarchy (e.g. information). The implicit assumption is that data can be used to create information; information can be used to create knowledge, and knowledge can be used to create wisdom.«

ROWLEY, 2007, P. 164

Rowley (2007) reviews definitions for the different stages of the pyramid from over 40 authors. The following definitions are either summaries by her or sources quoted by her.

DATA

»Data are discrete, objective facts or observations, which are unorganized and unprocessed, and do not convey any specific meaning« (ROWLEY, 2007, P. 170). They are symbols that represent properties of objects, events and their environment, produced by observation (ACKOFF, 2010).

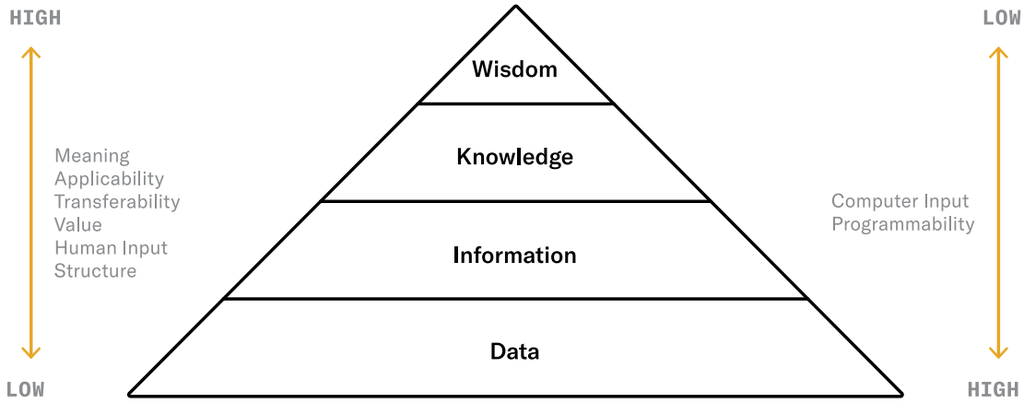


Figure 07: **The DIKW Hierarchy**

INFORMATION

»Information is data that have been shaped into a form that is meaningful and useful to human beings« (LAUDON & LAUDON, 2006, P. 13). It is »contained in descriptions, answers to questions that begin with such words as who, what, when, where, and how many« (ACKOFF, 2010).

KNOWLEDGE

»Knowledge builds on information that is extracted from data [...] While data is a property of things, knowledge is a property of people that predisposes them to act in a particular way« (BODDY, BOONSTRA, & KENNEDY, 2005, P. 9).

Rowley (2007) writes: »Pearlson and Saunders [(2004)] concur that knowledge is information from the human mind and includes reflection, synthesis, and context: ›Knowledge consists of that mix of contextual information, values, experience, and rules [...] Knowledge involves the synthesis of multiple sources of information over time. The amount of human contribution increases along the continuum from data to information to knowledge‹ [(PP. 13 – 14)]« (P. 172).

WISDOM

Wisdom is only defined and discussed in a very small subset of the literature and not considered very elaborately. Rowley (2007) writes: »Jessup and Valacich [(2003)] see wisdom as accumulated knowledge, which allows you to understand how to apply concepts from one domain to new situations or problems« (P. 174).

TRANSFORMATION PROCESSES

In order to move from one stage of the pyramid to the next a transformation process of some kind is required: Bellinger, Castro and Mills (N.D.) argue that these transformation can be seen as different ways of »understanding«: »They suggest that moving from data to information involves ›understanding relations‹, moving from information to knowledge involves ›understanding patterns‹, and moving from knowledge to wisdom involves ›understanding principles‹« (ROWLEY, 2007, P. 166).

In her own version of the pyramid Rowley (2007) names a number of variables that increase as the pyramid is climbed upwards: »Meaning«, »Applicability«, »Transferability«, »Value«, »Human Input« and »Structure«. At the same time »Computer Input« and »Programmability« decrease (ROWLEY, 2007, P. 176).

Different Kinds of Knowledge

Multiple taxonomies for classifying different kinds of knowledge have been developed.

A PRIORI AND A POSTERIORI

»A Priori Knowledge« is knowledge that can be derived from reasoning, without experiencing something. A typical example of the is a mathematical equation. »A Posteriori Knowledge« on the other hand stems from having an experience, and then gaining knowledge by reflecting on this experience (GEMMA, 2014).

Gemma (2014) notes that »[i]t is believed that a priori knowledge is more reliable than a posteriori knowledge [because] everyone's experiences are subjective and open to interpretation«.

EXPLICIT KNOWLEDGE, TACIT KNOWLEDGE AND EMBEDDED KNOWLEDGE

A classification more typically used in Knowledge Management literature is »Explicit Knowledge«, »Tacit Knowledge« and »Embedded Knowledge«. Explicit Knowledge is »know-what« that can be formalized and codified. It can quickly be transmitted from one person to another (GEMMA, 2014) and is often organized systematically. It can be found in notes, document and databases (FROST, 2017).

Tacit Knowledge is »know-how«, that is intuitive, experience-based, rooted in context. It is regarded as being the most valuable source of knowledge (FROST, 2017) and is very hard to codify, store and communicate.

Embedded Knowledge is »locked in processes, products, culture, routines, artifacts, or structures« (PECORINO, N.D.). It is different from Tacit Knowledge in that it is not bound to a person, but rather can be distributed among a group of people. It can be formalized in rules and codes of conducts, but also be kept unformalized in the culture or ethics of an organization (FROST, 2017).

PROPOSITIONAL KNOWLEDGE AND NON-PROPOSITIONAL KNOWLEDGE

Propositional Knowledge is knowledge »of« something and can be expressed in propositions and is seen in contrast to Non-Propositional or »Procedural« Knowledge, that is knowledge »how to do« something (GEMMA, 2014). There are different kinds of Propositional Knowledge: Logical (»the result of the understanding of the relationship of ideas to one another«), Semantic (»the result of learning the meaning of words«), Systematic (»the result of learning a system of words, or symbols and how they relate to one another and the rules of operating in that system«) and Empirical (»knowledge that comes through our senses«) (PECORINO, N.D.).

Bruner: Representations of Knowledge

Bruner (1964) describes three »systems of processing information by which human being construct models of their world: through action, through imagery, and through language« (P. 1). He developed this classification in order to describe how children can solve more abstract problems as they grow older. However while these representations develop after each other, all of them remain »more or less intact throughout life« (BRUNER, 1964, P. 2). It's interesting however, that the ability to solve complex problems correlates greatly with the ability to use symbolic representation: Bruner considers »language as an instrument of thought« (BRUNER, 1964, P. 13).

»If we are to benefit from contact with recurrent regularities in the environment, we must represent them in some manner. [...] [T]he most important thing about memory is not storage of past experience, but rather the retrieval of what is relevant in some usable form. This depends upon how past experience is coded and processed so that it may indeed be relevant in the present when needed. Then end product of such a system of coding is what we may speak of as a representation.«

BRUNER, 1964, P. 2

Bruner describes representations as means by which situations are remembered (and manipulated) in the mind, but they can also be useful when talking about how to represent knowledge in a specific form of information. Each representation enables a specific kind of thinking and makes other kinds more difficult. Because of this, using the most appropriate kind of representation is crucial in order to enable to most productive use of knowledge in a certain situation.

ENACTIVE REPRESENTATION

Enactive representations means representing »past events through appropriate motor response« (BRUNER, 1964, P. 2). An example of this is remembering a certain movement as »muscle memory«: Riding a bicycle or walking down a stairway are actions that can be easily performed, but are hard to describe because they are only represented as actions in our memory.

ICONIC REPRESENTATION

Iconic representation means representing events by »the selective organization of percepts and of images, by the spatial, temporal, and qualitative structures of the perceptual field and their transformed images« (BRUNER, 1964, P. 2). This form of representation is mostly visual, meaning remembering things as mental pictures, that stand for one or more aspects of a situation.

SYMBOLIC REPRESENTATION

Symbolic representations means representing events or things using a system of more or less arbitrary symbols. An example of this is language (both spoken and written), as well as forms of mathematical, musical, or other notation. Symbols can be manipulated, ordered, classified, combined and so on. Because of this Bruner considers symbolic representation the most powerful one:

»Translations of experience into symbolic form, with its attendant means of achieving remote reference, transformation, and combination, opens up realms of intellectual possibility that are orders of magnitude beyond the most powerful image forming system.«

(BRUNER, 1964, P. 13 – 14)

Existing Solutions

We analyzed around 50 applications in detail, in order to get a clearer picture of the current market.

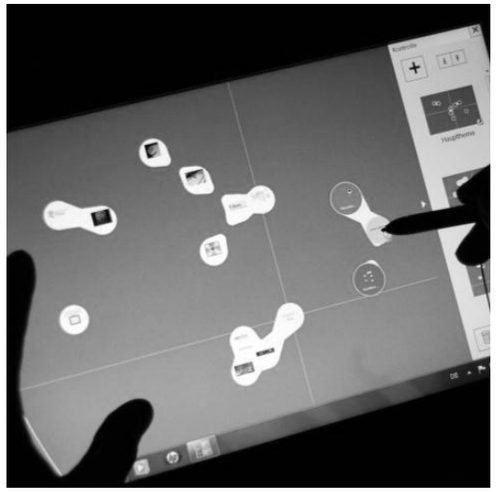
On the one hand we looked into →Creativity Support Systems, most of which come from scientific research projects. On the other hand we looked at different applications for →Knowledge Management, focusing on the consumer facing segment of the market, rather than the vast amount of highly specialized applications focused at professional users.

We purposely considered simpler and smaller applications in our research, like note-taking applications, as these are the main touch point with knowledge management systems that most people face, rather than the complex solutions that exist as well but are not widely used.

We grouped the applications into categories to get a clearer picture of what kind of functions they use to support creativity.

→ **Creativity Support Systems** (P. 41)

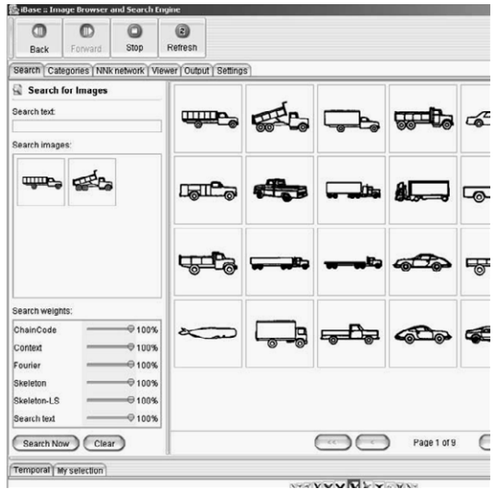
→ **Knowledge Management** (P. 43)



Visual Problem Analysis: These tools try to help the user comprehend a topic better by providing links and connections between different problems and related aspects.

Examples: BrainDump (BRADE, HESELER, & GROH, 2011)

Creativity Support Systems



Visual Creation Tools: Tools focussing on visual creations provide helpful feedback during the process of expressing thoughts visually within the ideation phase.

Examples: VisuaPedia (TAN, TRIPATHI, ZUIKER, & SOON, 2010), MICA-Graph (GARDONI, BLANCO, & RÜGER, 2005)

Brainstorming Tools: Tools supporting the brainstorming process are focussing on collaboration or AI based companions to create a huge diversity of ideas and thoughts.

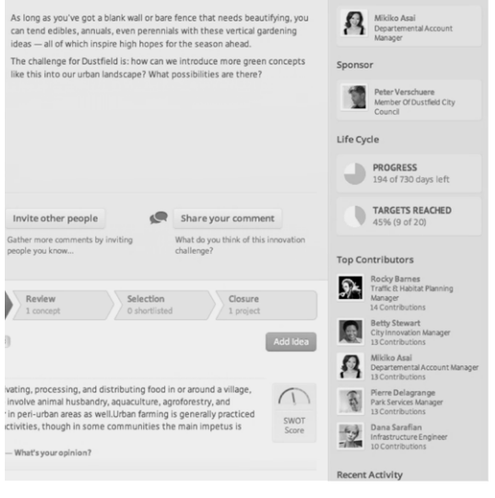
Examples: Idea Storming Cube (HUANG, YEH, LI, & CHANG, 2010), IdeaStream (FORSTER, FRIESS, BROCCO, & GROH, 2010), Pictionare (HARTMANN, MORRIS, BENKO, & WILSON, 2010)

Inspiration Tools: By highlighting current trends or displaying the solutions to related problems these tools try to stimulate and help users to come up with new ideas.

Examples: IdeaInspire (CHAKRABARTI, SARKAR, LEELAVATHAMMA, & NATARAJU, 2005), Trends (SETCHI & BOUCHARD, 2010), Idea Expander (WANG, COSLEY, & FUSSELL, 2010)

Idea Validation Plattform: Mainly focussing on collaboration in teams and companies these tools provide mechanisms to identify good ideas by voting or discussing them within the context of digital platforms.

Examples: PIT Idea Management Software (BELLANDI, CERAVOLO, DAMIANI, FRATI, & MAGGESI, 2012), CogniStreamer



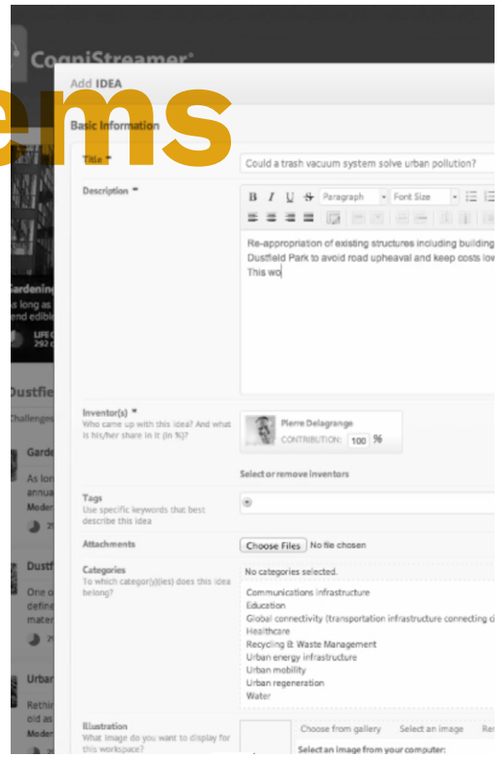
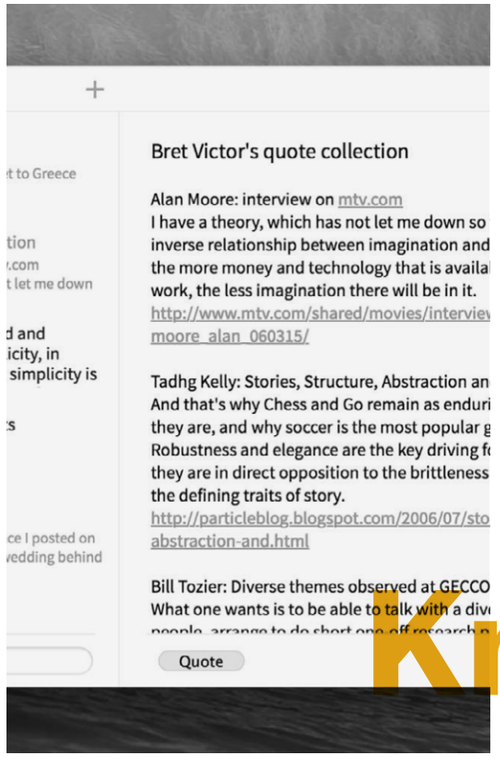
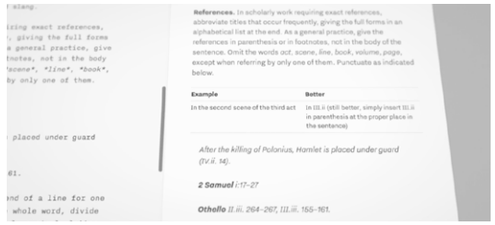


Figure 08: **An Overview of Creativity Support Systems**



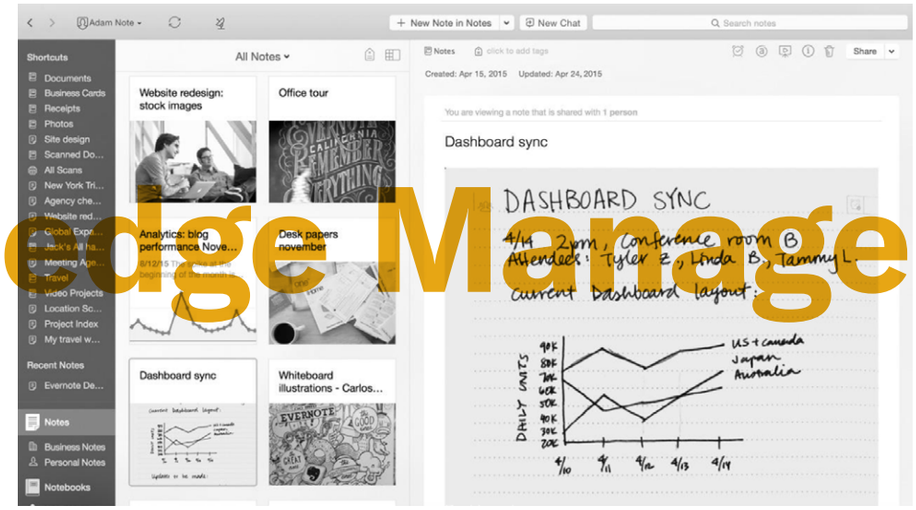
Note-Taking: In contrast to personal Knowledge Management tools note-taking applications are not focused long term usage. These applications provide functions to quickly document notions.

Examples: Apple Notes, Google Keep, Bear, Simplenote, TiddlyWiki



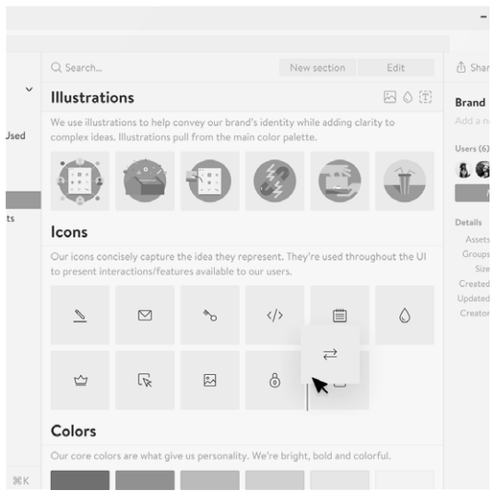
Word Processing: Tools that helps users to create, format and edit texts and documents.

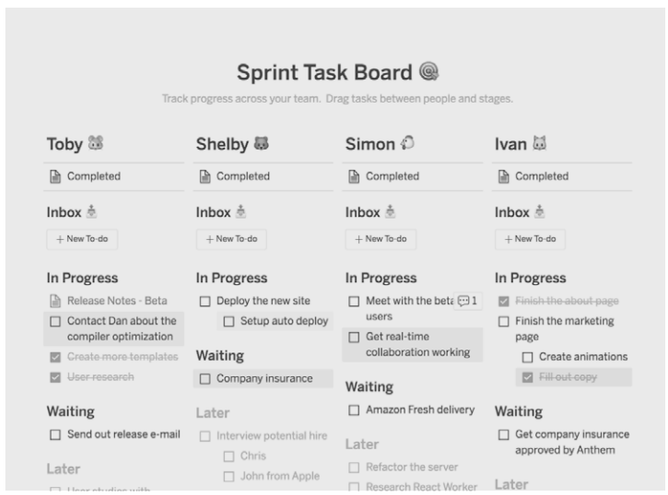
Examples: iA Writer, Apple Pages, Microsoft Word, LaTex Editors



Personal Knowledge Managemen: Personal knowledge management tools help single users to manage, create and collect information and to easily access it over time.

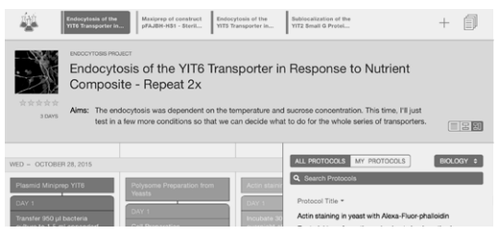
Examples: DevonThink, Evernote, Together, Microsoft OneNote





Specialized NoteTaking: This sort of tools are based on the principles for note taking, but are designed for highly specific use cases, like a lab book for scientific research.

Examples: Findings



Visual Collection: Visual collection tools help users to collect and manage different types of media.

Examples: Pinterest, Lingo, Pixave

Organizational Knowledge Management: This category of tools is focussing on creating a large and collaborative collection of information within an organization, which other members can contribute to.

Examples: Wikis, Notion

Figure 09: **An Overview of Knowledge Management Applications**

Knowledge Management

Criteria

In order to compare the applications with each other we defined seven scales of aspects relevant to the ideation process and rated every application on each of them.

PERSONAL USE – COLLABORATIVE USE

Is the application built for personal or collaborative use?

NO SMART FUNCTIONS – SMART FUNCTIONS

Does the application use smart functions like automatic text analysis or pattern recognition?

FEW MEDIA TYPES – MANY MEDIA TYPES

Is the application built for a small amount of media types (e.g. just text) or does it support many?

SIMPLE SYSTEM – COMPLEX SYSTEM

Is the ways the information can be structured in the application simple or does it allow for complex relationships?

LOW EFFORT – HIGH EFFORT

How much effort is required of the user to effectively use the application?

SHORT TERM USE – LONG TERM USE

Is the application designed for short term or long term use?

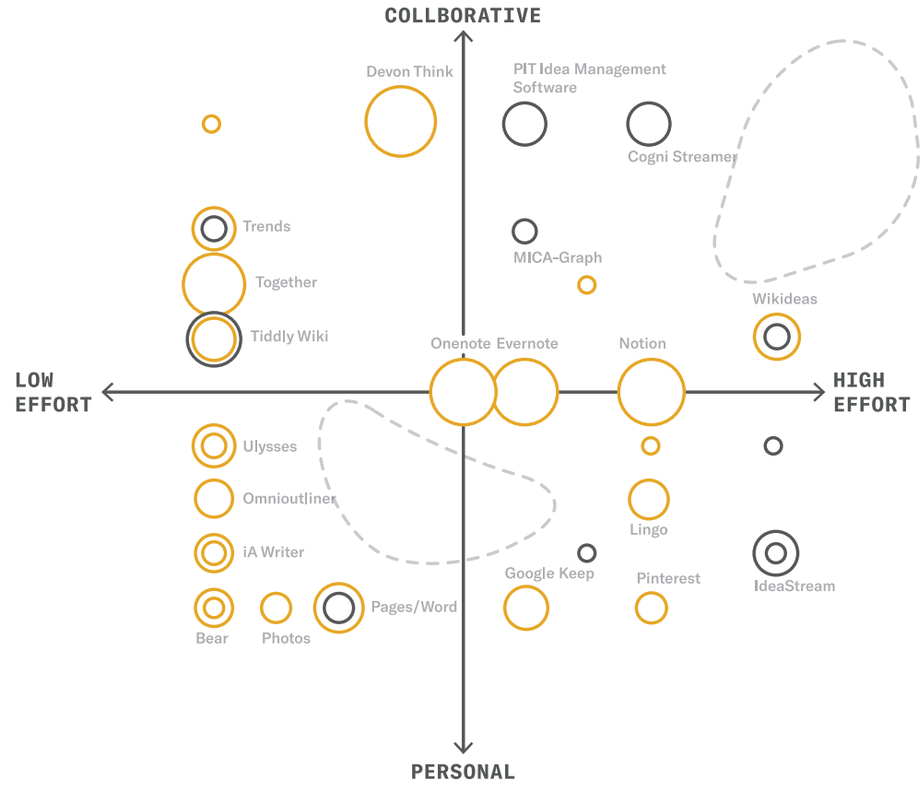
NO INTEGRATIONS – INTEGRATION WITH THIRD PARTY APPLICATIONS

Is the application integrated into an ecosystem or does it stand by itself?

We rated every application on every scale and assigned numeric values for each criteria.

Graphs

In the following step we chose two scales to compare with each other and created simple charts, using each scale as one axis. In all graphs the size of the applications reflects the amount of supported media types, while the color identifies it as an Knowledge Management tool or a Creative Support System.



PERSONAL USE – COLLABORATIVE USE AND LOW EFFORT – HIGH EFFORT

By comparing the level of collaboration and effort two main gaps became visible. First, we identified a lack of expert-focused systems with a high focus on collaboration. Although Evernote and OneNote represented a good balance of making it easy to store things and making collaboration possible, we identified a second lack for personal applications with interfaces for collaboration and requiring low effort to stay updated.

Figure 10: **Use and Effort**

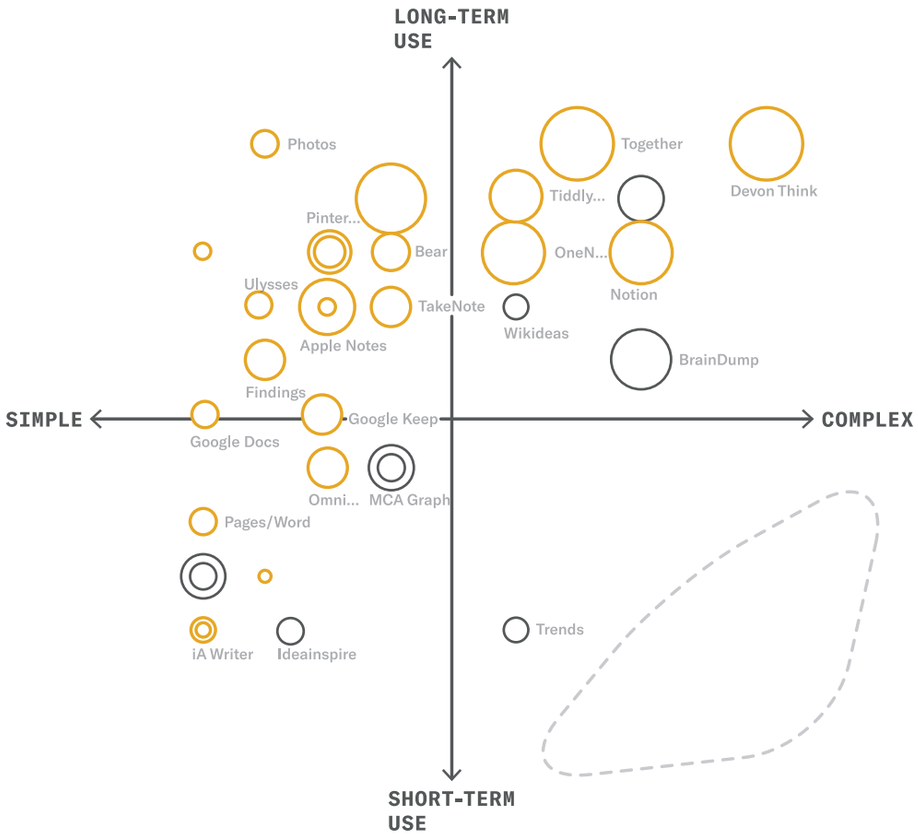


Figure 11: **Complexity and Duration**

SIMPLE SYSTEM – COMPLEX SYSTEM AND SHORT TERM USE – LONG TERM USE

While taking a look at the graph comparing the level of complexity and the term of use we realized a lack of applications with a high focus on long term use and a simple usage.

NO INTEGRATIONS – ECOSYSTEM AND NO SMART FUNCTIONS – SMART FUNCTIONS

This graph showed a lack of smart applications that are not part of an entire ecosystem, as well as a lack of highly integrated applications with some amount of smartness.

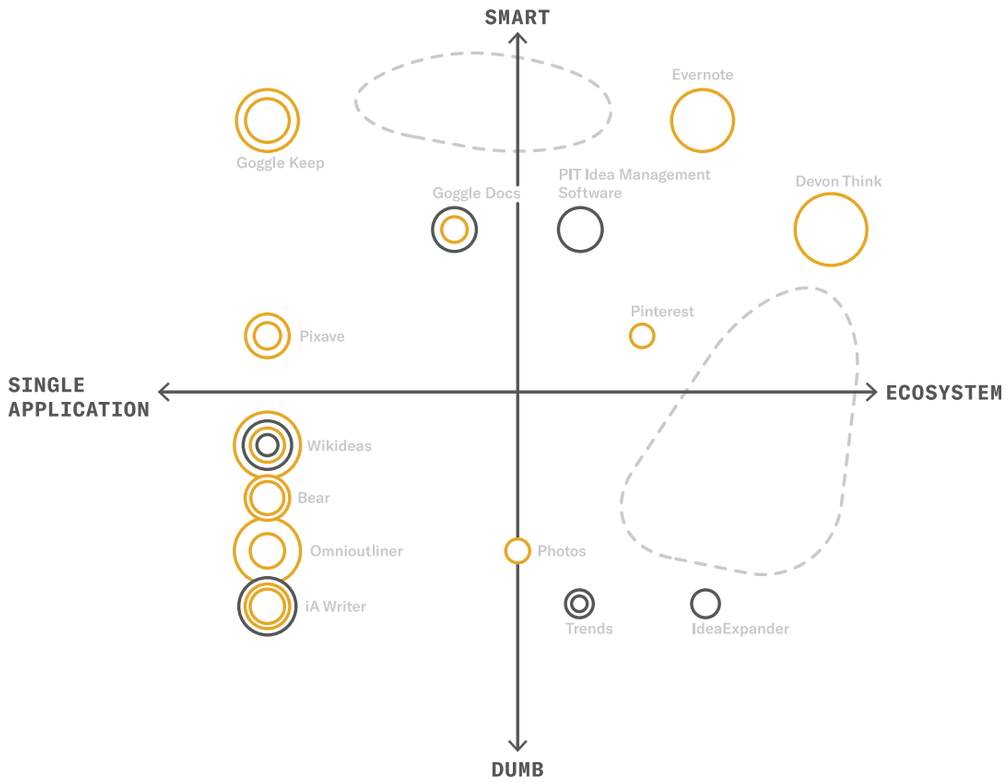


Figure 12: **Integration and Smartness**

Conclusion

The main conclusion regarding Creativity Support Systems are that they are mostly focused on a very specific step in the creative process: we couldn't find any system that covers the three phases of the ideation process (GABRIEL, 2016, P. 117). Most of them are focused on inspiration and the expression and communication phase of the process.

The Knowledge Management tools put their entire focus on collecting and organizing information, not the development and maturing of ideas and ideation in general. Especially the process of combining previously unconnected thoughts is neglected and only rarely considered at all.

Part 02

Synthesis

01 Design Sprint

02 Design Values

03 Basis of the Framework

After our research we did a quick Design Sprint to try out a couple of first concepts and get an idea of where our project could lead. Afterwards we focused on building the Basis of our Framework, looking at what actions it would have to perform and how those should be designed.

Chapter 01

Design Sprint

To get some ideas that we had develop during research off of our minds we did an early Design Sprint. It helped us consider our goals, what we would consider a failure of the project and which parts of the creative process could be supported.

Introduction

During the fourth week of our project we conducted a design sprint based on the Sprint concept brought to life by the design team of Google Ventures.

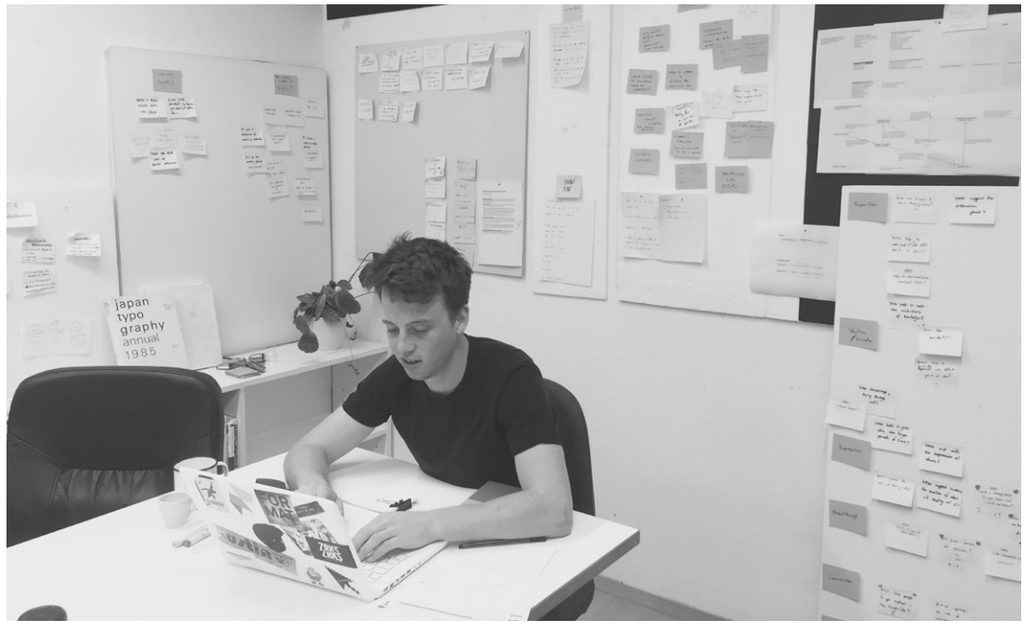


Figure 13: **During the Sprint**

Google Ventures describes a Sprint as »a five-day process for answering critical business questions through design, prototyping, and testing ideas with customers« ('THE DESIGN SPRINT – GV', N.D.). It usually consists of five days of close collaboration between a cross-disciplinary team in a company: Monday is for planning the path ahead, Tuesday is meant for ideation on existing and novel ideas. On Wednesday the team decides for a solution to test, which is prototyped on Thursdays. On Fridays the built prototypes are tested with real people. Using the sprint process teams can go from ideation to actionable test-results in just five days.

Our goal was primarily to explore the space we had opened up during our research, find and test a few promising ideas. We adapted the process and did some changes to make it fit our needs. We extended the ideation phase as there was no need to onboard other team members.

Goals and Questions

On Monday we reflected on our long term goals and how we might fail, and created a list of »How Might We«-questions, that we could try to answer during the week.

Long Term Goals

Framing our long term goals at the beginning of the sprint helped us to more clearly define what we are aiming for with this project. This set the stage for the further ideation phase.

- Build a place where ideas can grow.
- Help individuals (by themselves and in teams) grow more and better ideas.
- Create a digital »Second Brain«.
- Take the fear off of being wrong.
- Help people to create and grow ideas.
- Help to find better solutions for more problems.

How Might We Fail?

Questioning how we might fail proofed to be a helpful step in thinking about what we wanted to accomplish. We not only talked about the question of how we might fail, but also discussed our underlying assumptions. This also provided a helpful basis for defining our →design values later on.

→ **Design Values** (P. 73)

THE RESULT IS JUST ANOTHER NOTE TAKING APP

Within the creative process the recombination of gained knowledge is important. In the preparation phase note taking apps can help to create a storage, but to enable new ideas different functionalities have to be available as well.

THE SOLUTION IS TOO BIG

We have an over complicated concept, which is too hard to communicate and too hard to use.

IT'S JUST A COLLECTION OF CREATIVITY METHODS

There are already enough creativity methods and just creating a collection of them (or developing a new one) does not do justice to the power of digital applications.

IT FORCES A STEP-BY-STEP PROCESS

The creative process is not linear. Forcing a step-by-step process on users therefore cannot help to grow ideas, it will rather prevent them from growing because it is too rigid.

IT'S TOO THEORETICAL OR TOO MODEL/SYSTEM ORIENTED

The models offer a good way of talking about the creative process. However they are just models and not exact representations of the true process. While they can inform our decisions, our main focus should be on building for actual people.

IT'S AT THE WRONG PLACE

Ideas happen everywhere. It's too easy to lose focus and just built for a specific platform out of habit. We need to carefully consider what the best places for supporting ideas actually are.

WE UNDERESTIMATE THE MENTAL ASPECT OF IDEATION

The process at the center of ideation can only happen within the mind. We should try to support this process rather than replace it.

WE TRY TO MAKE IT TOO RIGHT OR OUR SCOPE OF USERS IS TOO BIG.

By trying to solve the ideation and problem solving process for everyone it gets too complex and it lacks a clear direction. This might result in a very undefined direction of our result.

»How Might We«-Questions

During our research we discovered that the area around information collection and knowledge management is vast. We collected »How Might We«-questions, aligned them to the process model of ideation and innovation and identified the questions that seemed the most interesting to us through voting.

PREPARATION

How might we make it easier to search through own archives?	All ideas are based on knowledge. Having a large archive of wide knowledge improves the ideation process. In order to free up the mind some knowledge has to be collected as information. Making this information easily searchable, so that it can be turned into knowledge again more quickly makes it possible to have more knowledge at hand at any time, allowing for better ideas to develop.
How might we help to understand information with different points of view?	»Blockades by Perception« are one of the most fundamental barriers inhibiting us from creating new ideas, because they happen on an unconscious level. Helping users to overcome those by supporting them to look from a different point of view could improve the amount and quality of ideas.
How might we help to reactivate/grow unmatured ideas?	Some ideas get put aside, but they could be valuable if developed further. Looking at ideas with a fresh set of eyes can help to find the ones that are worth revisiting.

IDEATION

How might we help to create new combinations of knowledge?	Bisociation is at the center of the ideation process. Supporting this process would improve the amount of new ideas created.
How might we foster serendipity?	Through serendipity great breakthroughs can happen, but a too neatly organized collection of thoughts can prevent it.
How might we encourage trying things out?	Ideas develop and ripe through speculation. Making it easier to try out different things helps validating ideas and increases the chance of coming up with new ones.
How might we help to embrace failure?	Trying out new things will often result in failure. This is part of the process and actually a good thing. Making this clear will encourage users to try out things and thereby come up with new ideas.

EXPRESSION

How might we help to grow ideas over longer periods of time?	Ideas do not happen in an instant, they need to grow over time.
How might we aid with the expression of ideas?	Many ideas don't grow because expressing them is hard or requires abstraction (thereby changing the idea). A way to more directly express ideas will help to make it easier to record and continue developing them.
How might we communicate the value of a note?	The real value of a note is how much time we spend on its creation, iteration and further development. When presenting notes to the user, communicating the value of the note can help them find the ones that they understand the fastest, because they have already spent much time on it.
How might we support increasing the number of ideas and dealing with it?	Increasing the number of ideas increases the chance of finding a good one. But it also increases the cognitive load, making it harder to recognize good ideas. Helping users collect many ideas and dealing with them in an effective way will increase the number of good ideas.
How might we create a place to save ideas and unload your brain?	Keeping things in your mind increases the cognitive load, making it harder to find new ones. Unloading your ideas to a place where they are easily accessible helps free up »space« and allows you to focus on new things.
	Ideas that are not pursued anymore become part of your collection of knowledge. Sometimes you come back to them, and you might find a gem in there. Building a place to keep them and develop them further helps to let go of ideas (because they can be retrieved later) and find which ones keep popping up in your head.

BREAKTHROUGH

How might we help to recognize good ideas?

According to Linneweh (1994) the creative person is someone who recognizes the potential of a good idea (P. 60). Having a good idea is not enough, it needs to be recognized so that it can be developed and shared with others.

How might we break barriers and censors?

Barriers in our minds and external barriers are one of the main reasons why inhibting the creation and validation of ideas.

How might we raise awareness of barriers?

A first step in order to overcome these barriers is to be aware of them. Highlighting which barriers might currently be blocking the user might help to rethink her viewpoint.

COMMUNICATION

How might we help people to get feedback on their ideas?

The more ideas are shared, the more connections can happen. Additionally, most ideas grow and mature through collaboration.

How might we increase the rate of communicated ideas?

The more ideas are communicated the better the chance of someone else contributing something valuable.

VALIDATION

How might we make it easier to receive feedback on ideas?

Getting feedback that is helpful and actionable increases the chance of an idea being improved. Making it easier to give and receive this kind of feedback therefore can help foster the development of ideas.

Crazy-8's

After voting on the »How Might We«-questions we decided to ideate on the areas of Expression, Breakthrough and Communication. We used Crazy-8's to generate a large variety of ideas, which we clustered into groups in a following step.

HOW MIGHT WE CREATE A PLACE TO SAVE IDEAS AND UNLOAD THE BRAIN?

Intelligent Ranking

Easy & Rich Input

History/Evaluation of Ideas

Time Restricted Information/Ideas

Open Questions through Notes and Commments

Black Box for Unloading Your Brain

Storage

Connected Ideas/Sources

HOW MIGHT WE BREAK CREATIVE BARRIERS AND INNER CENSORS?

Augmented Output

Additional Information

AI Analysis + Feedback

Creative Stimuli

Privacy

HOW MIGHT WE HELP PEOPLE TO GET FEEDBACK ON THEIR THOUGHTS AND IDEAS?

Improve Sharing

Connect People

Allow Commenting

Communicate any Changes

Live Broadcasting of Note Taking

Ideation – Crazy-8's

Figure 14: **Crazy-8's from our Sprint**

Concepts and Prototyping

We decided on concepts that we wanted to test, developed user flows for them and built prototypes.

As a next step we voted for the concepts to pursue, build and test within this sprint and marked interesting clusters to keep in mind. We decided on two concepts and created a storyboard and user test flow to prepare our tests.

The Inspirationalist

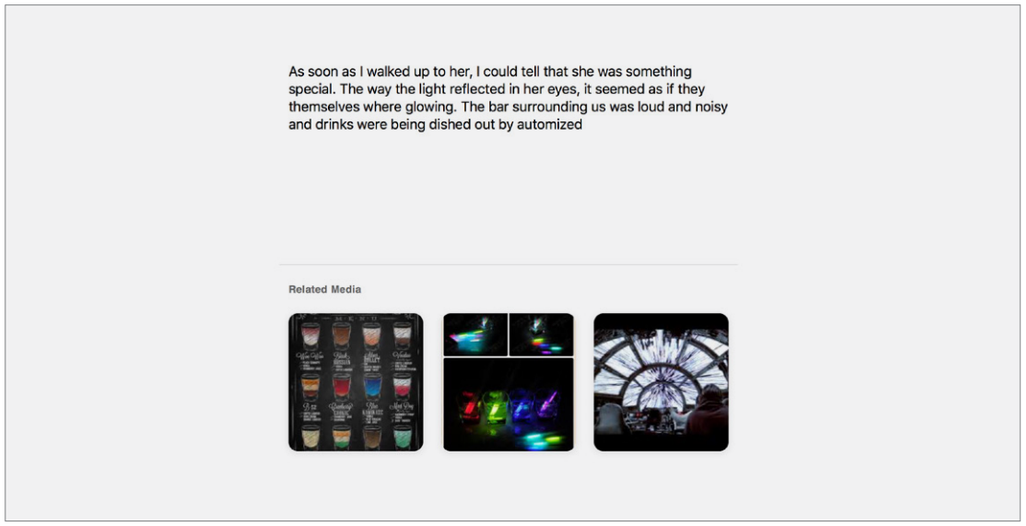


Figure 15: **Prototype for »The Inspirationalist«**

HYPOTHESIS

Through showing images that are related to the content that the user is currently writing about, ideas and thoughts can flourish.

FLOW OF USER TEST

After asking the testee a few introductory questions about how they collect information and get inspired we asked them to perform two main tasks: The first task was to think and write about ideas for how the queue in the cafeteria in Schwäbisch Gmünd could be improved. This should force the user to think about a solution – a more classic problem solving process. The second task was to write the introduction for the fictional short story »My Romance with a Robot«. With this creative task we wanted to compare if the user behaves differently when trying to perform a more open task.

PROTOTYPE

Using React, Keyword Analysis and the Bing Image Search API we built a quick prototype that displays images related to the sentence the user is currently typing and the bottom of the screen.

The Sharing Configurator

Figure 16: **Prototype for »The Sharing Configurator«**

HYPOTHESIS

Through having more refined options for configuring how ideas are shared users are more willing to share earlier and more often, breaking barriers that are stopping them from it now.

FLOW OF USER TEST

The introductory questions to this test focussed on how the user felt when sharing unfinished thoughts and ideas. We prepared a text describing a problem at an imaginary company: the handoff between designers and developers could be improved. The text stated how it could be improved, but it was written in a very rough style and slightly too personal against one employee. With this we tried to recreate a feeling of insecurity. We then asked the user to open the sharing settings and openly explain what they were seeing and trying the different functionalities. At the end we asked what they think about the concept of anonymously sharing an idea within a closed network (of colleagues, etc.).

PROTOTYPE

We built a prototype that looks familiar to many existing applications. The users can mark the state of the document, adjust which types of comments are allowed and block out specific parts. Additionally they can share the note in anonymously in their network.

User Tests and Results

We took both prototypes and showed them to potential users, watching their reactions and asking for their feedback.

We interviewed six people and showed all of them both prototypes. The results varied: Some people had difficulties, because the first prototype required them to write in English, which they were not used to. But even the people who did not have a problem with writing did not use the images as inspiration.

Since the text in the second prototype showed some open problems in the political structure of the company, the feedback was mostly that sharing this kind of idea would be the wrong way to tackle this problem. This made it hard for them to use the sharing settings. One big barrier for sharing that came up as well was that sharing an idea always means risking it getting stolen. We realized that a lot of barriers that could be teared down would require that a company supports an open culture of discussion.

Conclusion of the Sprint Week

In retrospect we consider the Sprint part success and part failure.

Our ideas were pretty broad after the first weeks of research, but we couldn't really grasp what the overall concept was. In retrospect, it seems like we started the sprint too early, because we wanted to get away from working purely theoretically. But we recognized that we did not yet have a sound basis to base our feature ideas on. We used this insight in the following weeks to work on creating this base. Yet, the Sprint still showed us a great overview of possible solutions and made us aware of problems users have and are aware of, as well as those that they are not actively aware of. The range of ideas created during the ideation phase also helped us grasp the extent of aspects that our systems needs to be supporting and group them into different clusters of actions.

Chapter 02

Design Values

We derived five statements that express our sentiments towards the relationship of certain opposing values. These Design Values are supposed to show on which values we want to put special weight: They do not show an either-or attitude, but an emphasis on one value. They are derived from our goals and thoughts on how we might fail during our Sprint, as well as insights gained from looking at different models of the creative process.

Behavior over Process: Rather than getting the user to learn and use a new process, the framework should first try and adapt to the user's behaviour. Using the framework needs to be seamless and smooth. It should be an extension of the mind, not a cage.

Emergence over Structure: Rigid structures inhibit the creative process. The framework should value the emergence of patterns and connections as they are happening and needed, rather than being fixed on a structure completely built by the user.

Privacy over Openness: Creativity is at its core a private, intimate process. Giving the user a space to develop his thoughts requires his trust. His privacy must be valued highly. This is especially important when considering how to help the user overcome barriers.

Collaboration over Solitude: In a modern environment collaborative creativity plays a central role and is key to a successful creative process. The creative process can benefit from solitude in the beginning when ideas are very vulnerable. But in the long term collaboration is a pillar of creativity.

Proactive over Reactive: Instead of always waiting for the user's action, the framework should proactively curate and augment the input.

Chapter 03

Basis of the Framework

In order to have a sound base to built upon we considered – in abstract terms – what we want to built and how it should be designed. We discussed which actions need to be accomplished by using our framework and how it fits into the space of personal knowledge. We derived Design Goals, helping us to focus on how we can reach our goals.

Outline of the Framework

The framework is built around the actions and properties of the mind and serves as an extension thereof. The mind and the framework have interfaces on two sides: Retrieving Artifacts and Understanding, and Expressing Ideas and Creating Artifacts.

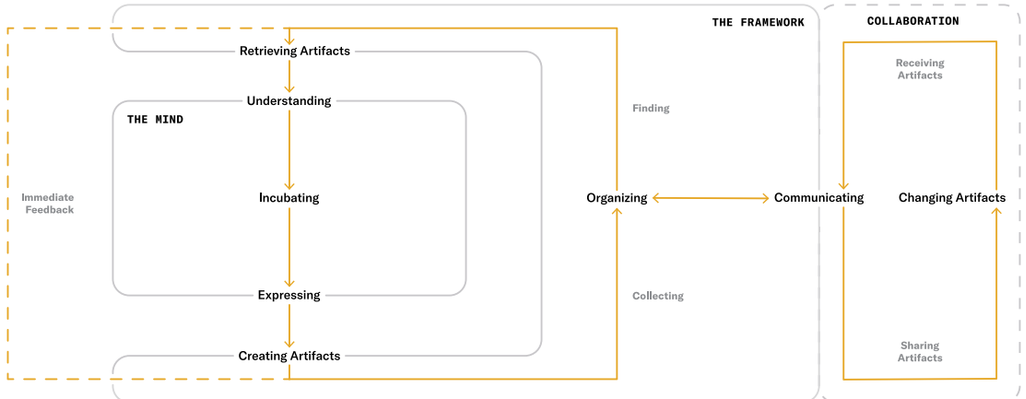


Figure 17: **Actions in the Framework**

→ **Cognitive Processes: Bisociation** (P. 17)

→ **An Availability-Based Classification of Knowledge** (P. 80)

Incubating

Incubation is the central creative process of the mind. It is where new ideas are created through →bisociation. This process cannot be externalized and automated. Therefore – in order to support creativity – the outside conditions for this process have to be optimized. We consider the outside conditions to be the knowledge that is →available (or within reach) to be used for bisociation, as well as the ability to express thoughts and ideas.

Artifacts

Artifacts are pieces of information that represent knowledge (once) possessed by their creator, that can be used to recreate this knowledge.

Interface: Understanding – Retrieving Artifacts

Artifacts can be used to retrieve some or all of the knowledge encoded in them through understanding. The information in the artifact has to be understood by the mind in order to be turned into knowledge, which can then be used for the incubation of new ideas (either directly or after being stored in the long-term memory). How much knowledge can be (re-) created from the artifacts depends on multiple factors: The quality and information richness of the artifact plays the largest role. But it also makes a difference if the recipient is the same person as the creator and how long back the artifact was created. Depending on this, additional knowledge that is not encoded in the artifact may be retrieved from the brain.

Interface: Expressing – Creating Artifacts

Through the expression of ideas, thoughts and knowledge in general, artifacts are created. These can be collected, organized, shared and retrieved. The goal of creating artifacts needs to be to capture as much of the knowledge in information as possible.

The creation of artifacts itself can support creativity, as different forms of representing knowledge allow for different ways of thinking and additional information can be added by the system during the creation (through computation of models and augmentation). If the expression is immediate, a feedback loop can develop, in which the idea is improved while it is expressed.

Organizing Artifacts

The collection of artifacts serves as an extension of the mind and is supposed to increase its storage capabilities. But to turn information into knowledge again and to use it in the incubation it needs to be found. Finding artifacts is made possible by organizing them in a way that fosters this. The organization of artifacts can happen both manually and automatically and finding artifacts can happen both actively and without specific action by the user.

Communicating

Communication is the interface of the system to the outside: To foster collaboration artifacts can be shared with others and artifacts created (or manipulated) by other people can be received.

An Availability-Based Classification of Knowledge

→ **Different Kinds of Knowledge** (P. 45)

We created a classification of knowledge based on its availability (rather than based on its qualities like →tacit knowledge and process knowledge), putting the focus on knowledge that is »stored« for later use.

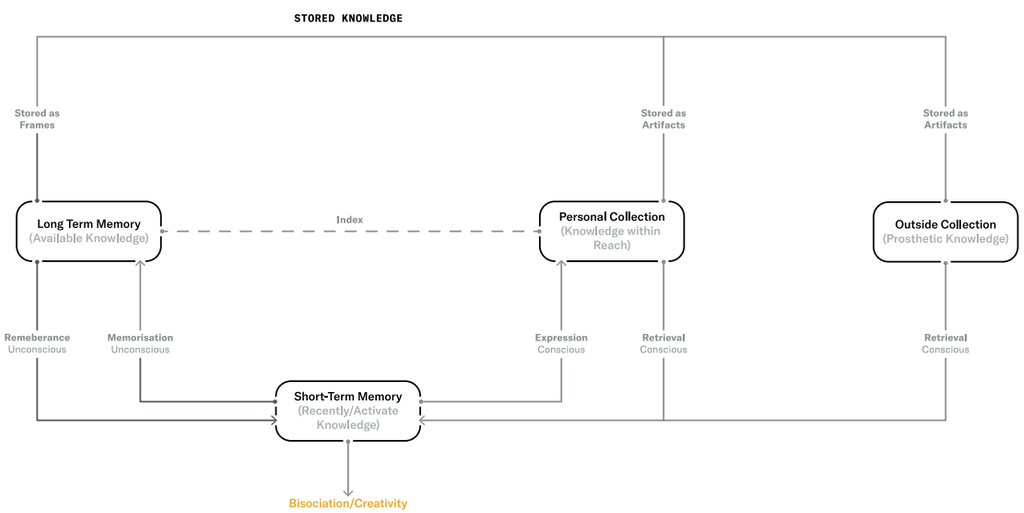


Figure 18: **A Classification of Knowledge**

Recently Activated Knowledge: Short-Term Memory

The knowledge that is used while thinking and that is available for the bisociation process has to be stored in the short-term memory. We call this knowledge »Recently Activated Knowledge«.

Available Knowledge: Long-Term Memory

The knowledge that is stored in the long-term memory is called »Available Knowledge«. It can be transferred to the short-term memory by means of remembrance. Vice versa Recently Activated Knowledge can be turned into Available Knowledge by means of memorization. It is important that both the processes of remembrance and memorization are happening unconsciously, but can be fostered for example by using certain techniques that enhance the chance of knowledge being remembered.

Knowledge Within Reach: Information Collection System

Knowledge that saved to the personal collection by expressing it from the short-term memory, turning it into information and saving this

information in a collection (or saving an expression of the knowledge that someone else created) is called »Knowledge Within Reach«. This knowledge can be retrieved by looking at the information that it is represented by and understanding it. How much can be retrieved depends greatly on the quality of the saved information. Both the transfer from and to the short-term memory require actions that are executed consciously.

Index

The knowledge stored in the collection does not need to be stored in the long-term memory, thereby freeing it up for other knowledge. The mind only needs to know that this knowledge is saved as information, creating a kind of mental index of the collection. With this index one can remember that this knowledge exists within reach and can be retrieved if needed.

Prosthetic Knowledge

There is also a last kind of knowledge: knowledge that one does not explicitly know exists, but that can accessed, should it be searched for. A term used for this kind of knowledge is »Prosthetic Knowledge«. An example might be the knowledge stored in books in a library: The content of each book is unknown, but the knowledge can be gained, should one look for it. Probably the most important collection of Prosthetic Knowledge is the internet. It is a vast collection of human knowledge, all available at one's fingertips by means of looking if it exists.

Design Goals

We defined design goals which describe how the different aspects of the framework should be designed in order to support creativity as much as possible.

General

Designed for Long Term Use: Most ideas don't happen in an instant. They start as hunches and need to be grown and nurtured. This is a process that takes time.

Encouraging Speculation: Trying out many things increases the chance of finding the right thing. Most ideas don't appear finished, continuously iterating them in an evolutionary style is necessary to improve their quality.

Creating and Retrieving in One Place: Creating, editing, organizing and retrieving should happen in one place to lower the friction of the creative process.

Creating Artifacts from Knowledge

Quick: Users should collect as much of their knowledge as possible in the form of information. To foster this the creation of artifacts needs to be quick and seamless.

Appropriate: To collect as much of the knowledge as possible the form of the information has to be appropriate for the knowledge and its context.

Build for Knowledge Retrieval: Artifacts should be constructed in a way that is rich in remembrance and contains as much knowledge as possible.

Immediate: Immediate creation of artifacts can enable an internal feedback loop, where the act of creation becomes the act of understanding and iterating on an idea.

Inter-operational and Open: In the mind, all knowledge is created equal. Different kinds of artifacts need to be able to be combined and connected, so that creativity is not inhibited by technical barriers.

Extendable: New ways of expressing knowledge (like new systems of notation) allow for new ways of thinking. An extendable system can be fitted to the user's need, allowing more complex modes of representation.

Stimulating: Stimulating the user in order to support divergent thinking increases creativity by helping to overcome barriers.

Augmenting: The computer cannot just display the user's input, but also react to it and augment it, for example through computation based on mathematical models.

Collecting, Organizing and Finding Artifacts

Based on the Mind: Forcing a rigid structure based on technical principles and limitations rather than one that resembles the structure of the mind thwarts creativity.

Loose Connections: Less efficient and less rigid networks based on loose connections between pieces of information enhance the bisociation process by turning up unexpected connections.

Effortless: The purpose of the system is to help the user think. Organizing is necessary for the information to be usable, but are only a means to an end and should take up as little time and effort as possible.

Help Making up for a Bad Index: The mental index is unreliable and error-prone: Users forget about information they saved. The system needs to reckon with this and try and make up for a decaying index.

Retrieving Knowledge from Artifacts

Quick and Easy: The retrieval of knowledge is just a means to an end and should take little time and mental effort.

Enhancing: Enhancing the user's input with additional information makes it more helpful and complete and makes for a better understanding of the information.

Supporting Diverse Views: By showing related artifacts that the user might have forgotten, the available knowledge in the mind can be maximized and the chance of bisociation increased.

Help Rebuilding the Index: The mental index decays over time. Since it is the best and fastest way of finding information, maintaining it is part of the system's purpose.

Collaboration

Encourage Sharing: Sharing ideas and information helps to improve the quality of the ideas by offering different points of view and developing them further.

Easy Collaboration: Working on an idea together should be easy and not require any additional steps.

Easy Feedback: Receiving feedback should be effortless and fast. The quality of the feedback should be as high as possible, making acting on it easy.

Contextful Sharing: More context helps the person giving feedback to retrieve more knowledge and therefore improves the quality of their feedback.

Part 03

Concept

01 Documents as Units of Meaning

02 Open and Unrestricted Organization

03 Contextful Working with Documents

04 Tightly Integrated Collaboration

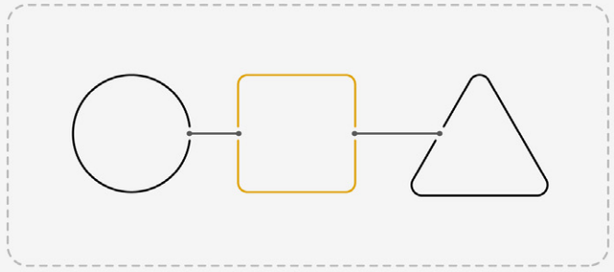
Proceeding from our Design Goals we devised a framework called »Artifacts« – based on its smallest unit of information – for creative expression and knowledge retrieval. It is based on four basic concepts and serves as the central hub for the user's creativity.

Chapter 01

Documents as Units of Meaning

Documents are central to the system. They are where the user expresses her thoughts, nurtures them and develops them further. In documents knowledge is stored in a rich, intuitive and sensible way.

Mixed-Content Documents



Design Goals: Inter-operational and Open Structures, Appropriate Expression of Thoughts, Quick and Easy Knowledge Retrieval

In the framework information is stored in documents, depending on how the user values the information and its semantic affiliation, rather than the technical limitation of files: A document is a is a unit of meaning, as defined by the user. It can be a combination of any types of content, allowing for a maximum of freedom of expression.

In traditional file systems, because of the technical limitation of files, thoughts are often broken apart. In order to use the right form of expression for parts of a thought, one has to scatter it across multiple files or even multiple library applications, or one might have to choose a less appropriate form for the sake of keeping the thought together.

In order to aid with the expression of a thought, to allow users to always choose the most appropriate form of expression and to make knowledge retrieval quick and easy, in the framework, all types of content can be part of one document. What belongs into one document is defined by the user and how he wishes to structure his thoughts, making documents a »unit of meaning«.

Example: One document can include Sketches of Wireframes, UI explorations done with a design application such as »Sketch«, as well as a To-Do List with elements to be added to the design. Another document could be made up of photos taken at a contextual inquiry, recordings of interviews as well as notes in written form.

Therefore, in the framework a document is made up from building blocks, called »Artifacts«, which can be either content types or templates.

Content Types

Content types are the smallest possible unit of information in the system. A content type could for example be »Rich Text«, or »Image«, but also »Written Music«. The decision on what constitutes as a content type is based on what the smallest piece of information is that is of value to the user. For example, a 3D-Model in total might be of value the the user, not every sprite that makes up the shape, making the model the content type and the sprites its data.

A set of basic content types, such as »Rich Text«, »Image«, »Drawing«, »Video« and »Location« come with the system. They offer a very high level of integration and are supposed to cover the basic needs of most users. Additional content types for more specific use cases can be added by installing applications.

EXTERNAL CONTENT TYPES

New content types can be added to the system by installing new applications that provide their content type to the framework. This means that the system is extensible, and the user can fit his set of expression tools to his needs.

Design Goals: Appropriate Expression of Thoughts, Extendable Ways of Expression

Example: After installing the app »iA Writer« on the device, the »iA Writer«-type can be used within documents.

External content types can be integrated with the system in multiple ways:

Preview: They have to provide a preview of their content, which can be interactive.

External Editing: They can offer editing the content with the application.

Inline Editing: They can offer partial or full →inline editing in the document.

→ **Inline Editing and Preview** (P. 94)

History: They can make use of an API that integrates their history of changes into the →history of the document.

→ **History** (P. 109)

Search: They can make use of an API that allows the search of the system to access their content.

Real Time Collaboration: They can make use of an API that allows for Real Time →Collaboration in the external applications via the system.

→ **Live Collaboration** (P. 114)

Variable Output: They can make use of an API that allows them to output variables that can be used by other building blocks and is updated from the content.

Conversion: They can offer conversions to other content type (for example a »Voice Memo« that automatically creates a transcript can offer the conversion to »Rich Text«).

The content of external content type can also be updated from the outside.

Example: The content of the content type »Album« offered by the »Photos« application, which allows user to display one of their albums in the document, can update when a photo is added to the album within the »Photos« application.

Templates

Content types are only one kind of artifacts that can be used in documents: there are also templates. Templates are »blueprints« containing one or more content types or other templates. They define a structure and can have specific required properties, views (defining how the properties are displayed) and functions (allowing the properties to be changed). They can also come with internal sub-templates that can be public or private, so that only they can access them.

Some templates come with the system, but new ones can be created and shared by users. They can be simple and only consist of a structure, thereby allowing users to add multiple content types to a document at once, if this combination is used very often. But they can also be more complex, if they make use of views and functions and can serve as a simplified form of content types.

Design Goals: Quick Expression of Thoughts, Extendable Ways of Expression

Templates can speed up the creation of documents, while at the same time being a fast way to extend the system and add new ways of expression. If a field is so specialized that no application has been developed for it, users can create their own templates, offering basic functionalities and being tailor made for their needs.

STRUCTURE

The structure of the template defines which parts it is made up of. The template can either require specific content types (or templates) or leave an empty spot for any content type (or template). It also defines how many building blocks it contains (a specific number, a maximum or any number).

Example: A »User Research Template« could be made up of an »Voice Memo« for recording interviews, a »Text« building block for jotting down notes and an »Image Collection« to take photos of the situation. A »Crazy-8 Template« could be made up of eight spots of any content type and a »Timer« →function.

→ **Functions** (P. 93)

PROPERTIES

Additionally to the artifacts they contain, templates can also specify required or optional properties. A property is a piece of data that is an additional information about a building block.

Example: A »To-Do List Template« is made up of any number of »To-Do Item Templates«. Each »To-Do Item Template« is required to have the property »State« that is either »Done« or »Undone«, and can have the optional property »Due Date«. A »Recipe Template« could require each ingredient to have the property »Unit«.

VIEWS

The view of a template defines which data and properties are displayed and how they are displayed, as well as which functions are displayed and how they are displayed.

Example: The »To-Do List Template« displays the »State« property of a »To-Do Item« as an active or inactive checkbox and calls a function when the checkbox is clicked. A »Quote Template« displays the »Source« property of a quote underneath. A »Comments Template« displays the »Comments« property of a building block underneath, with an input for the function to add a new comment.

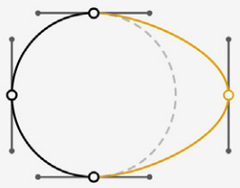
FUNCTIONS

Using a scripting language, functions can be added to a template. Functions are programs that change, replace, add or output data, or that call up other applications giving them data as an input.

Design Goals: Augmenting User Input, Enhancing through Outside Information

Example: The »State« property of a »To-Do Item« gets toggled between »Done« and »Undone«. Various properties of a »Literature Template« are transformed into BibTex and copied to the clipboard. The »Title« property of a »Movie Template« gets used as the input for a search on Netflix. It can also be used to trigger a search on »IMDB« that fills the empty fields (or optional properties) in the template.

Inline Editing and Preview



Design Goals: Creating and Retrieving in One Place, Immediate Expression of Thoughts

Rather than always having to open an application to look at the information and be able to express thoughts, the user should be able to do this right in the document. Because of this, every content type has a preview, displaying its content in an interactive way and many content types enable partial or complete editing inline. This means that users can express themselves immediately, while at the same time having access to complex features in the respective applications.

Every content type needs to offer the system a »preview« that can be shown within the document. This preview is shown when the application only offers external editing or is not installed or available on the device used to look at the document (and possible inline editing is therefore not available). The preview can be interactive and offer different ways to look at the content, allowing for immediate retrieval of knowledge and providing context for the rest of the document.

Example: The preview of the UI design tool »Sketch« could provide a way to select the artboard to be shown.

Content types can be integrated with the system on different levels: They can offer both partial or full editing inline (directly in the document) and external editing (with their respective application).

Inline editing means that the content cannot just be looked at but also be changed right within the document, allowing for quick and immediate expression of thoughts. Simple content types allow full inline editing,

meaning that all their options are available within the document. More complex content types can offer some basic editing for immediate expression right within the document, but offer the full range of options only in their application.

Example: The basic type »Rich Text« offers full inline editing and does not come with an external application: All formatting options are available right in the document. The external type »Written Music« could offer basic editing inline (adding new lines, adding basic notes and rests) while offering full editing only in its application (changing keys, adding lyrics, etc.).

History and Versions

In order to encourage speculation and trying out new things without risk the history of how a document developed is accessible for the user and a document does not have to exist in only one state, but can have many.

History

Design Goals: Encouraging Speculation and Evolution Driven, Build for Knowledge Retrieval

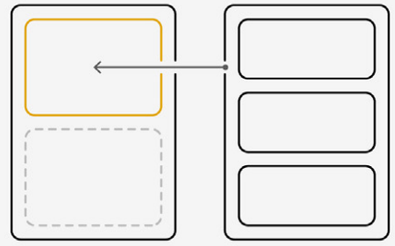
In traditional systems, the history of how a thought developed is lost after saving a file. In the framework the entire history of a document is kept and can be looked at, either just to skim over it, to jump to a previous point in history, or to create a new version of the document at a point in its history and develop it from there.

Versions

Design Goals: Encouraging Speculation and Evolution Driven

Changing a document according to his thoughts is a commitment for the user, because often times, when the changes don't work out, previous versions are lost. It is also hard to develop a document into multiple directions at the same time in order to iterate and compare the results. To solve this problem, in the framework various versions of a document can be kept and each, with its individual history, can be further developed. This is supposed to encourage the user to speculate and work in an iterative fashion.

Transclusion of Documents



Not all thoughts are independent of each other. Embedded documents allow to portray the rich structures that they can happen in.

Design Goals: Supporting Diverse Views, Structure Based on the Mind

In order to allow for more complex constructs of thought, documents can be embedded into each other. This means that one document is not just shown as an individual document in the system, but is also displayed within other documents and can also be edited from there.

If the embedded document is changed in one location the changes are just local at first, until the user takes action and decides to sync his changes to all occurrences of the document. If the document is changed in two locations that it is embedded in (and the changes are only local), when the users syncs his changes from one of those locations he is warned that this will overwrite changes to the document in a different location.

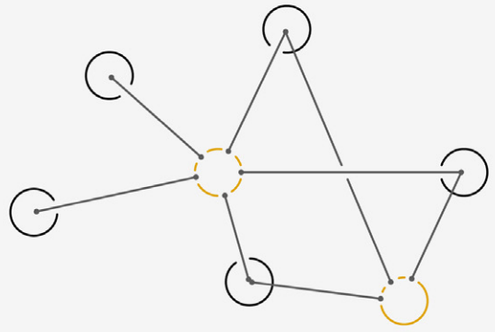
However there is also the possibility to save the (local) changes as a version of the document and display this version in one location, while still displaying the other version of the document in different locations. The same way, if a document has multiple version, in every location that the document is embedded in a version to be shown can be chosen, enabling diverse views on one document in different contexts.

Chapter 02

Open and Unrestricted Organization

In order for the user to use his documents, they have to be organized. In the framework this is achieved with tags defined by the user and automatically collected metadata. For both navigation and search the documents are filtered using these properties.

Organization with Tags



Rather than forcing the users to create a large, inflexible structure to organize their documents, in the framework tags are used to organize documents.

In 1945, before digital computers in the modern sense ever existed, Vannevar Bush (1945) wrote in his famous article »As We May Think«: »When data of any sort are placed in storage, they are filed alphabetically or numerically, and information is found (if at all) by tracing it down from subclass to subclass. It can be in only one place, unless duplicates are used; one has to have rules as to which path will locate it, and the rules are cumbersome. Having found one item, moreover, one has to emerge from the system and re-enter on a new path.« For him, this was a reason to call for the invention of a machine that allows for a new approach to how knowledge is collected and accessed. Instead, when computers became common, their file systems were based exactly on those metaphors that Bush criticized. Now, more than 70 years later, the file system commonly used is still based on the inflexible model of folders.

Design Goals: Designed for Long Term Use, Structure Based on the Mind, Structure Based on Loose Connections

To allow for looser connections, while still enabling users to quickly track down and open their documents, in the framework documents are organized using tags. This means that a document can have any number of tags assigned, and those can be used to find the document in the collection. Tags are more flexible than a system of folders, because while they can also be used to build a hierarchical structure they also allow direct access to lower levels of hierarchy. Additionally, tags have the large benefit that while some tags might stand in relation to each other, others that have no relation can also be added to the document. This means that a single document can be seen in multiple contexts and additional contexts can be added later, without forcing the user to change the existing structure. Users can create their system of organization as they go on and extend it later and do not have to create an elaborate taxonomy beforehand that they then have to adhere to.

Assigning Tags

Design Goals: Quick and Effortless Organization, Help Making up for a Bad Index

While tags as a way of organization come with many benefits, assigning them to a document is often seen as more cumbersome than placing a file in a folder structure. Assigning tags is therefore an integral part of the framework's design and is designed to be as easy and quick for users as possible.

After a new document is created, there are multiple ways in which the framework assists users in assigning tags: The user can add a set of tags to a →workspace which will then be added to each document created in the workspace. This means that when the context of a document can be inferred from the place where the document is created, tags will be automatically added. The system also recommends certain tags to the user. The recommendation is based on a variety of factors, such as the content of the document (and tags given to documents with similar content), the documents opened around it, as well as the tags already assigned. When the system can deduce a →hierarchical structure in the tags that are being used, this is weighted as well. This relevance formula is also used for the recommendations that are displayed as autocomplete, if the user needs to type to find the right tag. When the user saves a combination of tags as a →saved filter it can be used to add multiple tags to a document with just one click as well.

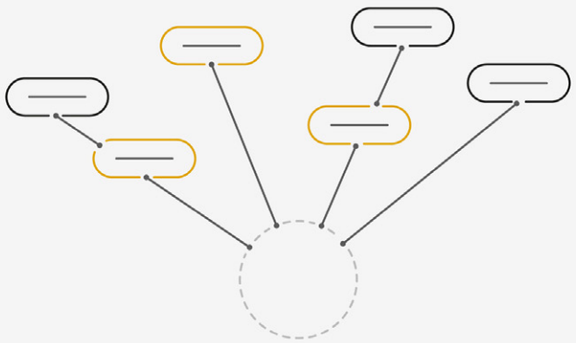
→ **Workspaces** (P. 109)

→ **Hierarchical Structures** (P. 104)

→ **Saved Filters** (P. 103)

All of those features combined make adding tags to a document effortless and help users finding the right tags to add to a document, even if they are not actively aware of their existence.

Organization with Metadata



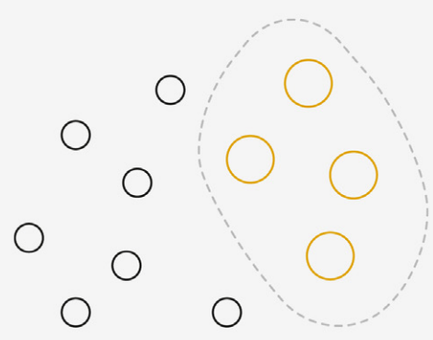
Not just tags can be used to organize documents, but also metadata collected by the framework.

While tags are a great way to manually organize documents into a structure, knowledge in the mind is not organized that way. It is accessed via association and often not the content of the thought, but rather when and how it was conceived are used for remembrance.

Design Goals: Artifacts are Build for Knowledge Retrieval, Structure Based on the Mind, Help Making up for a Bad Index

When a document is created or changed, the framework can record a large amount of metadata. Examples of such metadata are date and time, location, weather, heart rate, music currently playing, SSID of the WiFi and many more. This information can be used to track down the document in the collection if no tags were given or the user doesn't remember them at the moment. It can also be a powerful tool to select collection of documents and create a tag for it (for example all documents at the location of the user's workplace can be tagged with the tag »Work«). Last, the information can also be accessed from the document, helping users to remember the context in which they created it.

Filtering for Search and Navigation



Tracking down a document to open it happens via filtering.

Design Goals: Quick and Easy Knowledge Retrieval, Help Making up for a Bad Index, Supporting Diverse View

When the user wants to track down a document, there are two initial conditions that are possible: First, the user can search for a document. In this case she knows of its existence, but is not sure how to find it. Tags, free text search and metadata are used to narrow down the list of documents until only one is left (or the list of documents is small enough the spot the document in question). Second, the user can navigate to a document. In this case she knows »where« the document is (e.g. which tags are assigned to it) and wants to get there as fast as possible.

In both cases filtering is used to achieve the goal. In the framework, the filter element is designed to allow both quick navigation and precise searching. It shows a list of recommended filters (tags, collaborators and metadata) that can be used for quick access and should suffice in most situations. Additionally all tags and collaborators can be accessed and metadata filters can be configured manually.

Saved Filters

Combinations of filters that are used more often can be saved as »Saved Filters« and be given a name for quick access. If the user wants to navigate to »Work«, »Project 1«, »Prototype« very often, this combination of tags can be saved as »Project 1 Prototype« and be used to filter the collection with just one click.

Metadata Filters

Metadata filters set a range in which the metadata of the documents that are looked has to be. This could for example be »Creation Date between

01.04.17 and 20.05.17« or »Created within 100m of Rektor-Klaus-Straße 100«. These filters can be recommended by the system, but they can also be changed or created from scratch by the user. The system also recognizes Natural Language Input and can turn it into a metadata filter, so that the user can enter »Created this month« and have the right filter inserted. A formalized filter language is used, rather than completly relying on Natural Language, because it makes manipulating the search term later on easier: The variable of filter can be increased incrementally, in Natural Language the term would have to be deleted and typed again.

Context Aware Relevance Algorithm

Design Goals: Supporting Diverse View, Help Making up for a Bad Index

Both the tag recommendations and the list of results use a context aware algorithm to calculate the relevance of items. This is meant to ensure a high probability that a document that the user is looking for is accessible as quickly as possible. Additionally, it is supposed to bring related documents to the user's attention that she might not have been aware of.

TAGS

→ **Workspaces** (P. 109)

Factors that are weighted to create the list of recommended tags are which tags are added to the →workspace; which tags were used for filtering last, or created last, or assigned last; which tags are assigned to the other documents that are currently opened (and which of these documents were edited last) or were opened in the workspace before. Special weight is given to tags that are used high up in »hierarchical« structures:

HIERARCHICAL STRUCTURES

To ensure quick navigation using tags, something that is cumbersome in most systems, the systems recognizes when tags are used to build a hierarchical structure. It uses this information to display the most important tags as recommendations and show the next lower tag based on the tags already used for filtering.

Example: The Tag »ACME Corp« is used in conjunction with »Project 1«, »Project 2« and »Project 3«. It is therefore likely that »ACME Corp« is a tag that is higher up in the hierarchy.

RESULT LIST

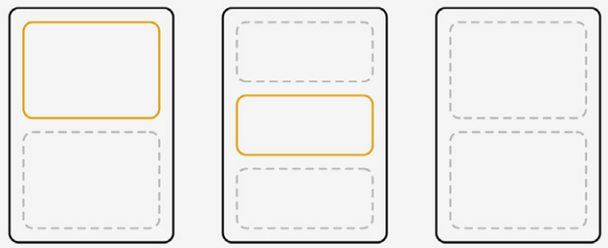
Factors that are weighted to create the list of results are how similar documents are that are currently opened (in tags or in content); if the document was opened in the workspace before; when the document was last edited and other metadata (for example if the current location is close to the location where the document was created); and the »Investment« that the user made in the document (e.g. how much time was spent editing the document).

Chapter 03

Contextful Working with Documents

To make effective work with the framework possible, users can have multiple workspaces in which they can open their documents. Workspaces add context and are the place where users can find inspiration.

Multiple Documents

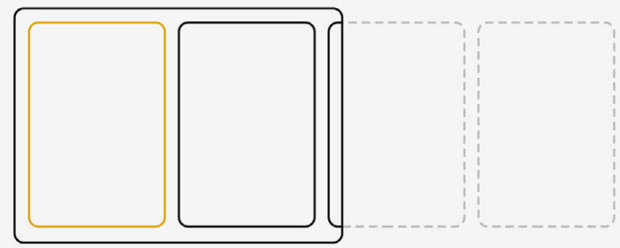


User can work on multiple documents at the same time.

Design Goals: Supporting Diverse Views

For effective work to be achievable and to make mental cross connections between multiple documents more likely, it must be possible to work with multiple documents opened simultaneously. This enables users to compare two or more documents, retrieve knowledge from one document while working in an other one and move components from one document to another.

Workspaces



A workspace is a place where multiple documents can be opened. It gives context and is a place to continuously work on a specific project or area of interest.

Users can have multiple workspaces and in each workspace multiple documents can be opened. This gives users a context that they can work in: they could for example use one workspace for one project, opening and closing documents related to this project as they see fit. Because they can jump between workspaces there is no need to close all documents before working on a different project.

Automatically Assigned Tags and Collaborators

Design Goals: Quick and Effortless Organizing

Because often times a workspace corresponds to a specific project, tags and collaborators can be assigned to a workspace. These will then be added to every document created in this workspace, so the user does not have to add the same tags over and over. This makes creation of documents faster and organizing them easier.

History

The history of a workspace is a list of all documents once opened in this workspace. It is kept so that users can quickly find documents that they had once open, without having to remember their exact tags or title.

Filtering

A workspace can be filtered: Through a free text search all documents that are opened, all documents in the history and in the →inbox of the workspace are filtered while typing. This assures a smooth experience for user

→ **Inspiration: Inbox** (P. 110)

that like to keep many documents opened at the same time and is especially helpful when looking for a document in the history of the workspace.

Inspiration: Inbox

Design Goals: Stimulating, Inter-operational and Open, Supporting Diverse Views

Every workspace also comes with an inbox, where content related to what the user is currently working on is presented. Rather than just letting the user create freely, the system additionally tries to support the user by offering information that he might otherwise have missed: In the inbox of the workspace documents from the user's collection and from outside applications that are related to whatever the user is currently working on. Outside sources could include system applications, such as the user's Photo collection, his emails, his web browsing history and the browser in general. Via an API other applications can support this as well. Viable applications would be communication apps (e.g. »Slack«), apps used to collected inspiration (e.g. »Pinterest«) or apps offering a stream of content (e.g. »Product Hunt«).

CONTEXT AWARE RELEVANCE ALGORITHM

In order to create a list of content that might inspire the user and foster bisociation processes, multiple factors are weighted. The list of content needs to be relevant to the user' current focus, so the factors change as soon as the user starts working in the workspace and especially when content is created or is changed.

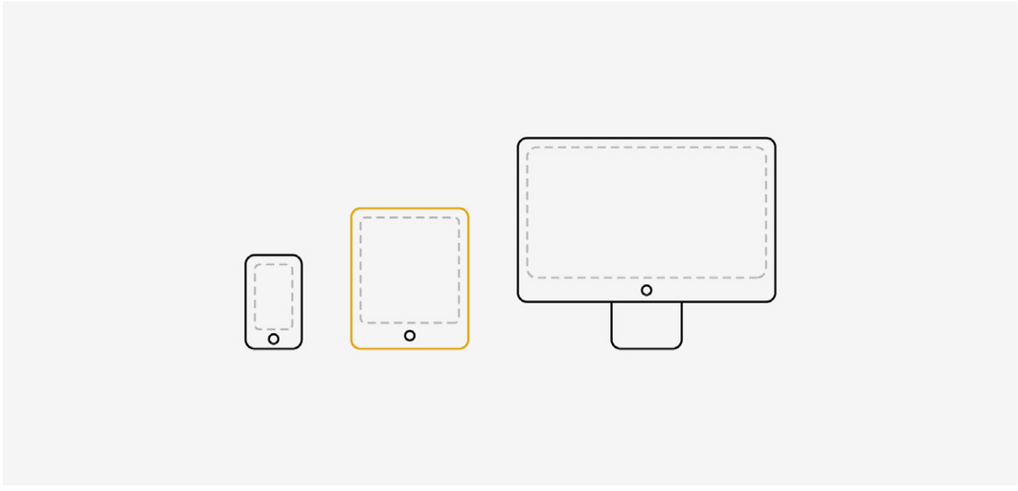
Because of this, the most important factor is the content that the user is currently editing, because the list is supposed to be adapted to the user's current focus. The tags and collaborators of the documents, tags assigned to the workspace; other document opened in the workspace; and the history of the workspace are also factored in.

The algorithm is skewed towards content that might be unexpected, such as documents similar in content but different in tags or document that the user has not opened in a long time.

HIGHLIGHTING OF NEW CONTENT

Whenever new content is added to the list, it is highlighted until the user has taken a look at the list. This is supposed to alert the user that new content that might inspire her current work is available. New content can appear on the one hand while the user is working, because the factors used in the algorithm change, but also when new content is published that is related to what the user was working on last. So the user might leave a workspace to work on something else and come back to find the inspiration list filled with new content that appeared in the meantime.

Device Sync



The user's entire collection of documents, as well as the workspaces (and which document are opened) are synced across all devices.

Design Goals: Designed for Long Term Use, Quick and Easy Knowledge Retrieval

To enable the user to retrieve his knowledge at any time and express himself immediately, his collection needs to be available and editable wherever the user goes. Because of this, it is synced across all devices. While not all applications may be available on all devices, the →previews are, so that knowledge retrieval can happen uninhibited.

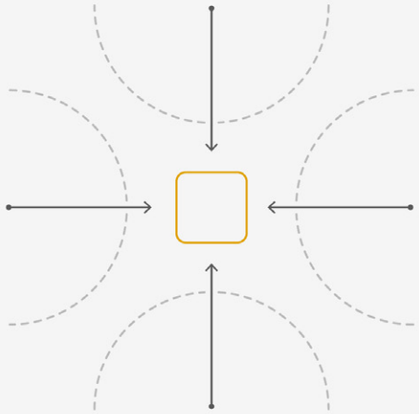
→ **Inline Editing and Preview** (P. 94)

Chapter 04

Tightly Integrated Collaboration

While the framework is focused on individual users rather than teams, collaboration and social creativity still play a large role in most contexts. Collaboration is therefore built into the framework and made as effortless as possible, encouraging users to share their ideas and continue developing in a cooperative fashion.

Collaborating on Documents



Design Goals: Easy Collaboration

To collaborate with others, users can give them access to documents and work on those together via Live Collaboration.

Live Collaboration

When users work on a document together, they can see each others changes live and react to each other. This mode of collaborations allows for frictionless teamwork and reduces the chance of conflicting changes. Live collaboration is not only possible within the document and with inline editing, but can also be implemented by →external applications.

→ **External Content Types** (P. 91)

Adding Collaborators to Documents

Collaborators can be assigned to documents just like tags. This makes it incredibly fast and easy to start working together on a document and means that collaboration is always just a few clicks away. When collaborators are added to a document with read/write access, they get full access to the document: the document behaves like any other document in their collection. This means that they can also access the history of the document and all its version, as well as the document's metadata. The goal of this is to give them context and allow them to understand how the document developed so far, making the collaboration more fruitful.

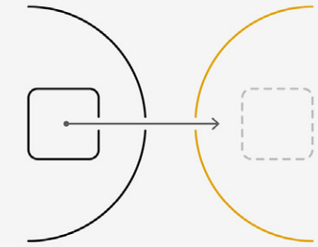
Design Goals: Contextful Sharing

Adding Collaborators to Tags

One or more collaborators can also be added to a tag. This means that the users will be added as collaborators to any document that has this tag assigned. This can be used on the one hand to share entire projects with teams (for example by adding a group of colleagues to the tag »Project 1«). On the other hand it can be used to group users into teams that you can

share individual documents with (for example by creating a tag called »Project 1 Team« and assigning this tag to the documents that you want to share with the team).

Sharing Documents



Documents can be easily shared and sent to other people with just a click.

Design Goals: Encourage Sharing

When users want to simply share their ideas, rather than collaborate on them with others, they can send a copy of a document, which can be read-only. It can be in a format that can be imported into other people's collection, letting them access the power of the interactive →previews or converted into a more traditional file format.

→ **Inline Editing and Preview** (P. 94)

Part 04

Execution

Working our way from rough wireframes to polished screens we designed the framework as an application. We reached our final design through many iterations and employed rapid prototyping techniques to test our designs as we went along.

Chapter 01

Introduction

We decided to build the framework as an application for the iPad Pro, basing our visual language on the official Apple guidelines to make the application seem authentic.

Process

We worked our way through multiple levels of fidelity in both visual design and prototyping.

In order to take our concept and turn it into an application we started with wireframes and »Crazy-8« sessions, then went on to iterate on the individual components, to explore their complexity and try and find a visual style. At the same time we started building many low fidelity prototypes using various tools (e.g. Keynote, Principle, React) to test flows and design the interactions. Once we had settled on a →Visual Language (P. 121), we went on to build all components into one coherent application, continuing to iterate on the details. After having found a consistent style we rebuilt all the components again, this time building them pixel-perfect and adding them to a shared component library, which we then used to put together our final screens and flows.

Obviously this process and the conception stage were not completely separated and some ideas reflected in the concept of the application were only developed during the execution phase. Having a dynamic process helped us to stay flexible and integrate new ideas as they came to be.

We put a special focus on creating content for our flows, well aware that to communicate the power of the framework and the flexibility of our conceptual innovations, having content that people who see the flows can relate to is key.

Platforms

We decided to communicate the framework as »replacing the file system« and built the application exemplary for the iPad Pro.

In order to fully support creativity, we decided that the framework has to run on all platforms, so that it is always in reach. To make an argument for our framework and to get people to imagine its ramifications, we decided to communicate it as »replacing the file system« for average users. While the traditional folder structure might still be accessible for people well versed with computers, most people would only ever use the framework (much like the command line interface is still existing on modern desktop computers, but most people use the GUI).

Because of time limitations we decided to create the visual design for

the application for only one platform. We chose the iPad (specifically the iPad Pro), as it is a device that is just starting out to be considered for work contexts and creative expression. It will only get a file system application in fall 2017 and we hope that because so far there has been none, people consider it as an »empty canvas« and are ready to explore the idea of a new way of managing documents on the device. Additionally the task of designing a productivity app for a device that is mostly considered to be a device for consuming content seemed like an interesting challenge to us.

Visual Language

The visual language is based on the iOS design guideline by Apple, making the application feel part of the operating system.

While the concept of the framework is novel, the technologies necessary to build it already exist today. We don't want to communicate Artifacts as a concept that will exist some day in far future, but want people to image what it would be like if it was available tomorrow.

Only the provider of the operating system could make the interventions necessary to make the framework work, replace the file system and would have the power to get application developers to adapt the new system. In the case of the iPad Pro and iOS this would be Apple.

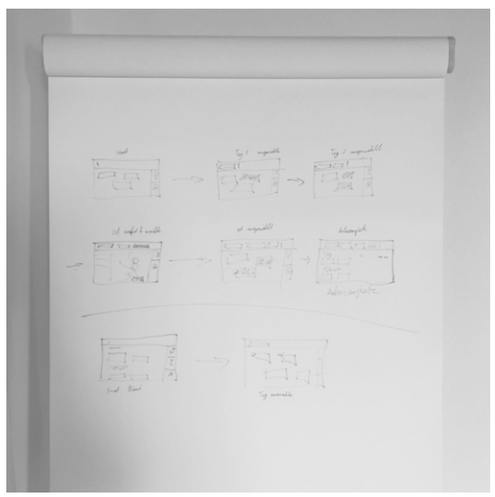
Because of these two considerations we decided to try and make the visual design seem like something that Apple might ship in fall and that is a part of the iPads operating systems. We adhered to the guidelines of iOS 11 (to be released in fall 2017) but had to expand them in many ways, introducing lots of new components and modernizing existing ones to make them more flexible. We oriented ourselves by the existing styles for iOS, but also took cues from macOS for elements that have already been solved for desktop computers.

We learned that creating an application with so many new features, that feels like it could be part of the existing system is a great challenge. Nonetheless we consider this to be the only right approach for what we are trying to accomplish and are contented with the result.

Chapter 02

Whiteboard Wireframing

To create a shared understanding and align our visions of what the application would look like we spent a couple of days wireframing each section of the interface on a whiteboard. We conducted a user testing session with a rough prototype to test if the structure of the application would be understood by users.



Wireframes

On a whiteboard we created quick wireframes for the different parts of the application.

Figure 19: **Different Sections of the Application as Sketched Wireframes** (Opposite Page)

Focusing on the sections Search and Filtering, Document Previews, the Structure of Documents and Artifacts, and Collaboration we quickly went through a large amount of variants, carefully considering which work out and which don't. This process helped us to develop a general structure for the application and assess the complexity of the different features. We could also align our visions and create a shared understanding of how the application would be structured.

The wireframes became the base for all of our following iterations and helped us to focus on a subset of possible solutions. Both our →Interaction Model and the different UI components were based on insights that we gained during those sessions.

→ **Interaction Model** (P. 127)

User Testing

To see whether users would understand the way documents and tags work in our application we did a user test.

Based on our wireframes we created a prototype, showing the flow of creating a new document, adding artifacts to the document and assigning tags, as well as searching for documents using tags and saved filters. We showed this prototype to five potential users with the goal to verify whether they understand the different parts of the application and their role, interviewing them beforehand about how they currently structure their files. The feedback was positive and most testees immediately recognized the benefits of documents and a tag-based structure. They also raised some interesting points, mostly about the feeling of safety created by a folder structure, as well as where our prototype did not fit to their workflow. We took this feedback and integrated it into the concept, as well as the execution of our framework.

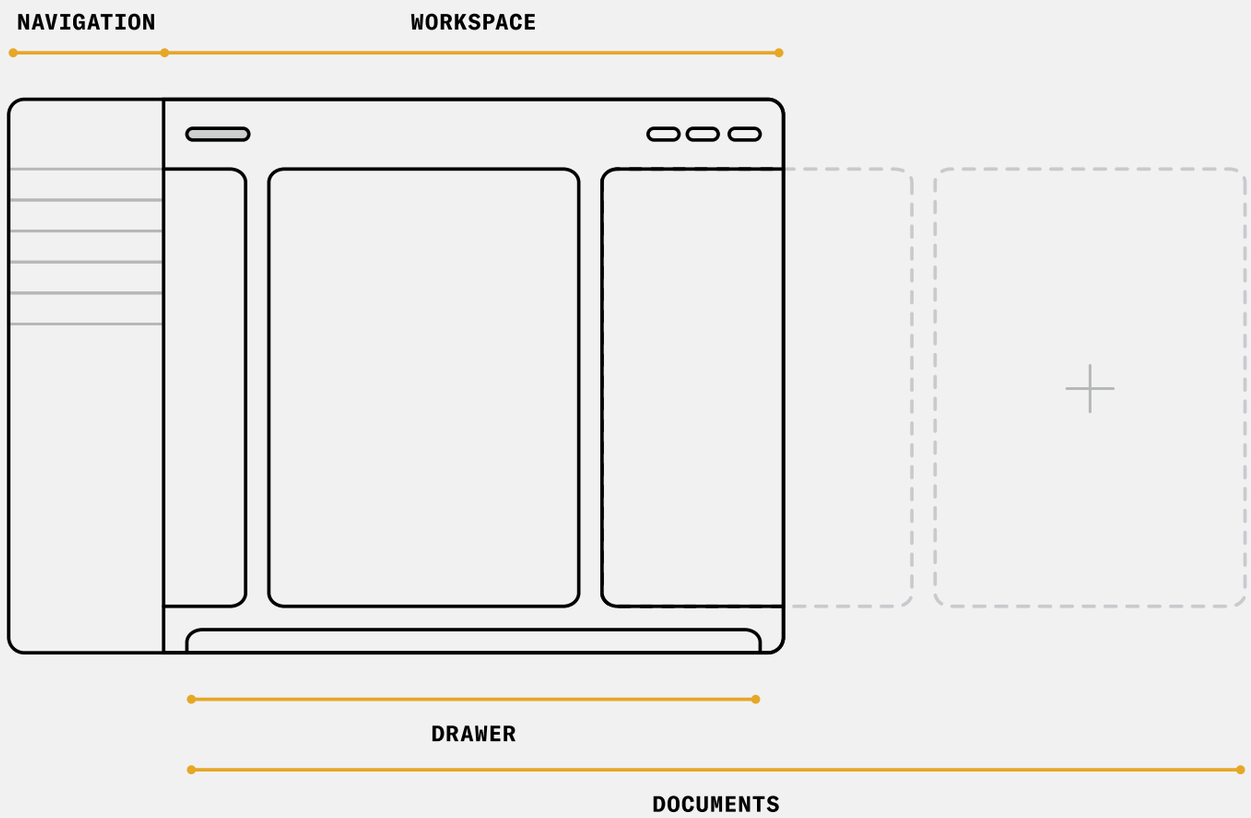
Chapter 03

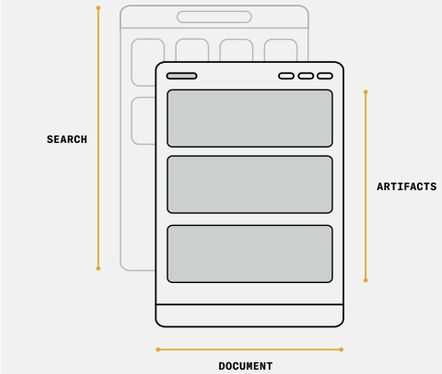
Interaction Model

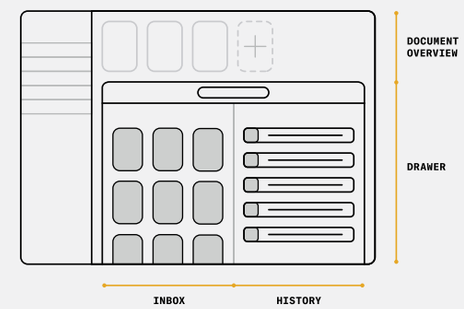
For the iPad application we created an interaction model suited for touch, that still allows handling multiple documents at the same time. It employs spatial metaphors and designed to be consistent, yet flexible.

Structure of the Application

The application is structured in a way that allows users to work with a large number of documents simultaneously and makes it easy to create relationships between those documents.







A sidebar navigation is used to switch between workspaces and create new ones. In the workspace there is a header containing information about the workspaces and the tags it automatically assigns. The main element of the workspace is a scrollable array of cards, each representing a filter view or a document. Each card can be resized to fill 25%, 50%, 75% or 100% of the width of the workspace. On the bottom of the workspace there is the drawer.

When a new card is added to the workspace it displays a filter view. From this view a document can be opened (or a new one created). The document opens within the card, above the filter view, and contains its artifacts (→Figure 21).

The drawer moves up from below, resulting in the cards being scaled down. It consists of the inbox, the history, as well as a filter element used to filter the workspace (→Figure 22).

Figure 20: **Structure of a Workspace**

Figure 21: **Filter View and Document**

Figure 22: **The Expanded Drawer**

Chapter 04

Interface Iterations

Before reaching the final design of our interface we went through many iterations and prototypes. We want to share some of those here in order to show how the final design came to be and which approaches we tried but rejected.

Workspace

We designed the workspace as a central hub for many documents, but kept the visual design simple and reduced to put the focus on the content.

The biggest challenge was to deal with the huge amount of different content that might be displayed within a card: Some might contain only text, others a grid of document previews, others could contain an assortment of content types that we cannot predict. Because of this, the design of the workspace is reduced, utilitarian and minimal, putting the focus on the content of the users collection: the document previews and the documents themselves.

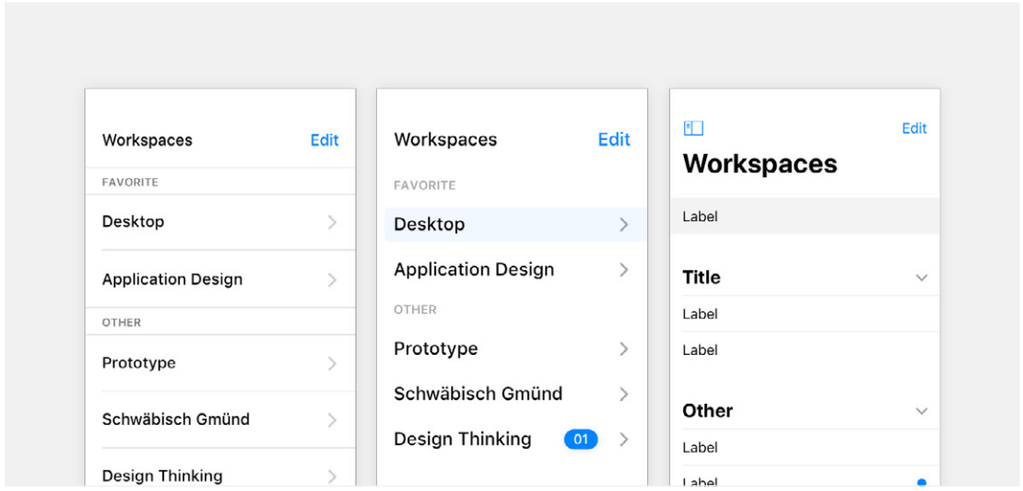
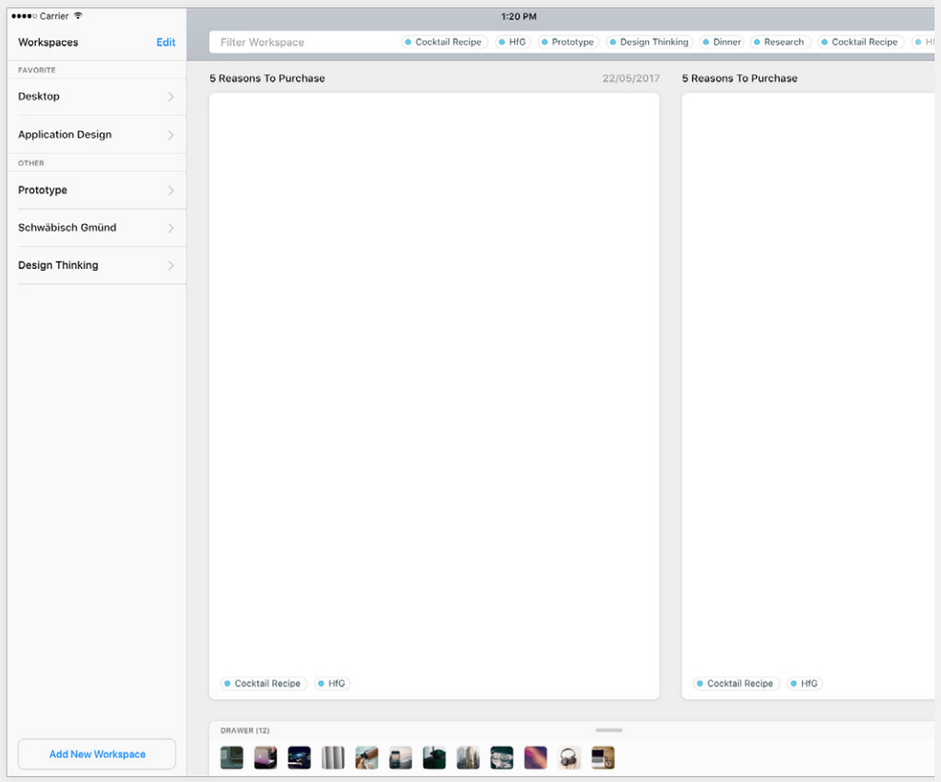
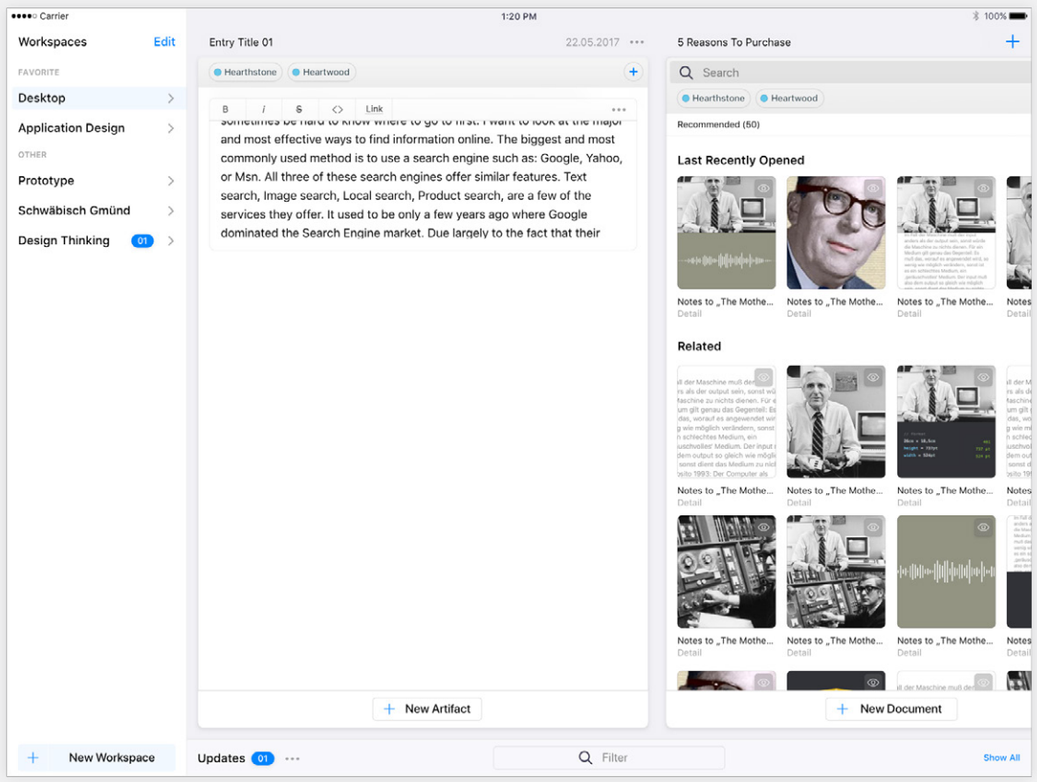


Figure 23: **Two Iterations of the Workspace**

Figure 24: **Three Iterations of the Sidebar** (Opposite Page)





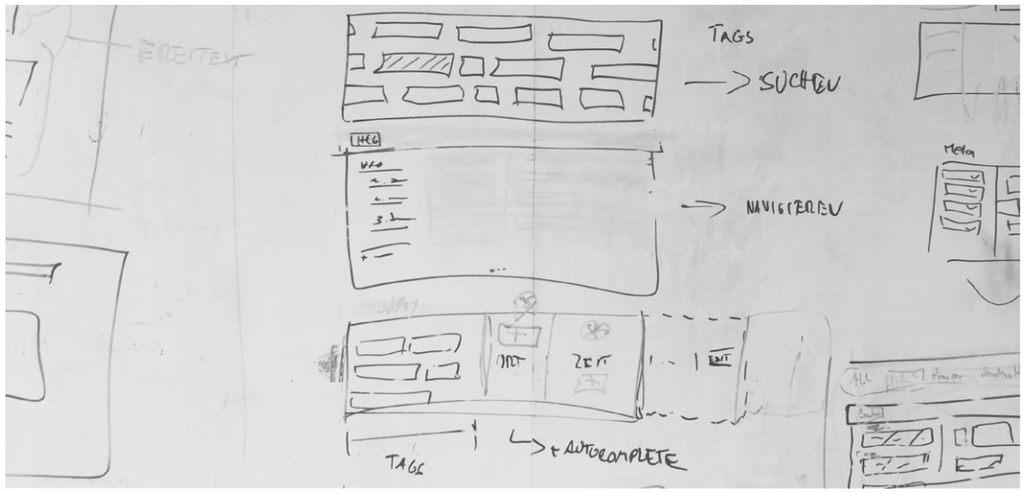
Filter

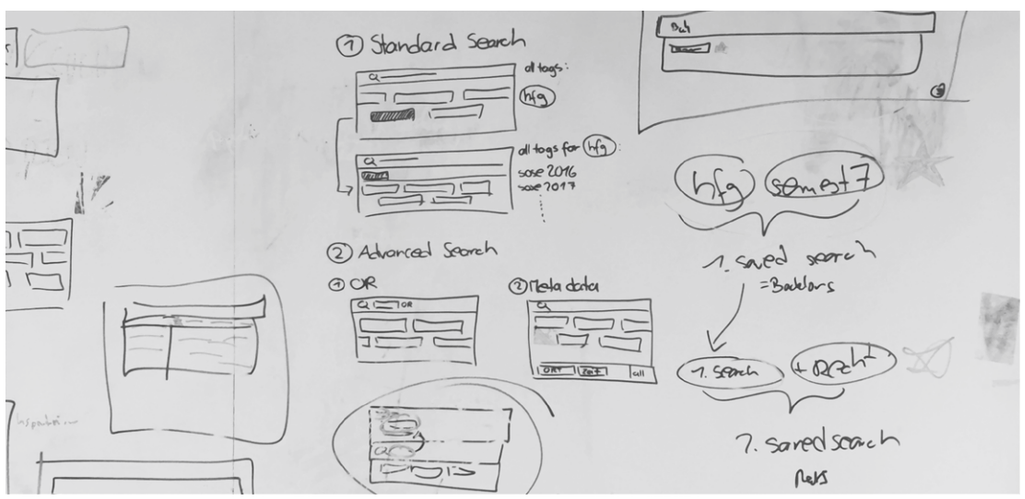
Figure 25: **Search Flows as Whiteboard Wireframes**

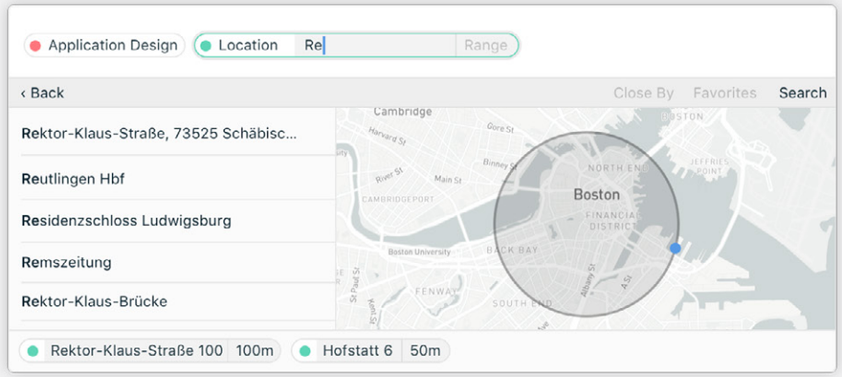
Figure 26: **Early Visual Iteration** (Opposite Page)

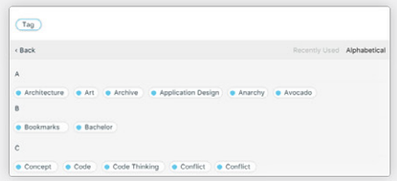
The filter element, designed for both search and navigation, is central to the user experience. We put much effort in making it easy, and above all fast to use.

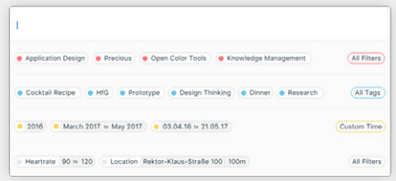
Because the possible combinations of filters in the element are infinite, we scribbled many flows to try out different possibilites. We also build a quick Keynote-prototype to see what the element would look like in motion. We then went on to iterate the visual design, first as an isolated element, then in the context of the interface.

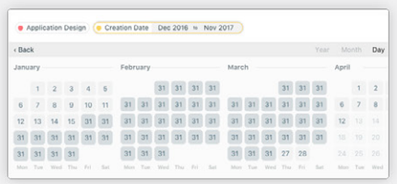


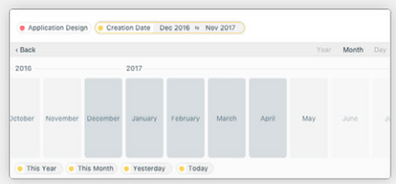


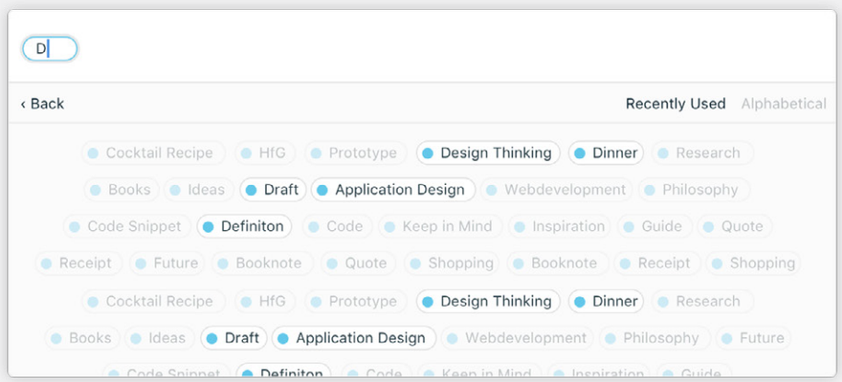


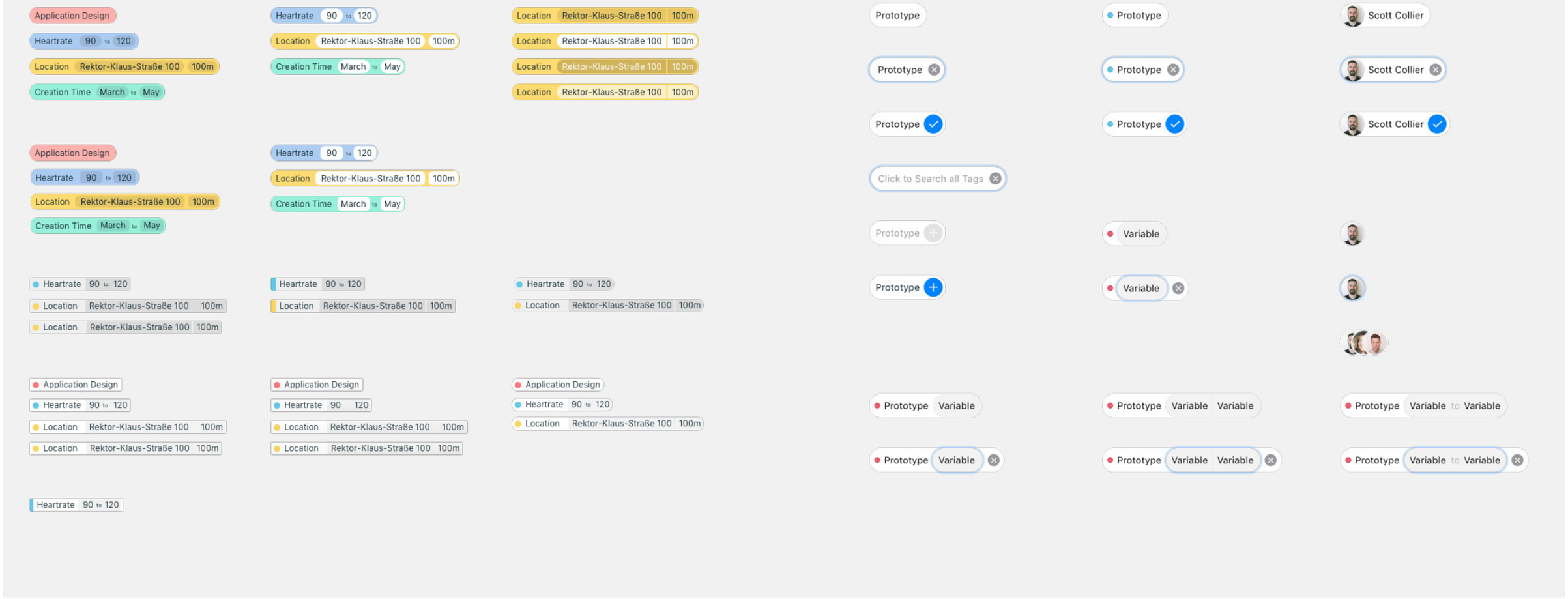












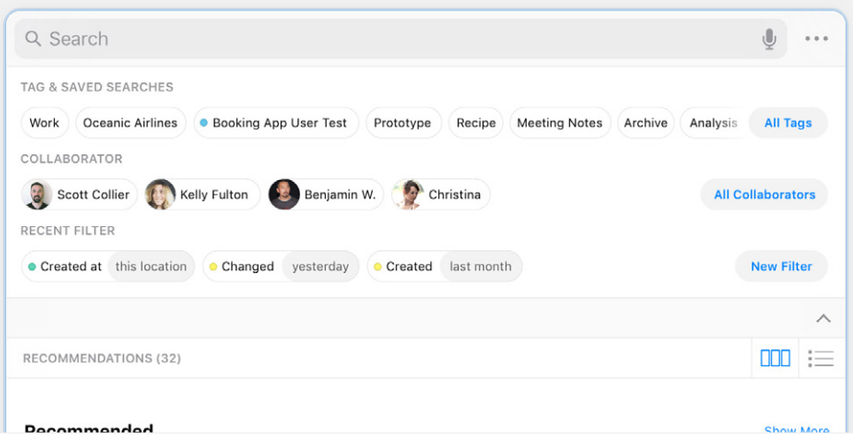


Figure 27: **Various Iterations of Tags and Filters**

Figure 28: **The Final Search View** (Opposite Page)

For the representations of the filters within the search bar and the tags we tried out many variations using color coding to display the type of filter. In the end we settled for a light style, making them slightly larger to represent better touch targets. Using React-Sketchapp we created the components in code, then rendered them in Sketch based on a list of data.

Document Preview

One of our goals was to make the preview of a document more insightful and display more of the content of the document.

In the end we chose a vertical representation that is a combination of the artifacts used in the document. It is supposed to create a unique representation of the document, making it easily discoverable in a list of results, if the user knows what he is looking for.

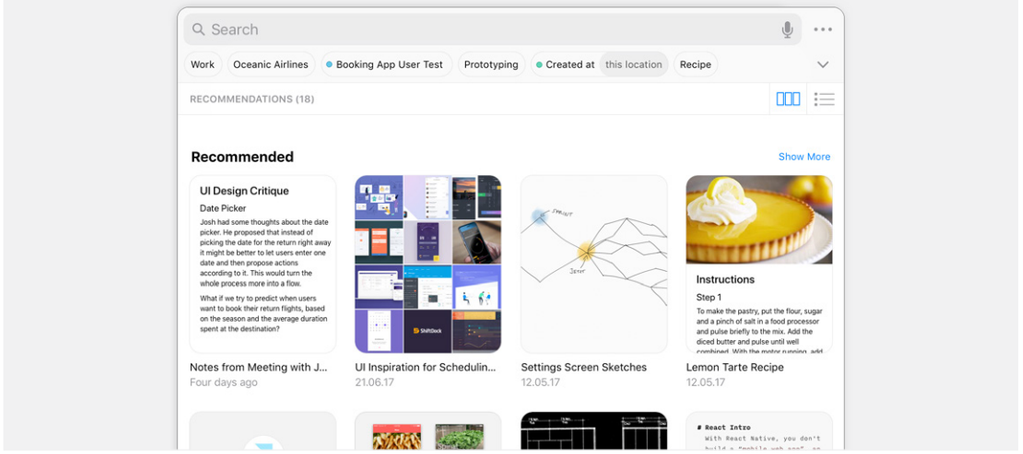
Additionally we created a »Peek Preview« interaction, where the user can peek into the document without leaving the result list and jump directly to a certain point. Using Principle we tried many scrolling behaviours in small prototypes, making sure the interaction feels natural.

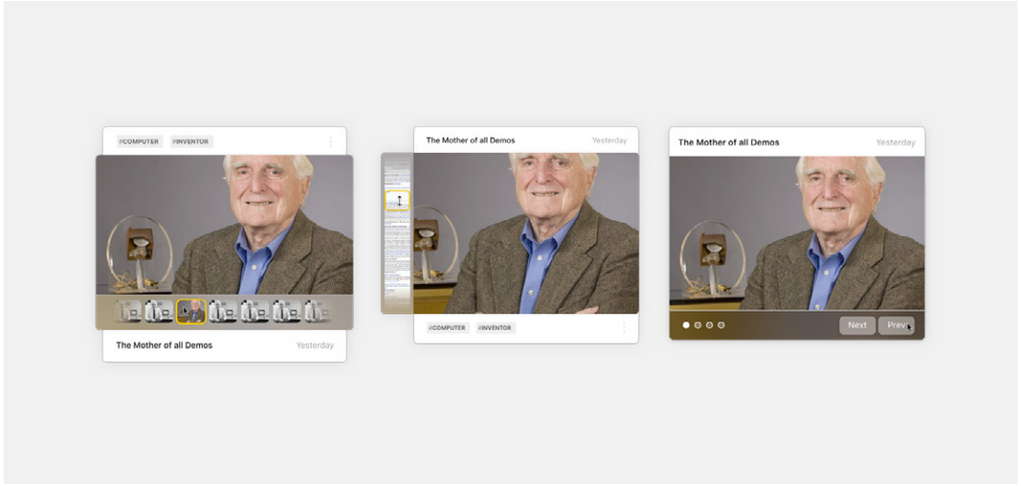
Figure 29: **Search Result: Grid View**

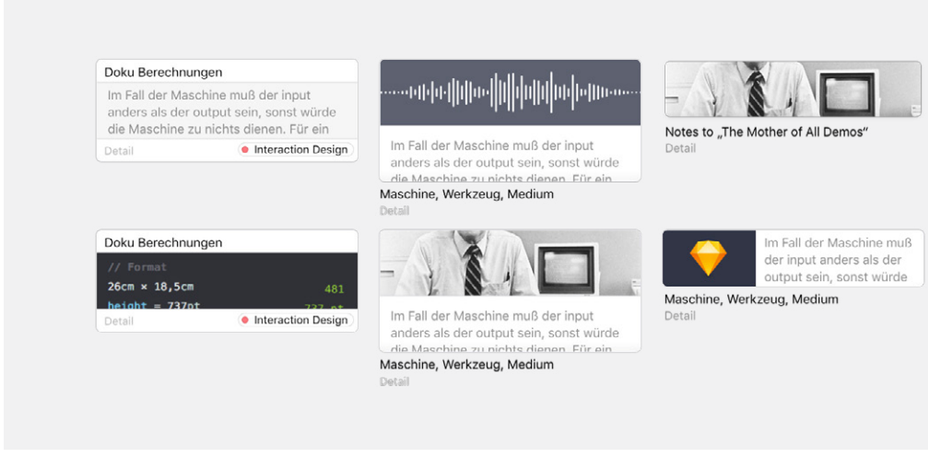
Figure 30: **Document Preview as Whiteboard Wireframe**

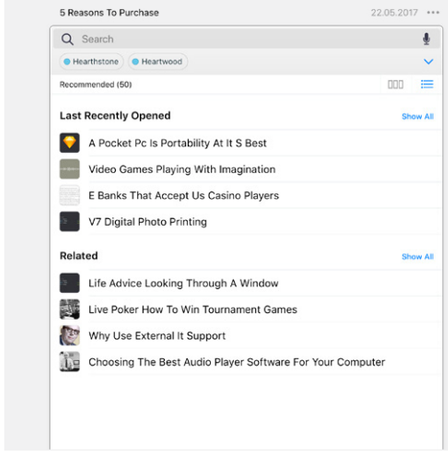
Figure 31: **Search Result: List View Iteration**

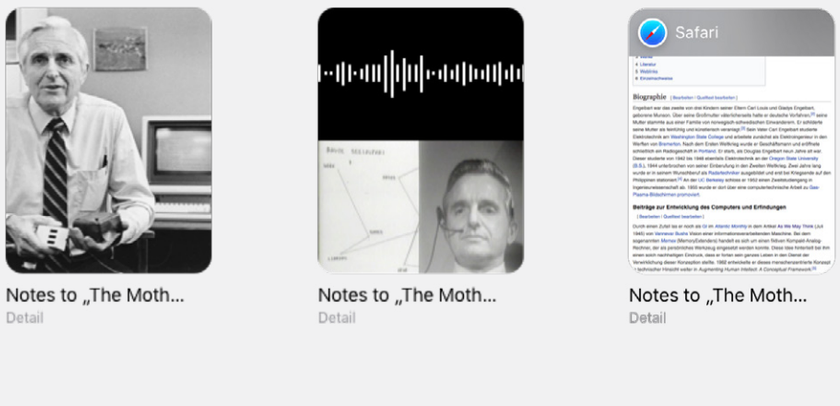
Figure 32: **Variations of the Document Preview** (Opposite Page)











Documents and Artifacts

Documents are the core of the framework. We designed to be versatile and to put the focus on the artifacts they are made up of.

We concentrated especially on the process of adding new artifacts, as it is vital for it to be effortless and quick in order to allow fast expression of thoughts. We did a session of »Crazy-8« brainstorming and after various visual iterations settled on a concept that combines a quick-add shortcut, a touch interaction to append a new artifact and a drag interaction to place an artifact at a specific position.

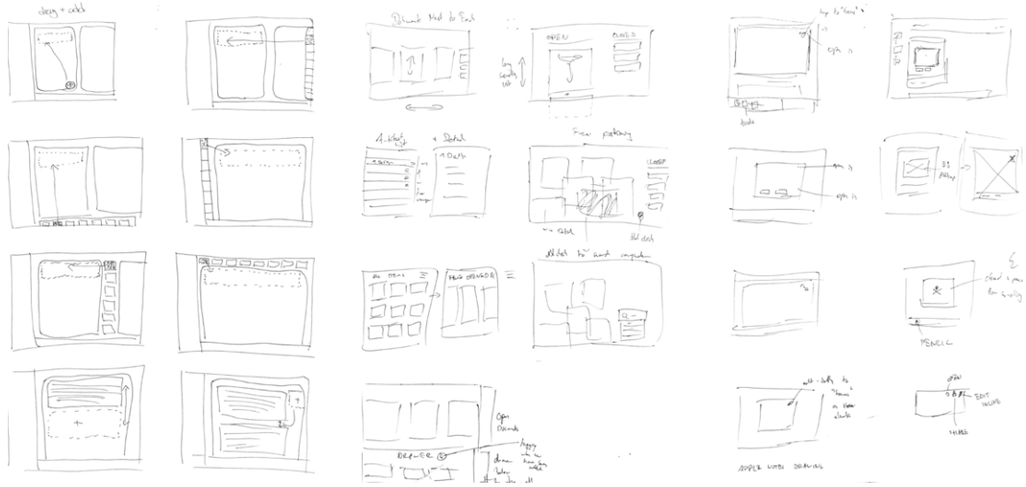
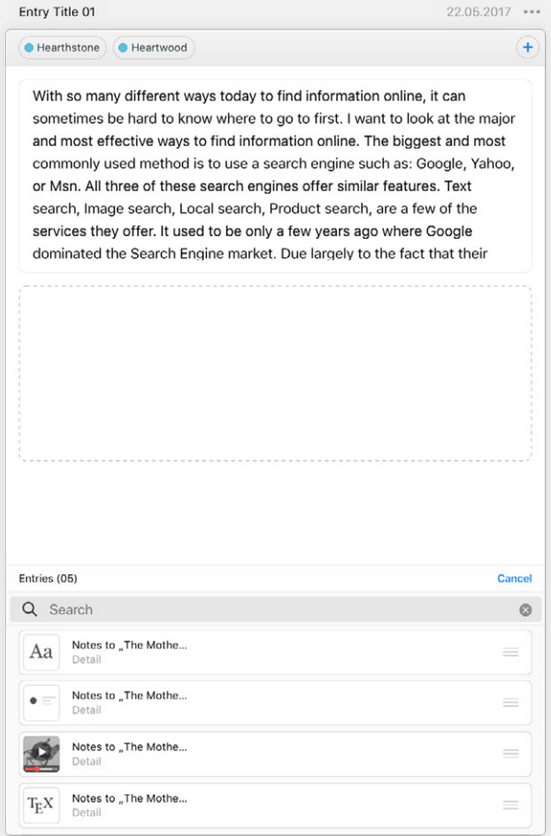
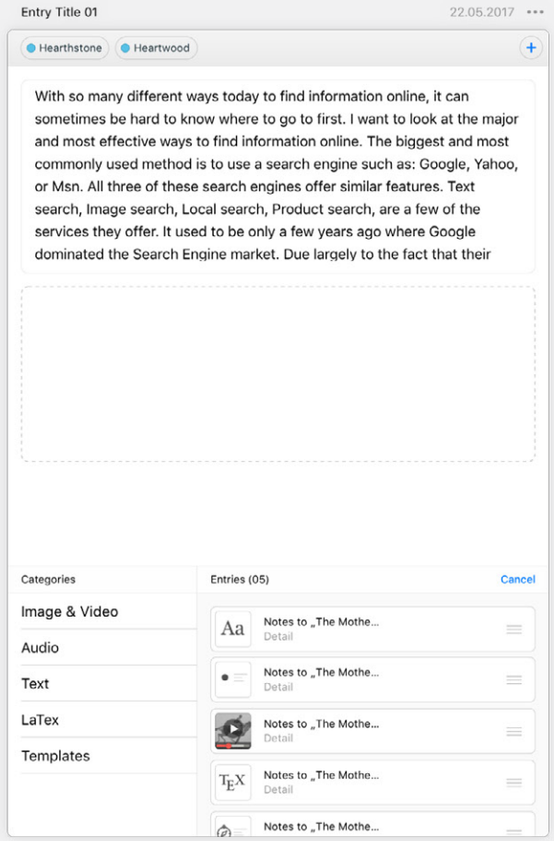
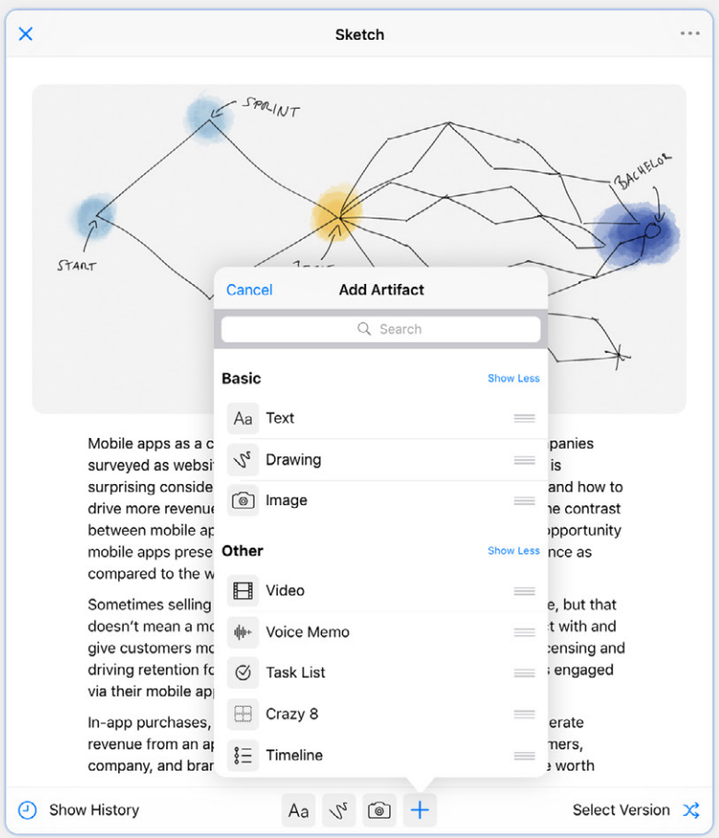


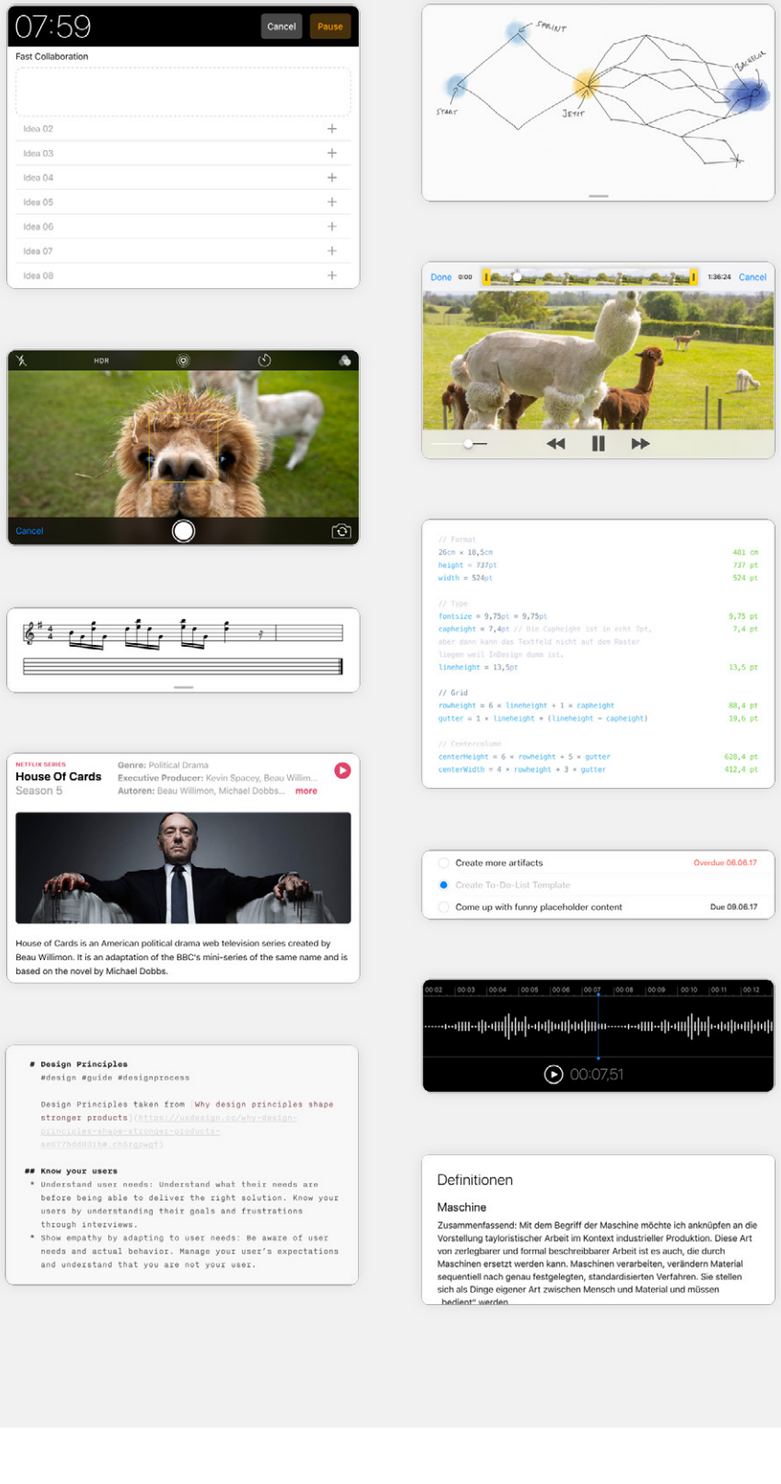
Figure 33: **Iterations of Adding Artifacts**

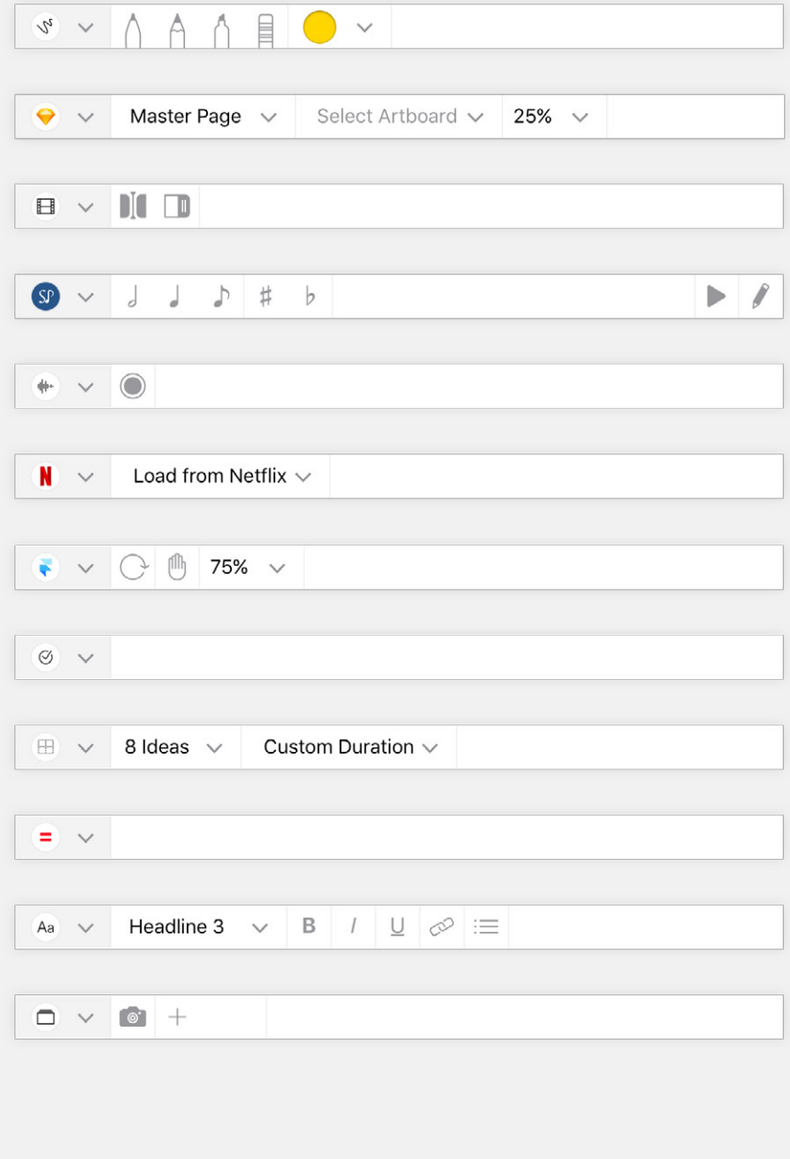
Figure 34: **Early Sketches** (Opposite Page)







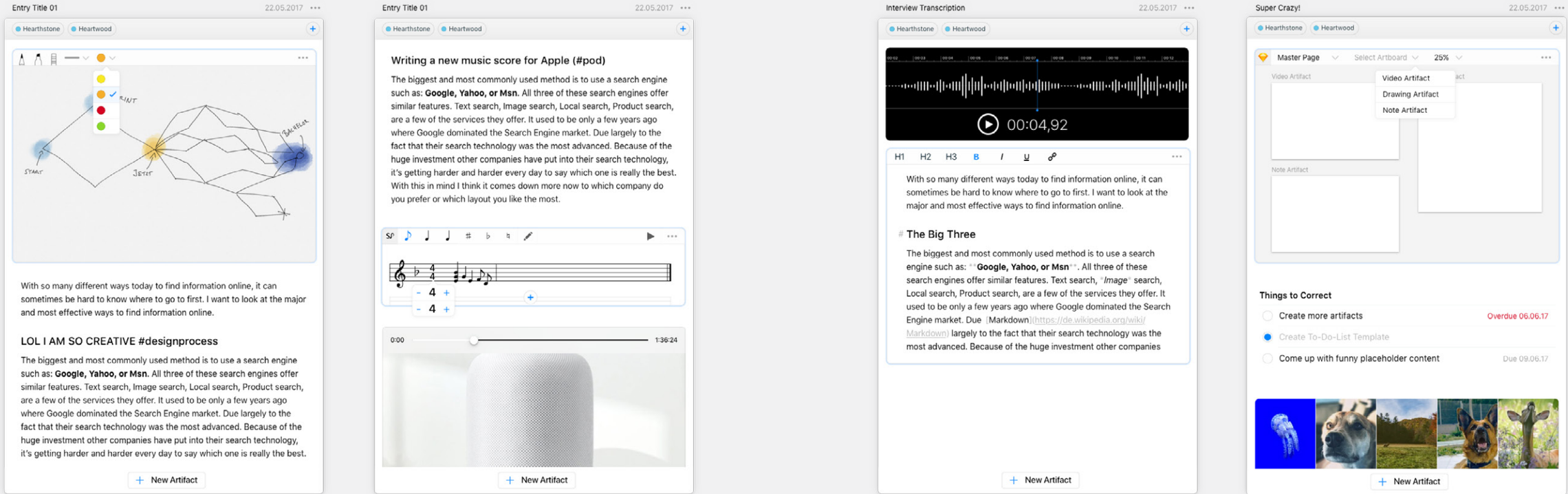


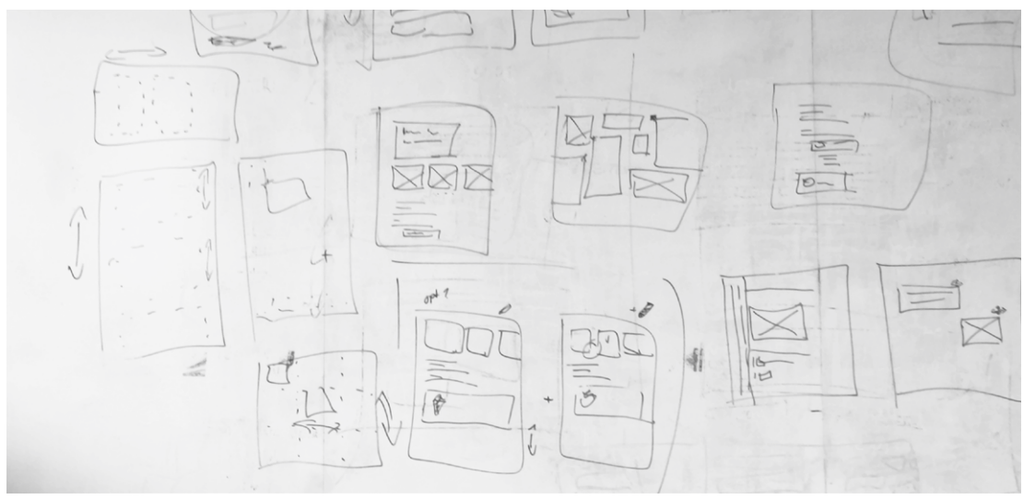


As artifacts can stem from any source, we tried to find a balance between a homogenous, system-like look while retaining the visual style of external applications. The toolbar, which is always displayed at the top of the document, will change very often when working with a document. Therefore we kept this element simple and created a set of standardized component used by all artifacts.

Figure 35: **Artifacts** (Opposite Page)

Figure 36: **Artifact Toolbars**





Early on we looked into different ways how documents could be structured and explored both straightforward and more free-spirited arrangements of artifacts (→Figure 38). In the end we decided that the most common use-case would be the traditional way of building up a document: from top to bottom. Free placement of artifacts is still available as a template.

We took our early artifact designs and combined them into mixed-content documents, exploring how they could be combined to tell simple stories.

Figure 37: **Combinations of Artifacts**

Figure 38: **Wireframes for Documents** (Opposite Page)

Chapter 05

Final User Interface

The following pages show an overview of our final user interface design.

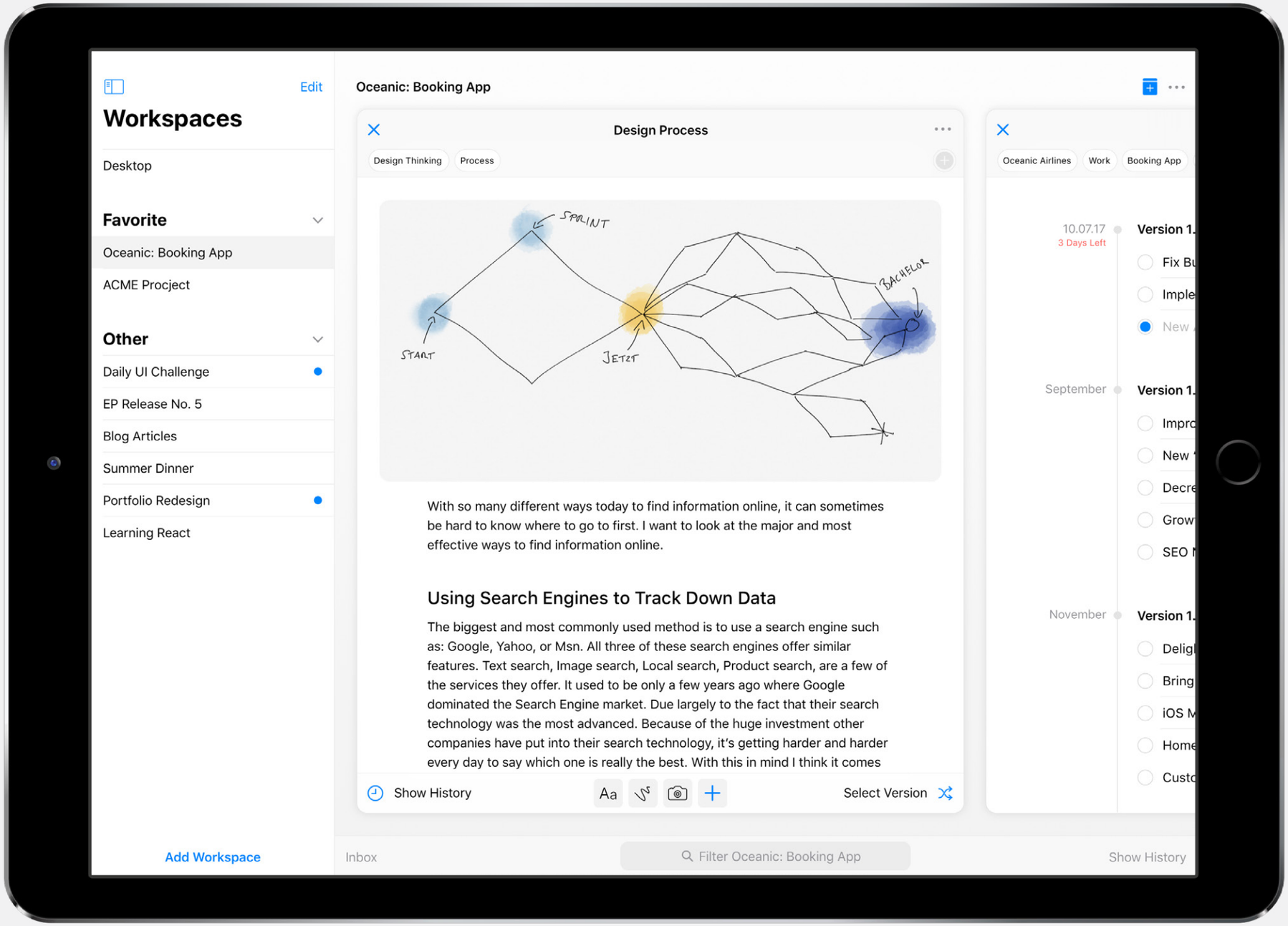


Figure 39: **A Workspace**

Artifacts

We designed fourteen artifacts: Content Types as well as Templates are included, and there are both artifacts provided by the system and examples of artifacts from external sources.

Each artifact comes with a toolbar and many can be edited inline. They can be combined freely into complex documents.

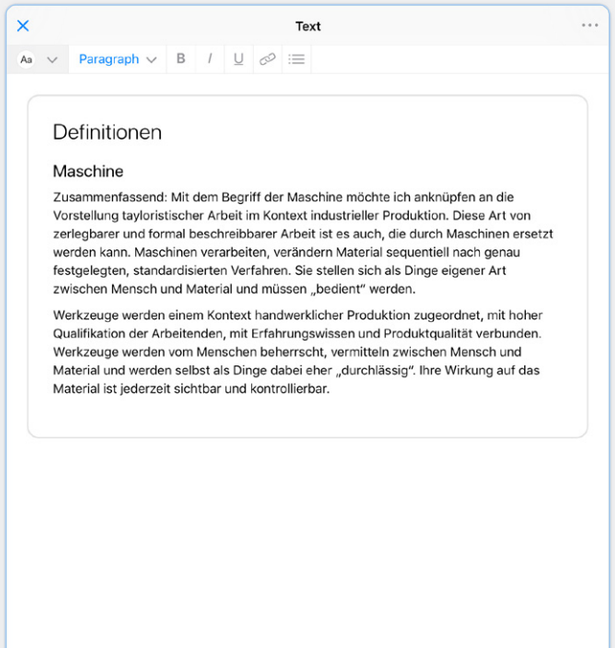


Figure 40: **Content Type Rich Text**

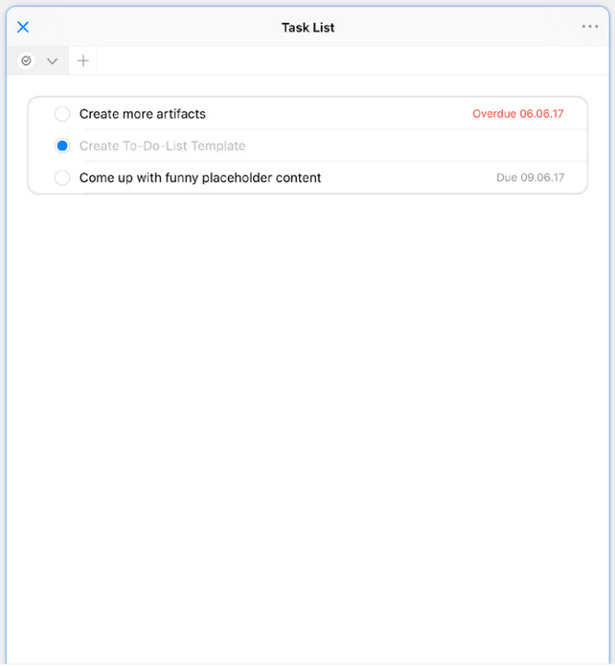


Figure 41: **Task List Template**

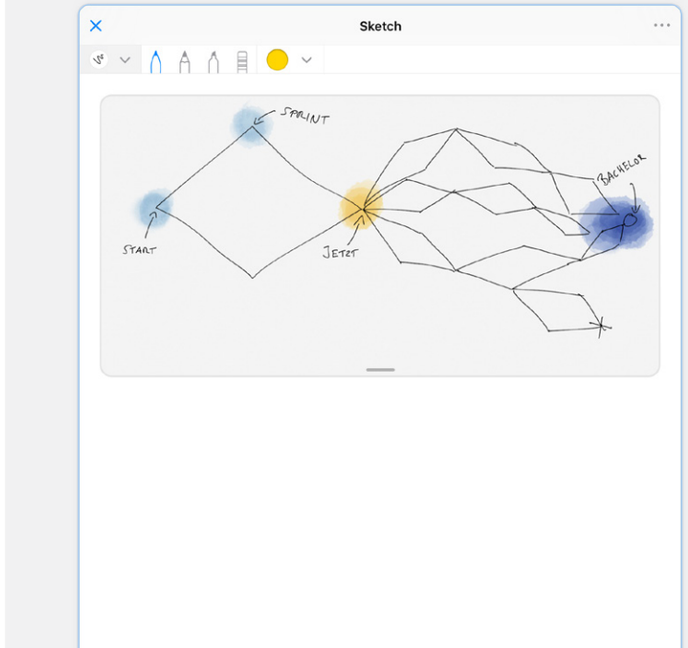


Figure 42: **Content Type Drawing**

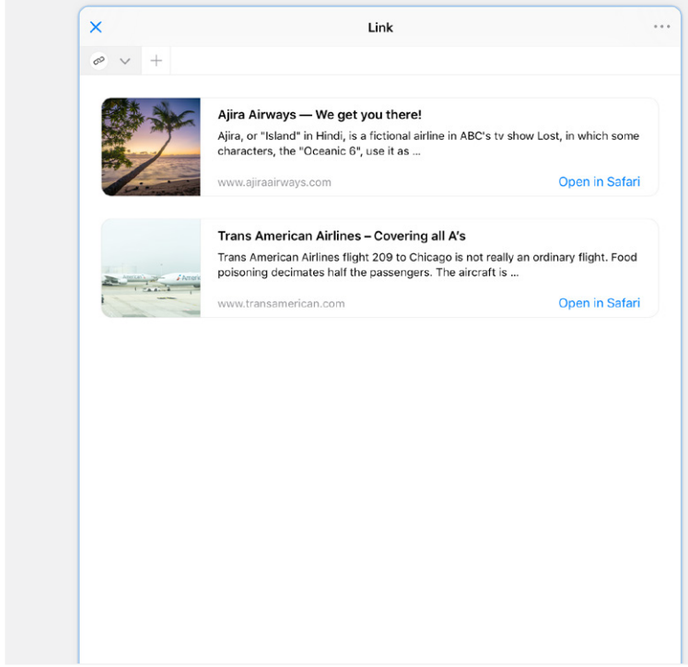


Figure 43: **Content Type Link**

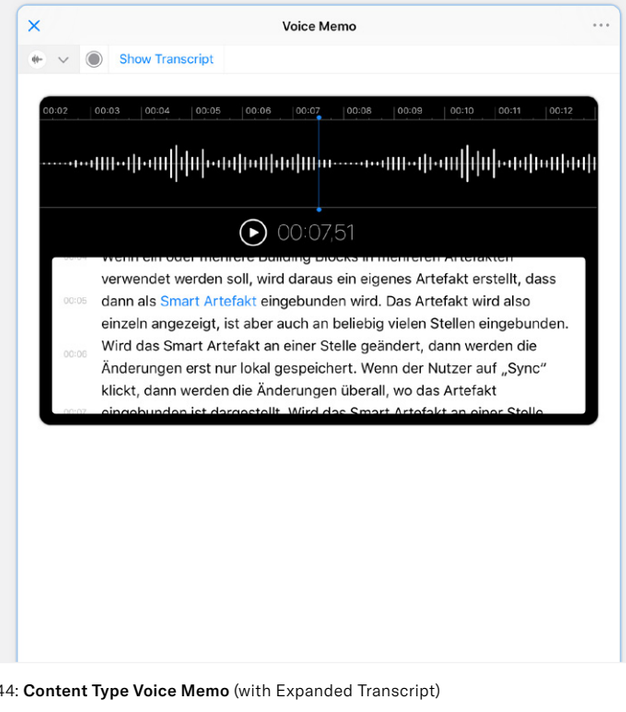


Figure 44: **Content Type Voice Memo** (with Expanded Transcript)

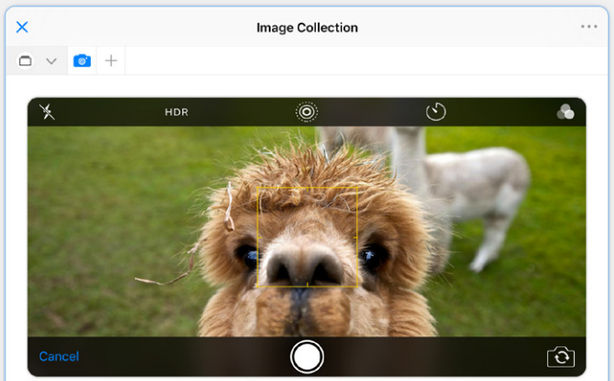


Figure 45: **Content Type Image** (in Camera Mode)

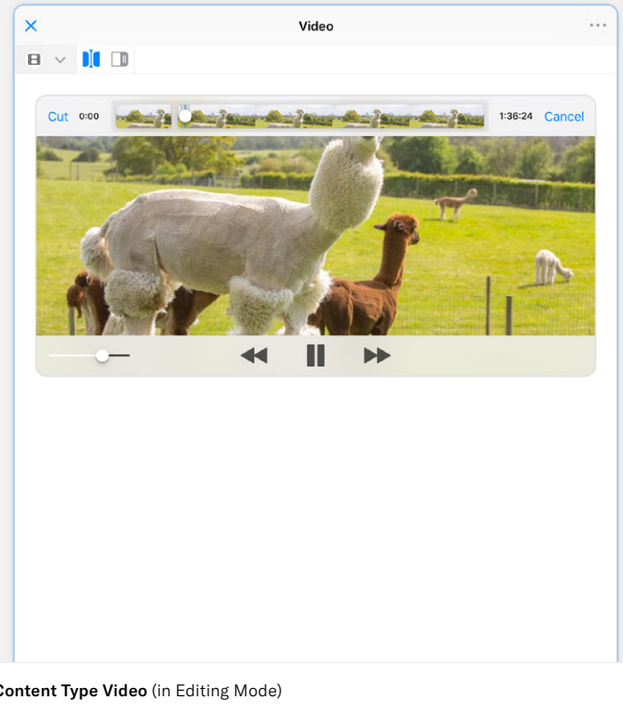


Figure 46: **Content Type Video** (in Editing Mode)

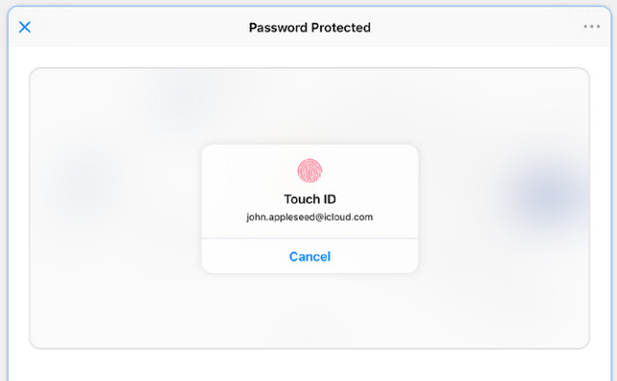


Figure 47: **Password Protected Template**

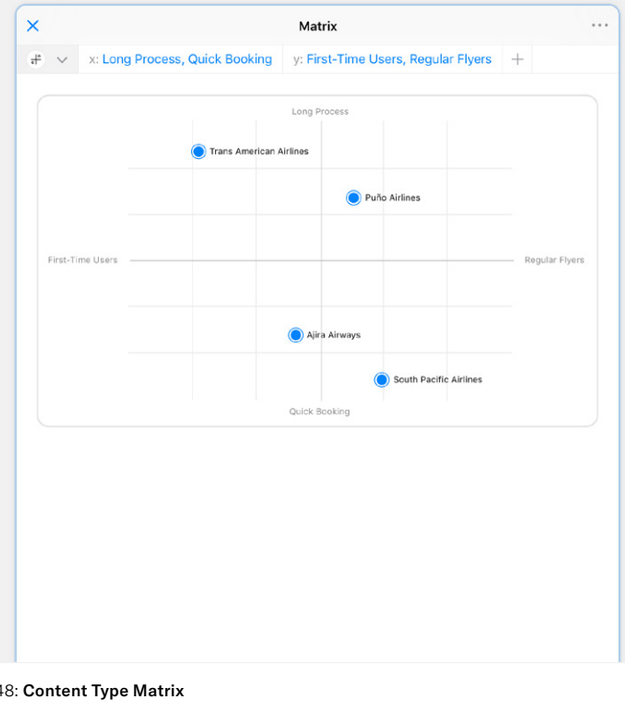


Figure 48: **Content Type Matrix**

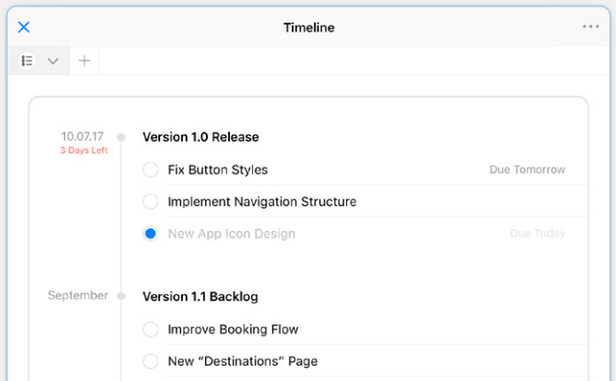


Figure 49: **Timeline Template** (Filled With Task Lists)

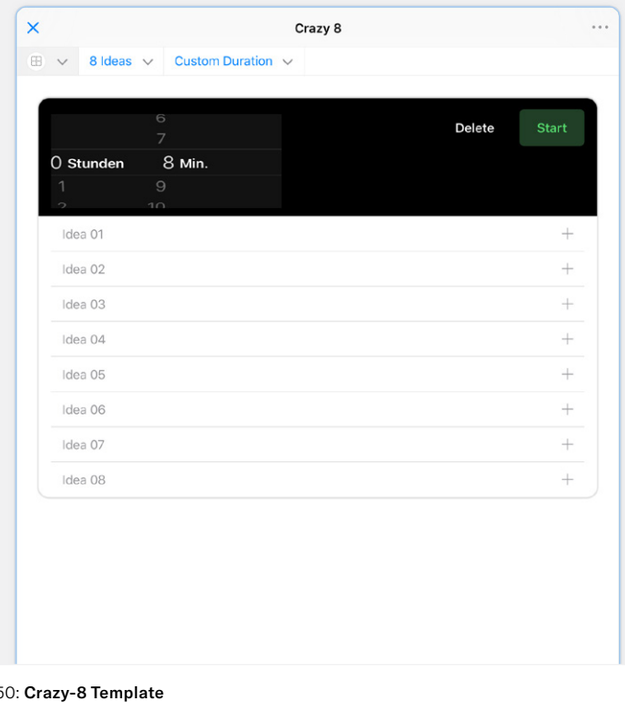


Figure 50: **Crazy-8 Template**

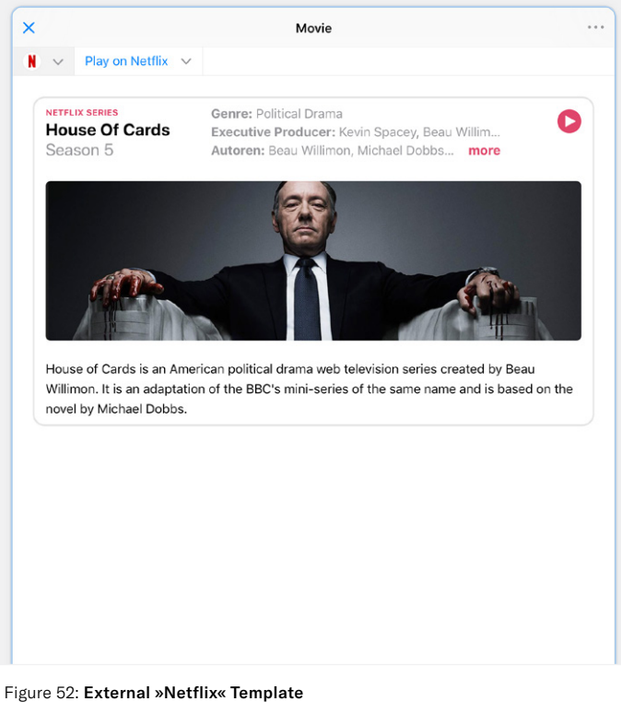


Figure 52: **External »Netflix« Template**

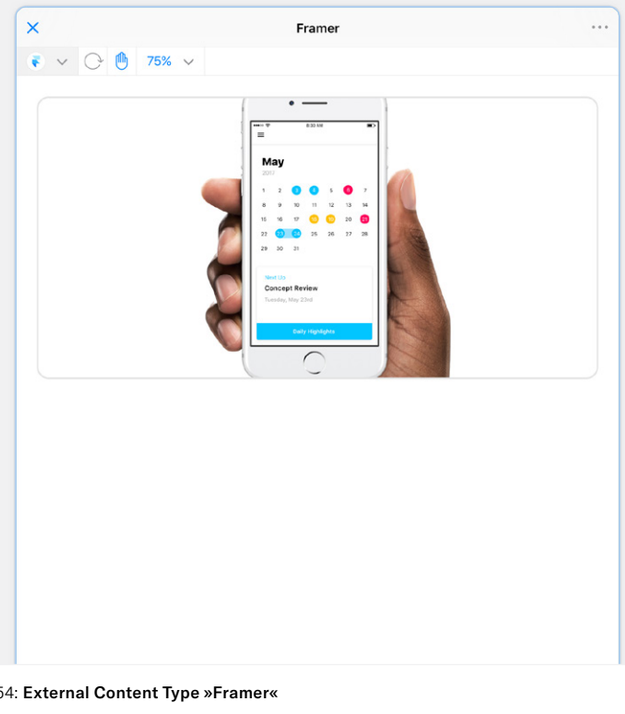


Figure 54: **External Content Type »Framer«**

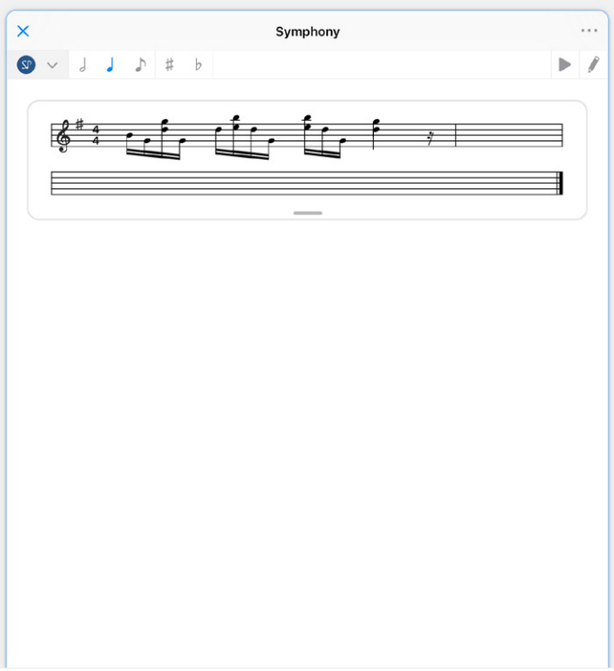


Figure 51: **External Content Type »Symphony«**

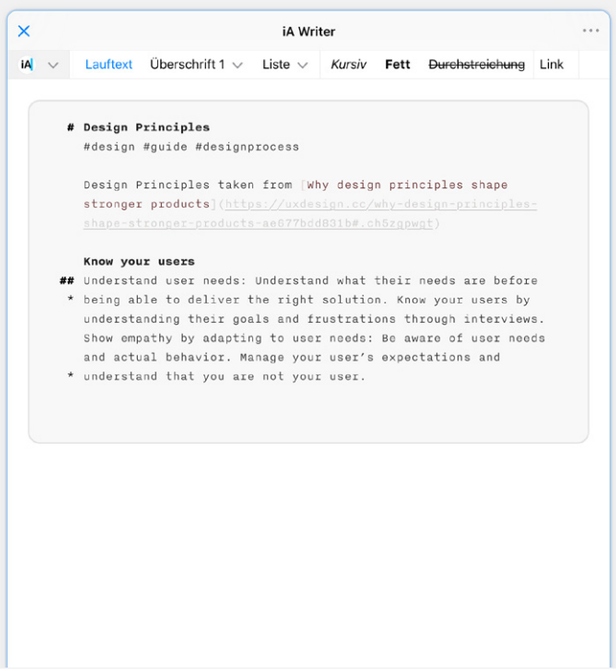


Figure 53: **External Content Type »iA Writer«**

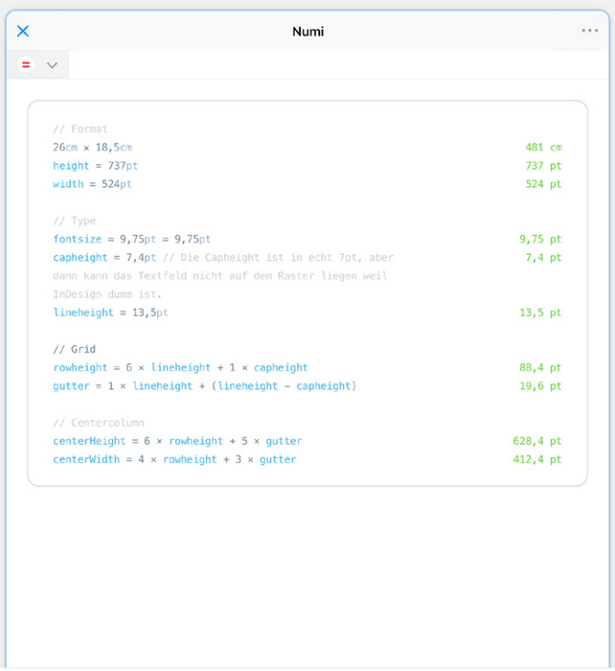


Figure 55: **External Content Type »Numi«**

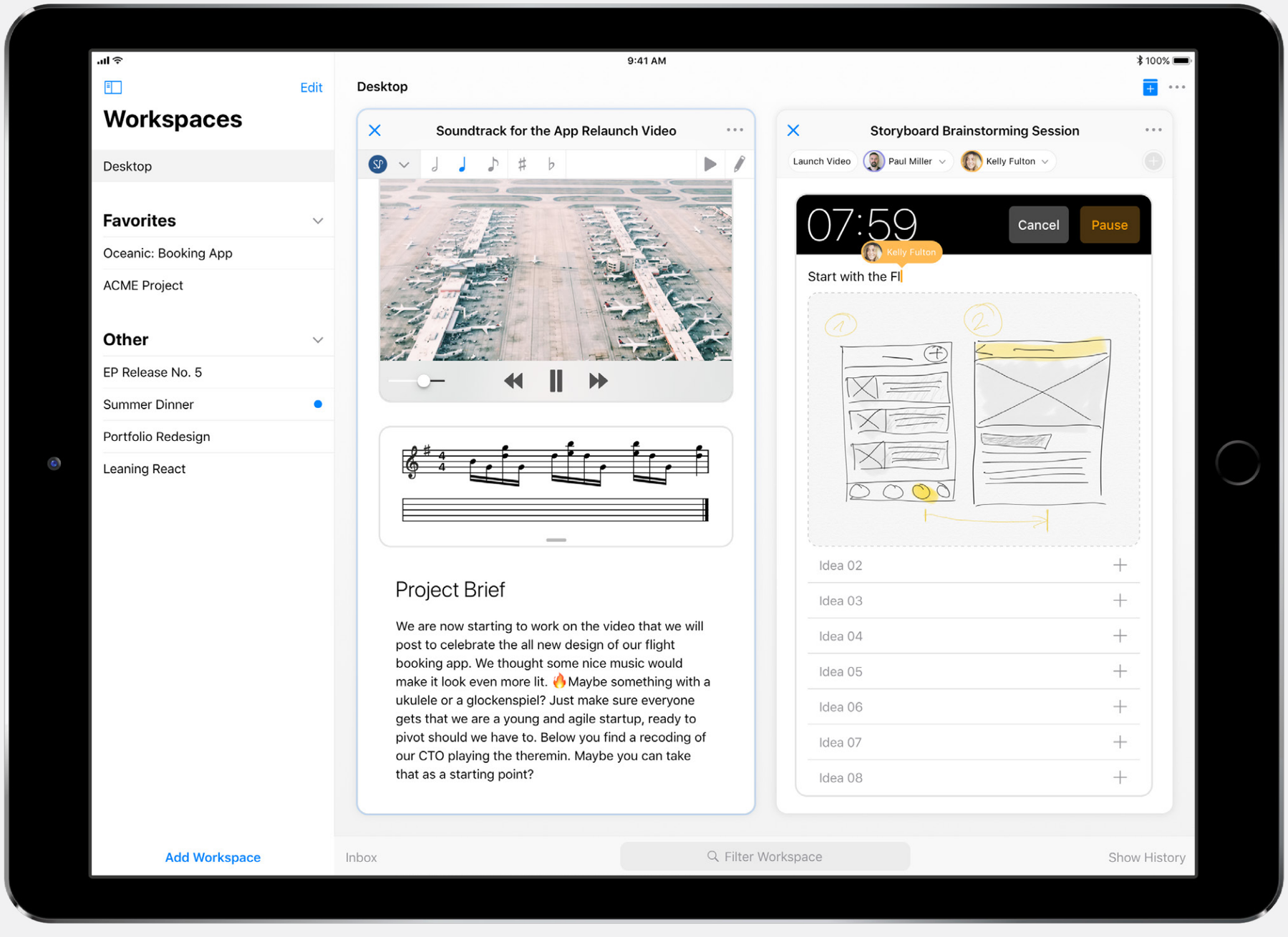


Figure 56: **Working Side by Side**

Assigning Tags

Assigning tags to a document can happen by adding tags recommended by the system or by manually adding a tag either through the autocomplete popover or via the complete list of all tags used in the system.

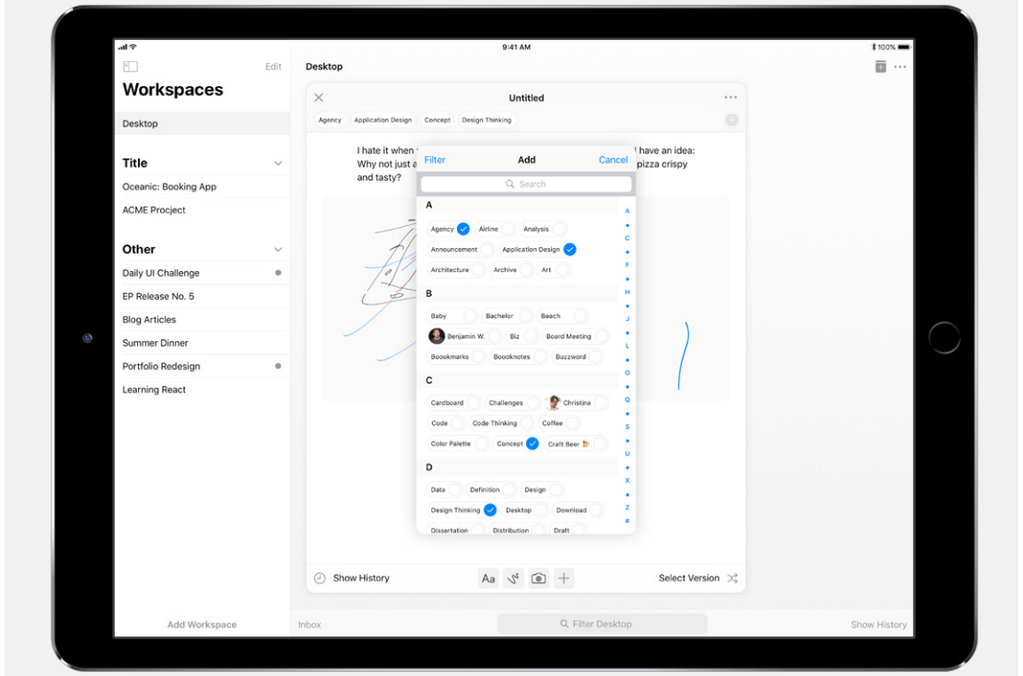


Figure 57: **List of All Tags**

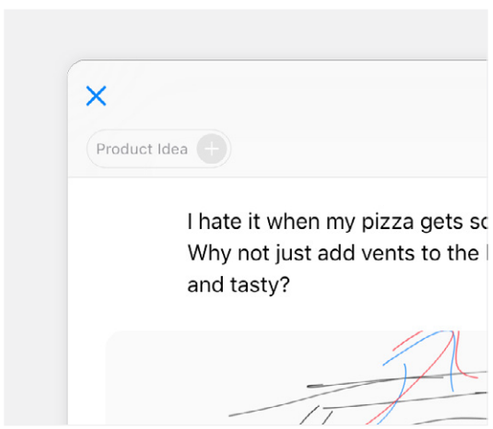


Figure 58: **Recommended Tag**

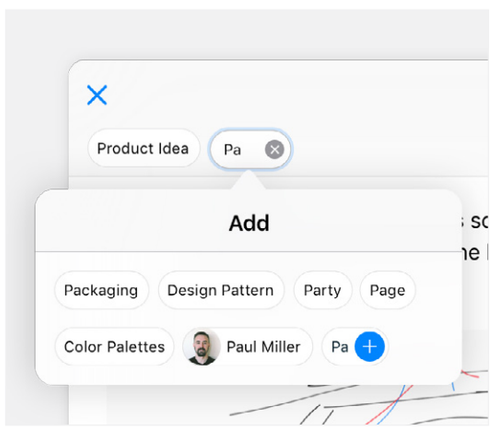


Figure 59: **Autocomplete**

Additional Functions

New artifacts can be dragged to any position in the document. Documents can be embedded into each other. One document can have multiple versions and the version to be displayed can quickly be selected.

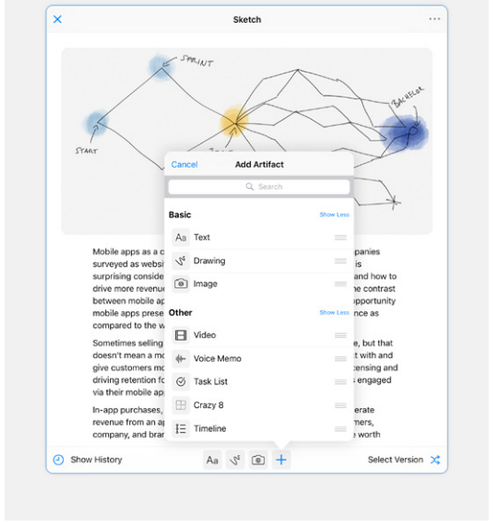


Figure 60: **Adding an Artifact to a Document**

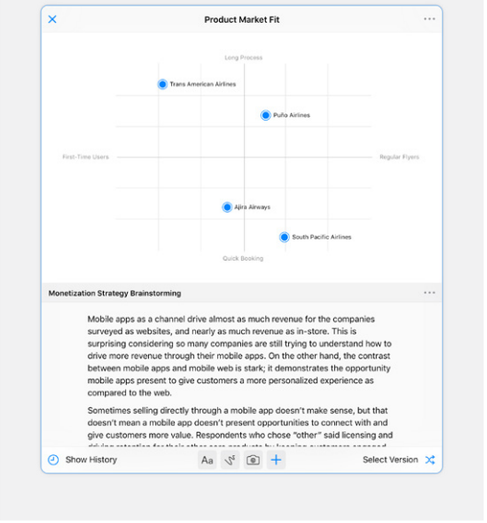


Figure 61: **An Embedded Document**

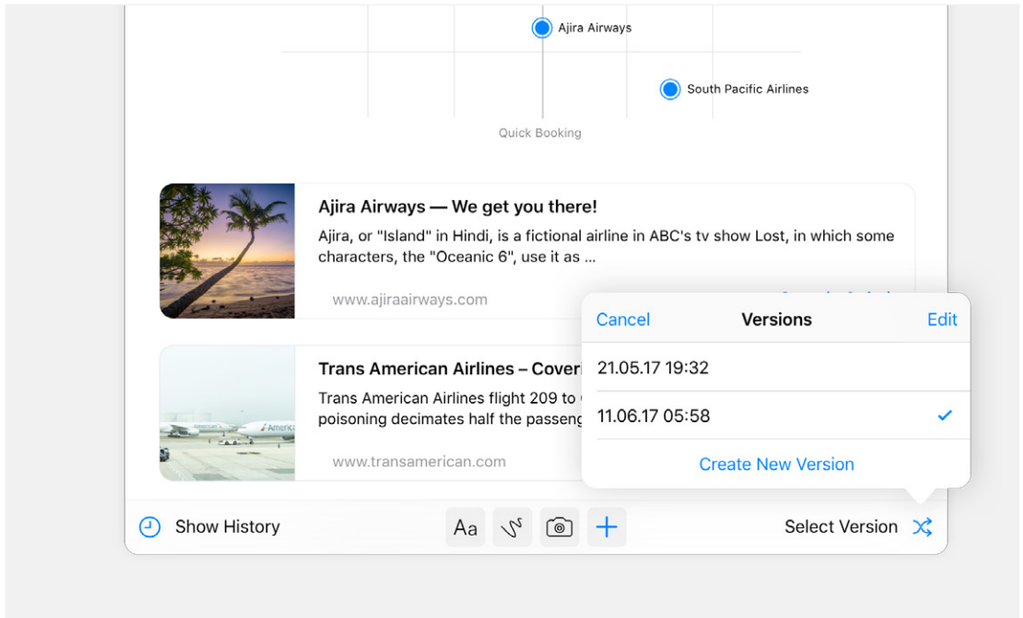


Figure 62: **Selecting a Version of a Document**

Drawer

The drawer can be opened to reveal the inbox with documents relevant to what the user is currently working on, the history of the workspace and the ability to filter the document displayed in the workspace.

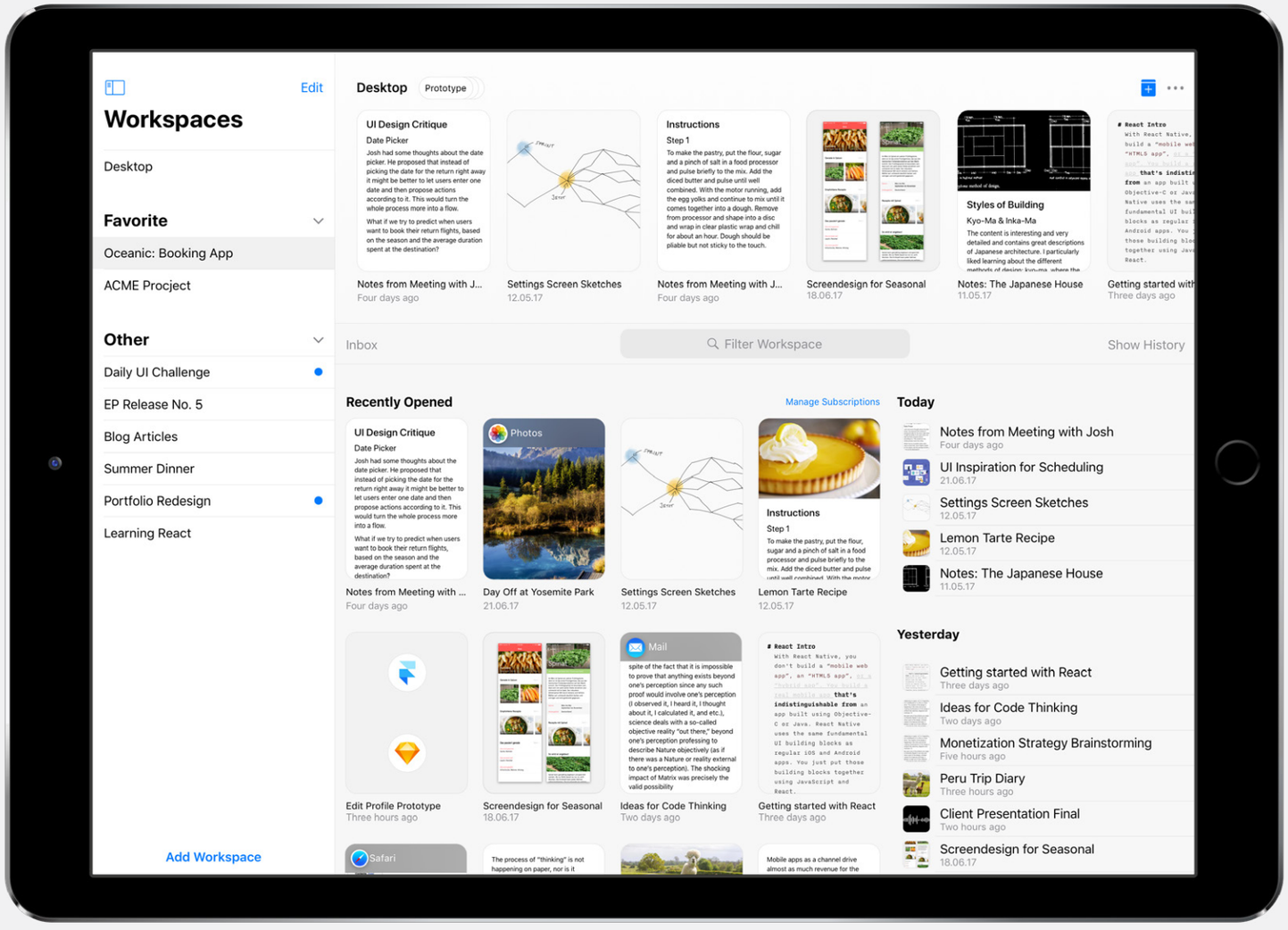
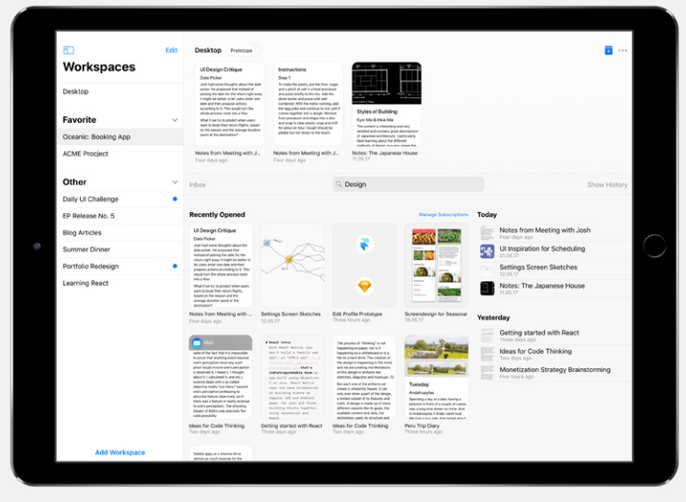


Figure 63: **The Expanded Drawer**

When the drawer is expanded, the user has access to all content related to the workspace. The inbox is filled with content that the user might be unfamiliar with or that she might not remember, in order to drive the making of cross-connections. The history is another way to access documents, by remembering where you had them opened, rather than their content.

Figure 64: **Filtering a Workspace**



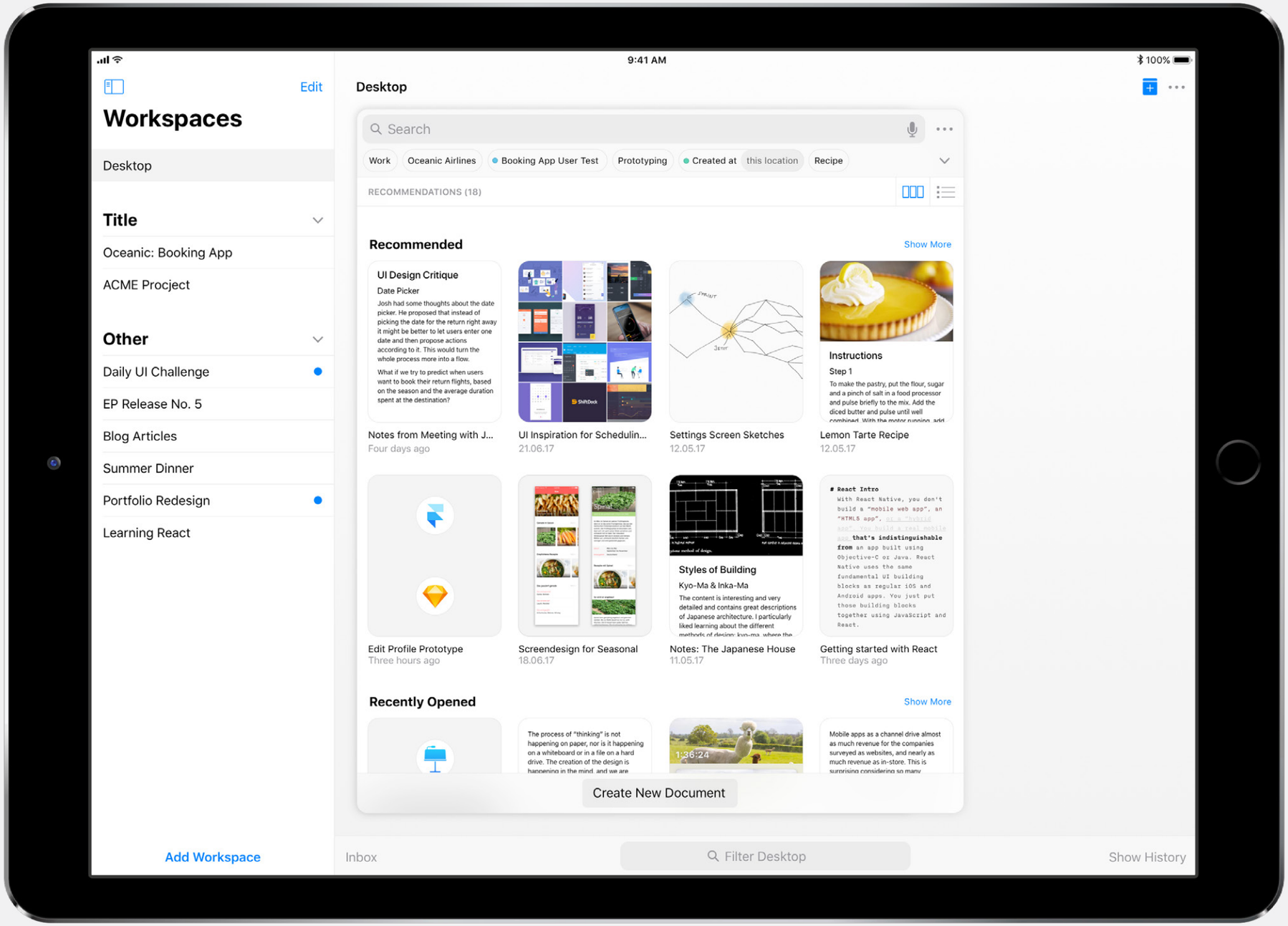


Figure 65: **A Newly Opened Card**

Filtering

Filters can be added via the recommendations bar, the expanded list of recommendations or via Natural Language input. Metadata filters can then be changed, while the list of results is updating live.

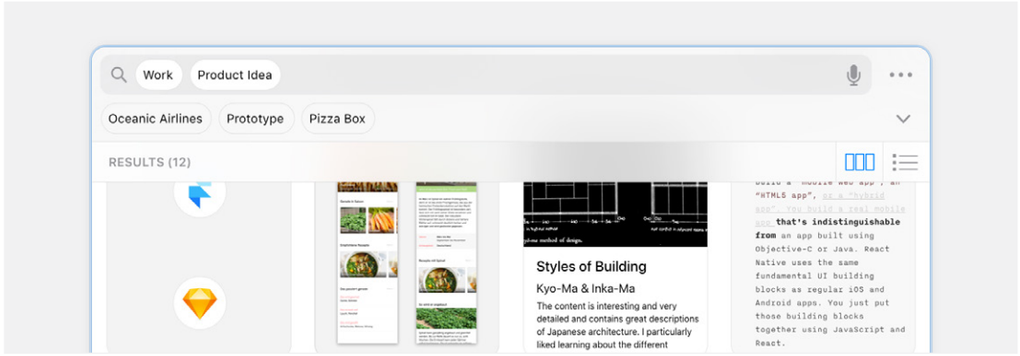


Figure 66: **Filtering with Tags**

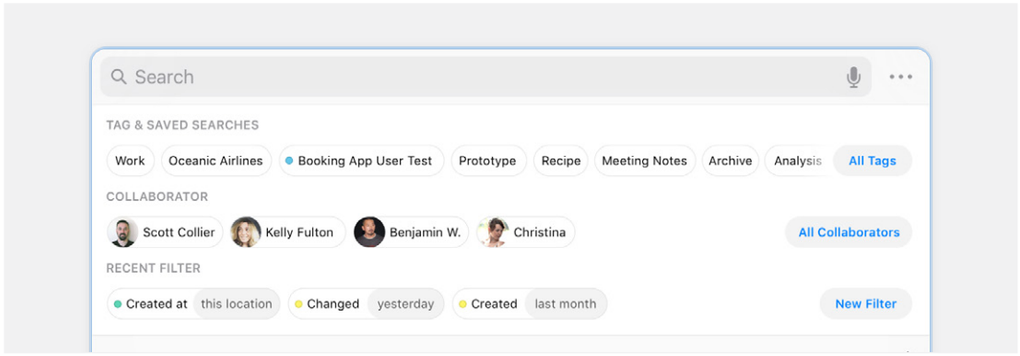


Figure 67: **Expanded Recommendations**

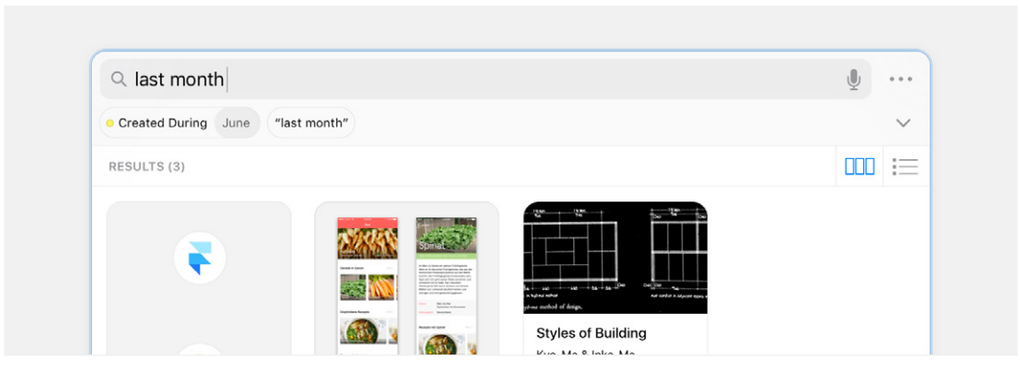


Figure 68: **Natural Language Recognition**

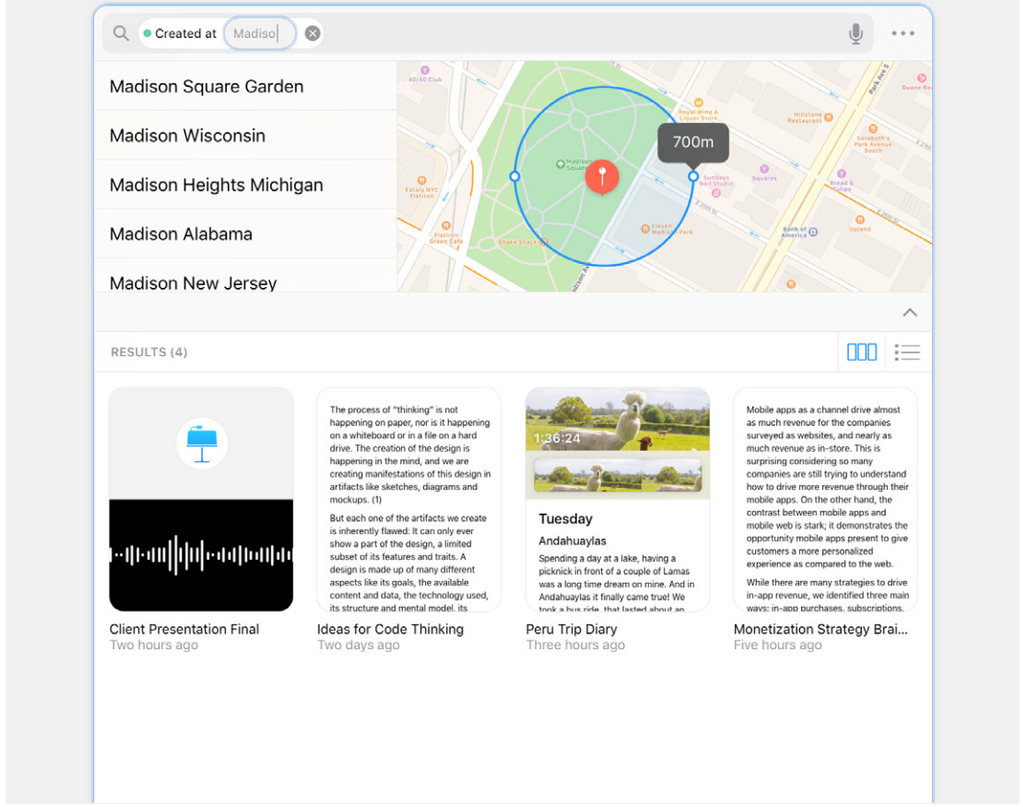


Figure 69: **Filtering with Metadata**

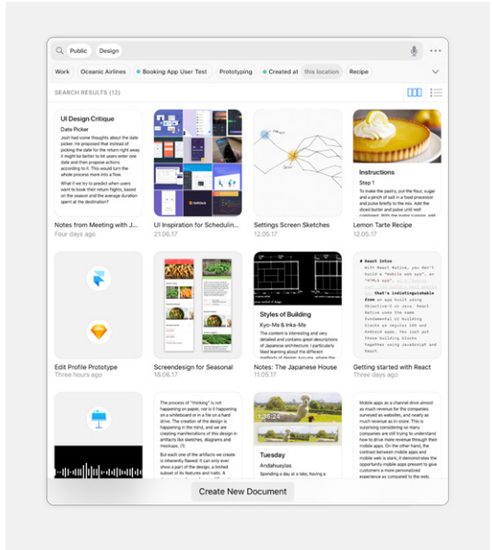


Figure 70: **Search Results as Grid**

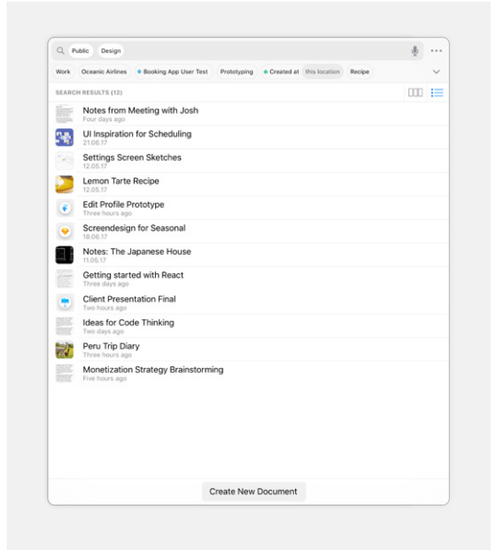


Figure 71: **Search Results as List**

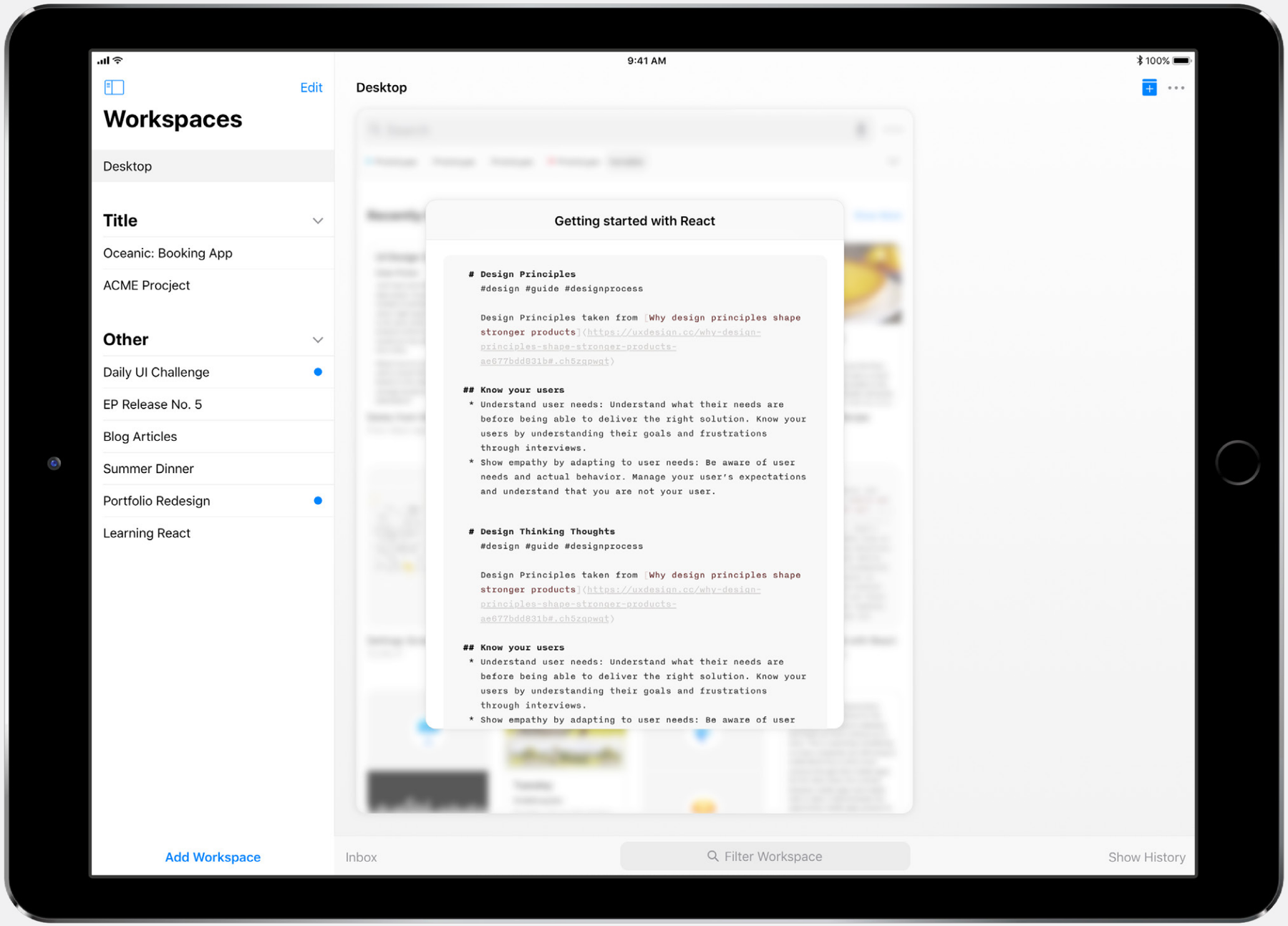


Figure 72: **Peek and Pop**

Collaboration

Collaboration can happen live in any document. Collaborators can quickly be added to documents the same way tags are assigned.

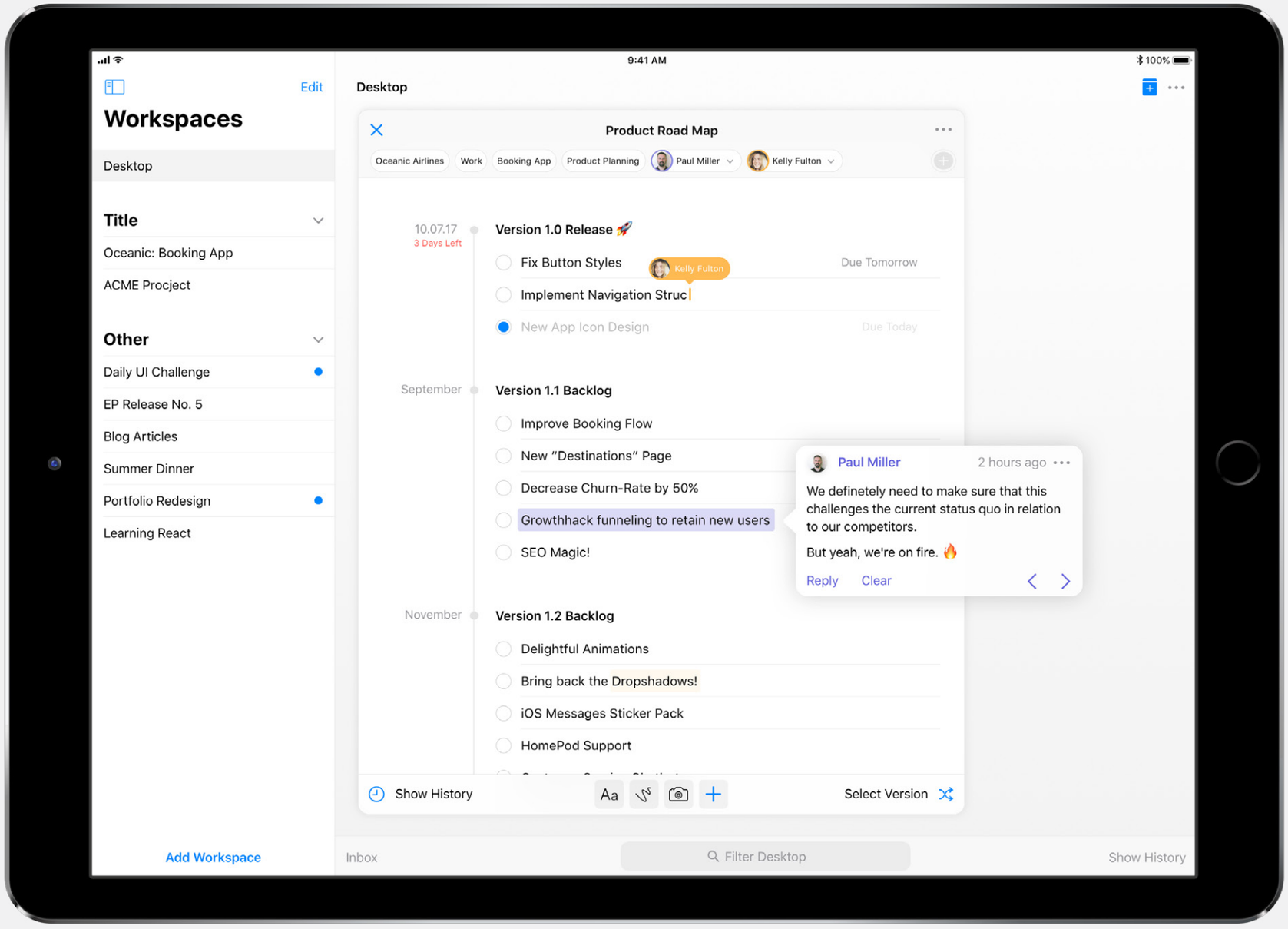


Figure 73: **Collaboration in a Document**

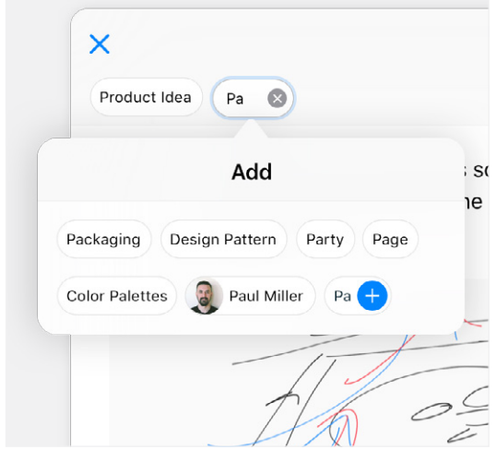


Figure 74: **Adding a Collaborator to a Document**

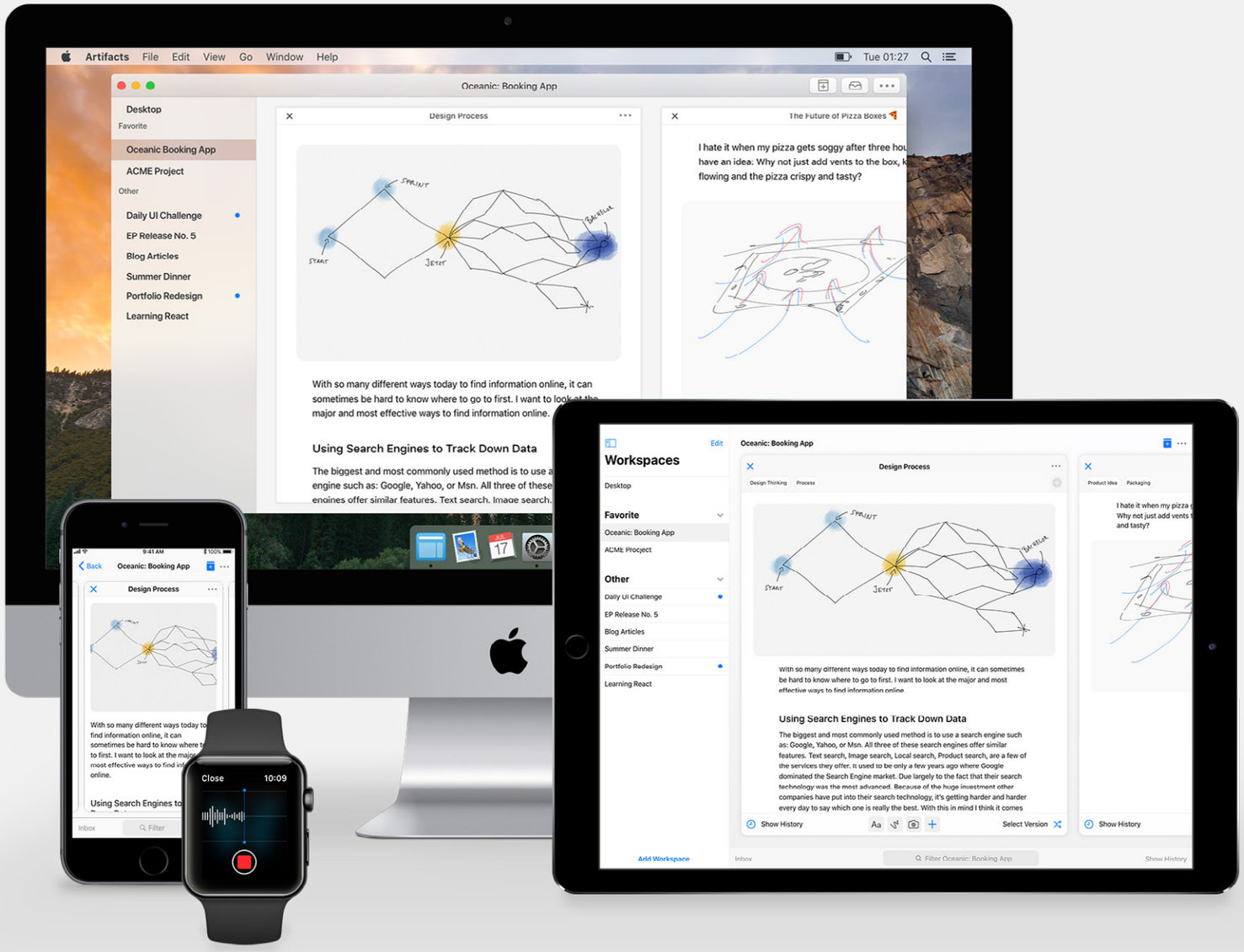


Figure 75: **Device Sync**

Appendix

Statement of Authorship

We herby declare that we are the sole authors of this bachelor's thesis and that we have not used any sources other than those listed in the Reference List and identified as references. We further declare that we have not submitted this thesis at any other institution in order to obtain a degree.

Schwäbisch Gmünd, 29.06.2017

Nikolas Klein **Christoph Labacher** **Florian Ludwig**

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