Increased Addressing of Human Senses as a Trend

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Abstract

One of the key results of Gendrich Altshuller's research is the definition of the "Laws of Engineering Systems Evolution". These Trends, structured into the well-known format by Gen3Partners (shown later in this paper) have proven their correctness over decades in the technical and non-technical environment.

This paper suggests adding another viewpoint to the trends by not only considering the development of technical systems themselves in a technical environment, but by focusing on the interaction of a technical system with users and the resulting requirements and development directions. The novelty is to propose an algorithm to fast identify gaps of a product addressing the human senses, thus being able to foresee product evolution. By defining a systematic approach, the development directions for products interacting with humans get predictable.

Acknowledgement

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1. Introduction

The development of the “Laws of Engineering System Evolution” is one of the fundamentals of Altshuller’s TRIZ Methodology. Due to some legal constraints, these “laws” have been renamed the “Trends of Engineering System Evolution (TESE)”. The focus is on engineering systems. Engineering Systems (ES) do not exist for their own purpose. They in fact address human beings and serve them (one way or the other). Of course, the level of interacting with a human being is different. For example, fishing lures are primarily designed to address the senses of a fish, but still a person will touch it, mount it on the fishing rod, see it, etc. Many other systems will have a limited interaction with humans, but during purchase, mounting, operation and dismantling, at some point most ES will get in touch with a human being (even for a pure Machine to machine systems M2M). This thesis deals with ES that are designed to have an interaction with persons.

Following this view the human being is the super system and even the target of the technical system. The interaction between both is done by the senses of the human being. Interpreting this with the trend of “increased coordination”, engineering systems evolve by increased addressing of human senses.

Alexander Lyubomirskiy has shown in his research that there is a trend of “coordination of images” [3]. This trend focuses on the visual sense of a human being. As the visual sense is the most used one and thus expected to be the most important, Dr. Lyubomirskiy was able characterize the coordination of images in a ranking. This study suggests expanding this approach to the additional basic human senses, auditory, kinesthetic, gustatory and olfactory. With this the complete basic human interface with technology and the world is addressed. The senses and as well the discussion that a human being has more sense or senses of animals will be discussed during this paper.

During the research (and this paper summarizes this journey) it became evident that considering the interaction between a product and its user - a human being - can lead to a forecasting and prediction of an engineering system evolution that is designed to interact with human beings. A simplified algorithm has been developed which makes it possible to identify gaps of a system related to the addressing of the human senses, thereby pointing out opportunities for further development and evolution. This paper describes the development of this simplified algorithm and discusses the systematic approach to this evolution.

The study is structured in the following way: The functional interaction between a human being and its environment is defined and classified, an assumption is formulated and the effect on the Main Parameter of Value (MPV) of an S-curve is defined (chapter 2). In chapter 3 the goals and tasks of the research are described. The single senses

and their appearance are detailed. In chapter 4 the actual state of the art is discussed. Chapter 5 suggests the improvement of impact of the senses and how this can be applied in a practical way. Chapter 6 concentrates on developing the algorithm to apply the suggested trend for practical usage and names examples on how this has been done in the past. Examples with prediction of the future are shown, and it is demonstrated how the trend is applied today to solve a challenge. Chapter 7 opens a possible further side line of the trend: how can we add sense to a human being with the help of novel technology? Chapter 8 details the personnel contributions of the applicant and chapter 9 represents the conclusion and recommendations.

2. Relevance of the topic of research

In the following section the interface between human beings and engineering systems and especially the effect on the brain and the evolving psychological reactions are discussed.

2.1. Interactions

The world can be divided into two parts: animated organisms (human beings, animals, bacteria, etc.) and unanimated materials (earth, rocks, bricks, technical systems, etc.). Both parts co-exist in the same environment and influence each other (Fig. 1).

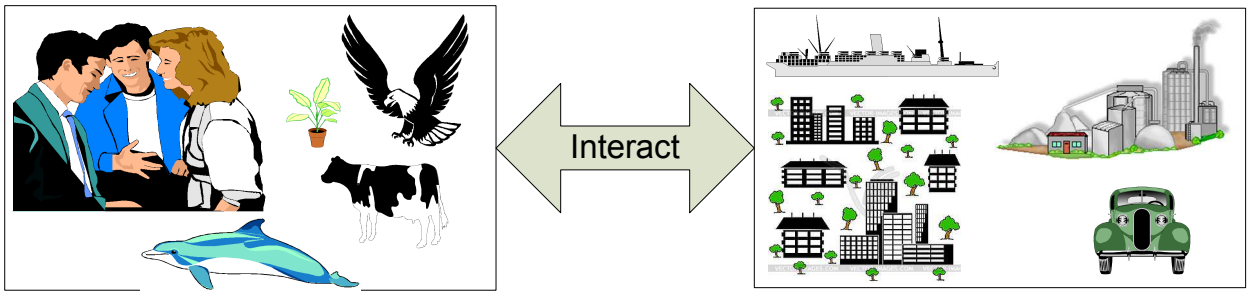


Fig. 1: Interaction of the two parts on our planet: animated / unanimated materials (CorelDRAW! Cliparts, 1993)

The interaction between both systems is based on the sensory / input channels of both parts. For unanimated parts this generally is the material surface (defined on the atomic level). Nevertheless, there are of course fields that may interact on deeper levels as well. For animated parts, it is the sensors that are available. Human beings generally have 5 types of basic senses [11]. Science is currently discussing whether there are more senses for a human being [29]. For example, the sense of equilibrioception – a sense of balance -, proprioception – knowing which parts of your body are where without looking -, kinesthesia – a sense of movement -, or chronoception – how we sense the passing of time. The last two ones could be allocated to the kinesthetic as a supplementary shaping. In this paper the procedure for the five basic senses will be developed as they mark the scientifically defined and accepted standard. It should be no problem to expand the procedure at a later point. The sense are:

- Seeing (visual) – distance sensing
- Hearing (acoustic) – distance sensing
- Sensing (touching), which may be separated into 3 separate aspects: touching (including vibrations), temperature, pain – nearby sensing
- Tasting (chemical) – nearby sensing
- Smelling (chemical) – nearby sensing (to a certain degree distance sensing as well)

Although this thesis focusses on ES designed for the interaction with human beings one could think of expanding the outlined method other living beings as well. In the world of animals, we find lots of supplementary sensors [16]:

- Bats use sonar
- Snakes use infrared light
- Bees and fishes can see UV radiation
- Fish use branch-line organs for the detection of water flow direction
- Electric eel can detect electrical fields
- Birds have sensors for magnetic fields and UV radiation
- Turtles detect the pH-value of water
- Spiders and scorpions detect vibrations
- Insects use polarized light for direction detection
- etc.

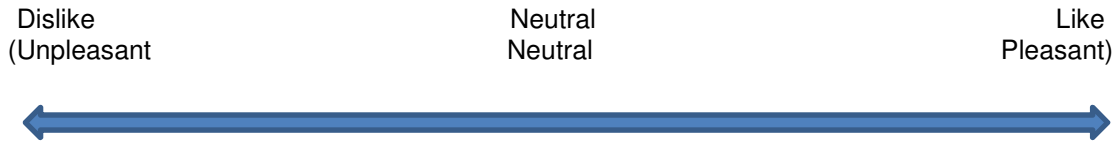
These non-human senses can also be considered by applying technology to transform them into human-detectable senses (see chapter 7.3).

2.2. Classification of interactions

Animals usually classify what they sense into 3 categories [11]:

- something to chase / to eat
- neutral – don't care
- dangerous / take refuge

For human beings, the principle is similar and can be simplified into:



All the information supplied by one or several of the senses is interpreted based on past experiences within a range from "like (pleasant)" to "dislike (unpleasant)".

With the decision "like (pleasant) / dislike (unpleasant)" (Fig. 2), humans direct their activities to the *feeling* layer. The other decision layer is the logical, cognitive decision process. It relies on countable and measurable arguments.

The most important trend is convergence to ideality. Technical systems aim at self-fulfillment of their functions. However, technical systems do not exist on their own and for themselves. They are always, maybe via other technical systems, linked to human beings.

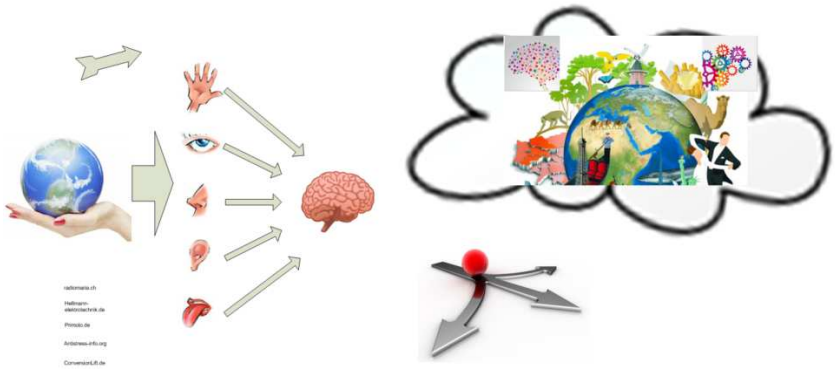


Fig. 2: Interpretation path for a living creature (CorelDRAW! Cliparts, 1993)

In the real world, an industry has been developed for the following purpose: marketing, design and advertising. In the last few years a discipline called neuro-marketing has evolved. The idea is to use neuroscience to better understand customer psychology and behavior in the dislike (unpleasant) / like (pleasant) sense. Research has shown that human beings react on information they get through their senses with emotions and feelings. Emotions are neutral and represent a bodily response to inner and outer events. An example is starting to sweat when temperature is rising. Feelings reflect the conscious experience of being in a particular emotional state. This means that there can be emotional responses without feeling, but you cannot have feelings without accompanying emotion [12]. This leads to the relation of wanting and appreciation. An example is the choice of eating chocolate while on a diet. You feel the urge for a snack and the sugar boost, but consciously think it's a bad thing to do. Wanting is an subconscious aspect, appreciation is a conscious experience. And the conscious aspect is the one that can be influenced.

According to the above statements, a person allocates his environment and the information he obtains about it via his senses to categories dislike (unpleasant) – neutral – like (pleasant). Of course, the binning is dependent on region, culture, experience and learning in life in general. Still the environmental perception will be categorized. Therefore, the technical ideality of a system must be taken into consideration for the human binning process as well.

A particular branch, sensory neuromarketing, is emerging, focusing on how sensory inputs other than visual and hearing can influence decisions (like the smell of fresh bred close to a bakery). So, neuromarketing, too, is currently developing in the direction of involving more senses.

There are studies regarding multisensory integration which describe a process by which information from different sensory systems is combined to influence perception, decisions, and overt behavior [19].

The sorting if something is pleasant or unpleasant differs for individuals. This cannot be defined as with a physical parameter where there are (in Newton's world) sharp definitions. For technical systems parameters are defined and changed according to the goal that shall be achieved. The human being then translates this parameter into his individual pleasance / unpleasance feeling. For example music: one of the parameters of music is the amplitude of the frequencies (that compose the music). The amplitude can be translated into the loudness of music. For young people loving rock music, a high amplitude can be pleasant while at the same time for an elder person is can already be unpleasant. There is an individual translation code that cannot be translated into a direct transfer function.

Loudness can as well be translated into the "visibility" of an acoustic signal: is it there (hearable, visible) or absent (not hearable, invisible). Loudness is defined as physical parameter in Decibel (dB). However, if the acoustic signal is heard (visible) or not depends on the person and generally on its age. Kids hear much lower signal levels to much higher frequencies as adults do. Fig. 3 illustrates this fact. Young kids hear an acoustic signal at nearly 0 dB (green line). The perception level is quite indifferent over a wide frequency span. Elder people need a higher dB to get awareness of a signal (blue/red lines). At the same time the sensitivity at higher frequencies is lower. Kids are also able to hear frequencies up to 18 kHz whereas elder persons stop around 15 kHz.

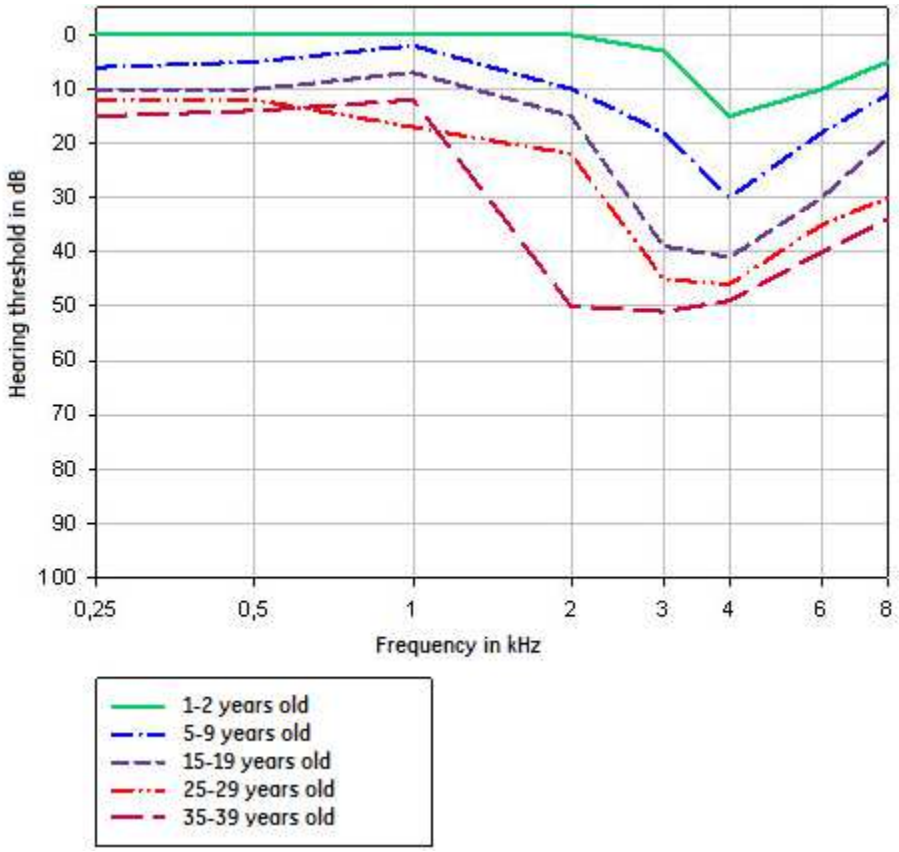


Fig. 3: Perception thresholds for acoustic signal for different ages (laermorama.ch)

So the “visibility” of an acoustic signal and its categorization into pleasant / unpleasant is depending on the individual person, although the physical parameters of the signal are the same. What was demonstrated here for the acoustic signal is valid as well for the other senses and will be discusses in the corresponding section later in this paper.

2.3. Evolution of classifications over time

Functionalities of systems are shaped to meet the like (pleasant) bin as much as possible. Still it must be considered that perception is changing over time. Noriaki Kano has developed a model for customer satisfaction (Fig. 4). He identified 5 levels of quality:

The first requirement type is called “Must Be”, or “Dissatisfier”. These are requirements that can dissatisfy a customer, but cannot increase satisfaction. This is symbolized by the lowest (red) arrow, which is negative when service is dysfunctional. It can only rise to the neutral satisfaction level as service functionality increases.

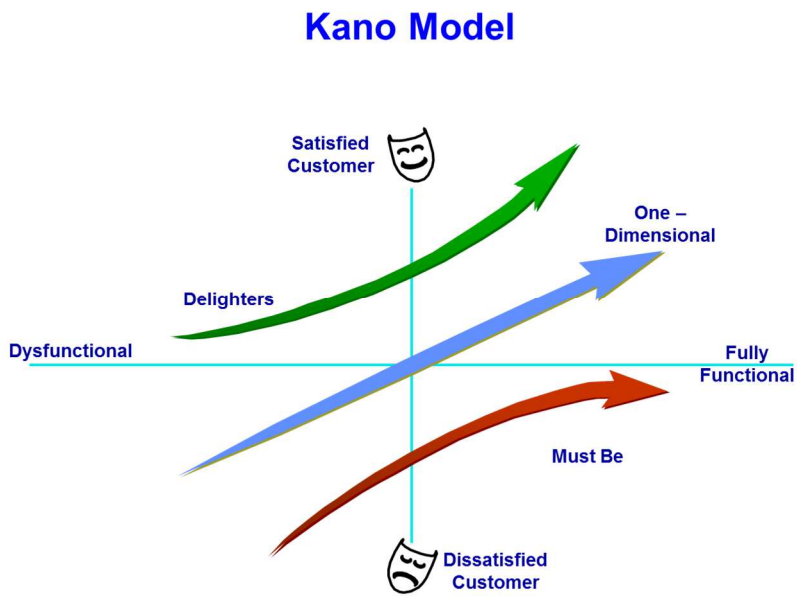


Fig. 4: Kano Model

The next type of requirement is called “One-Dimensional”, or “Satisfier”. The more such requirements are met, the more the customer will be satisfied, as symbolized by the middle (blue) arrow, which rises from left to right.

“Delighters,” also known as “WOW’s,” are attractive qualities that, if absent, will not cause dissatisfaction, but that will delight customers when present because they bring

new and unexpected value. This is symbolized by the upper (green) arrow, which rises from the neutral satisfaction level as functionality increases.

“Indifferent” requirements are those whose presence and functionality neither cause satisfaction nor dissatisfaction in the customer.

It is important to also note that some features are “Reverse Features” whose presence causes dissatisfaction, but missing them will not cause satisfaction (e.g. rust on a car). Reverse features are usually the result of poorly understood customer requirements or misconceptions about what customers really want.

The extended KANO model adds the dimension of time and the relationship of the customer function / need type to the model. Note that today’s excitement need, which is unvoiced by the customers because they do not know about the existence of the feature, quickly becomes the next performance need. Eventually and as time passes, the performance item becomes a basic need as illustrated by the time line (Fig. 5, yellow line). An example could be airbags in a car. At introduction, it was a delighter, then it became a performance need, today it is a basic function.

Fig. 5 also illustrates, by comparison to the earlier charts, the relationship between the types of customer needs: Excitement, Performance and Basic, and the related requirement types: Delighters, One-Dimensional, and Must-Be.

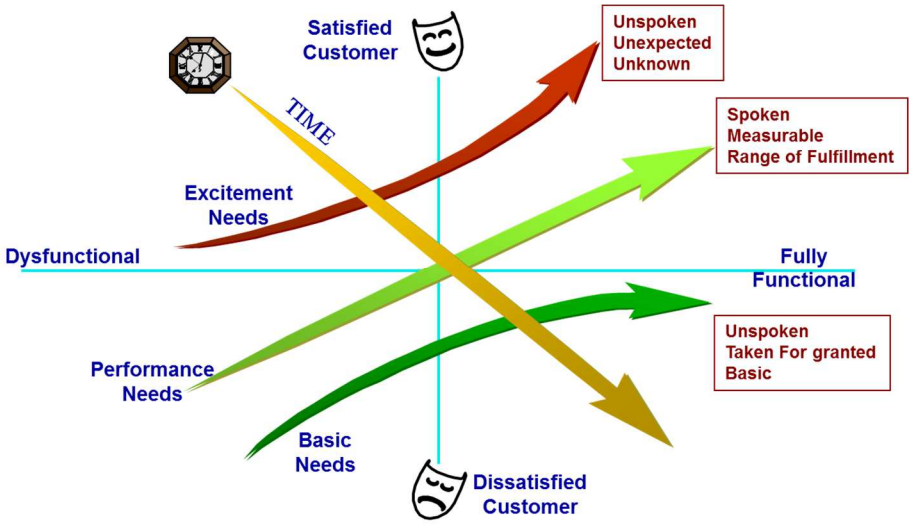


Fig. 5: Kano model evolving over time

To ensure economic success, new products have to be developed at an increasing pace, under cost and quality pressure [13]. One measure General Electric (GE) applies to meet those needs is Six Sigma. Since its introduction by Jack Welch in 1996, GE has been utilizing Six Sigma including the application of Six Sigma DMAIC (**D**efine - **M**easure - **A**nalyze - **I**mprove - **C**ontrol) and **D**esign **f**or **S**ix **S**igma (DFSS) very successfully for driving inventions, developments and innovations.

Tab. 1: Engineering aspects for idea evaluation

Engineering Aspect	Description
Performability	Will the product perform as the customer expects it to perform?
Affordability	Will the product meet cost expectations?
Featurability	Will the product provide added benefits?
Deliverability	Will the product be ready when the customer wants it?
Usability	Can the customer quickly and easily install and use the product?
Maintainability	How easy will it be to keep the product in service?
Durability	Is the product robust enough to withstand abuse?
Imageability	Will the product convey an image of quality and prestige?
Profitability	Will the product deliver acceptable levels of profit?
Investability	Does the product make sense in terms of return on investment?
Riskability	Are the risks that must be taken prudent?
Producibility	Can the factory and supply chain deliver the product?
Marketability	Do we have the means to sell the product?
Growability	Does the product offer growth and market expansion?
Leverageability	Does the product build on our core competencies?
Respectability	Will the product strengthen the reputation of the company?

In DFSS the 4th step “Analyze” (in stage 3) is employed for the development of conceptual designs. During this step 4, a team of experts is formed and ideas are generated by typically utilizing brainstorming methods. Subsequently, these ideas are evaluated regarding “engineering aspects” such as those listed in Tab. 1.

Still, even when complying with all these requirements, products and ideas do not sell automatically. In lots of discussions with customers the experience could be gained that even if all logical arguments were in favor of a product or solution, sales did not work if the feeling was not aligned and vice versa. This has been proven by science as well (sales-empowerment.com).

2.4. Assumption Formulation with respect to the Main Parameter of Value (MPV)

Translating the above results into TRIZ modeling gives the functionality shown in Fig. 6

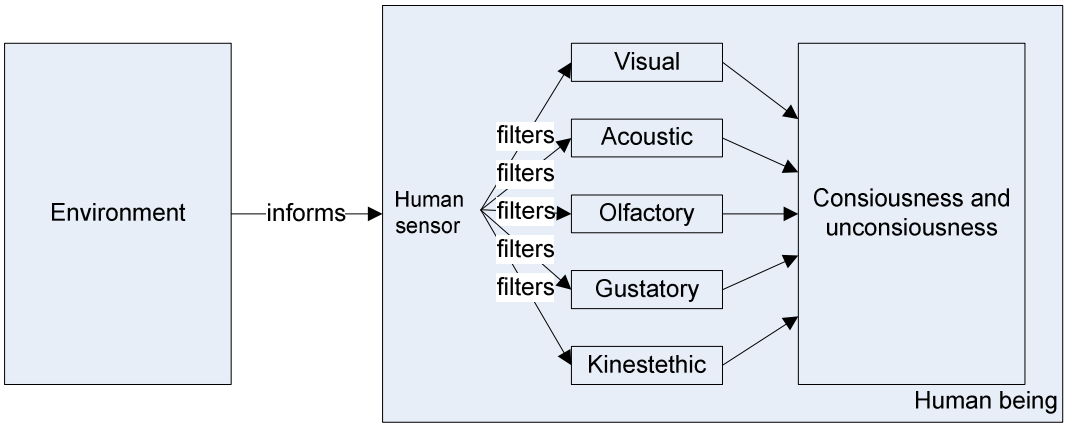


Fig. 6: TRIZ model of the environment – human being model related to senses

The environment informs the human being. All senses supply information that flow via a conscious or subconscious way to the brain. A parameter in the supply of information is the quality, how the information is transported. It can be insufficient, normal or excessive. For the different senses this quality is different. It can be summarized as ergonomics. The better the ergonomics (for each sense), the more efficient the information is.

The brain itself filters and interprets the information. As the filter and interpretation change over time the effect of the function (be it useful for a pleasant information or harmful for an unpleasant information) can change over time from excessive to normal and insufficient (or the other way around). Thus, the function has a time-related component, which is not controllable from the outside. The only certain knowledge that we have on human beings is that delivering the same information (as a TRIZ function) via varying channels can influence the effectiveness with which the brain reacts on the information [25]. Even if only one sense with poor “ergonomics” is used, it will take time for the brain to correctly handle the information. The more senses are used and the better the ergonomics are, the faster and more effective the brain can react. From this starting point the following assumptions are formulated.

TESE concentrates on the technical evolution of components, which reflects the logical side of the decision-making process. The first assumption is that components evolve towards emotional ideality in terms of generating an intensified “like” (pleasant) feeling or, in case of warning, an intensified “dislike” (unpleasant) feeling (Fig. 7 top). The second assumption is that components evolve from addressing only one sense towards addressing multiple senses (Fig. 7 bottom).

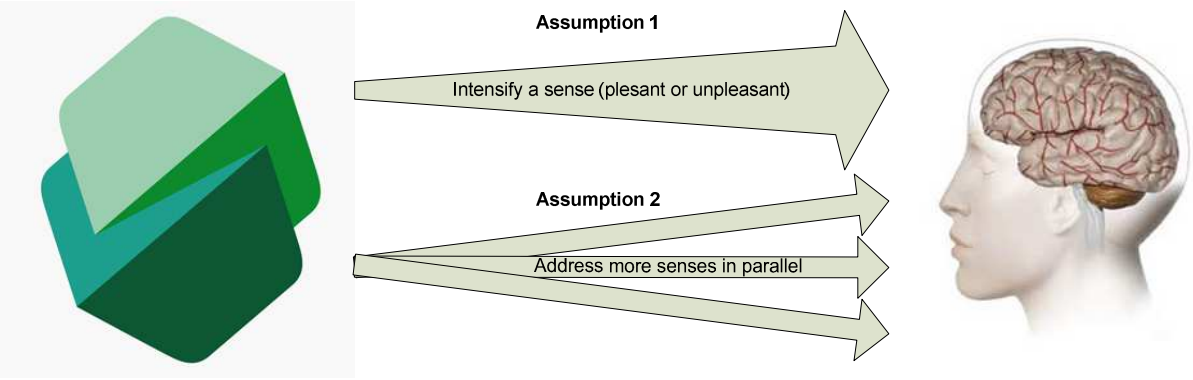


Fig. 7: Assumptions on trend evolution for components addressing the human senses

Assumption 1 focusses on improving the functionality of a single sense itself, e.g. by using the trend of dynamisation (for sound: from constant sound -> 2 tone -> multi tone -> gradient tone -> pulse ->…). This will ensure that the Main Parameter of Value (MPV) will constantly rise to compensate the time-related decline in awareness. When only one sense is considered, this is what is normally an action on the 1st and 2nd stage of the S-curve.

For modeling purposes, it is assumed that we can reach a maximum MPV of 100% when addressing all human channels for information input (senses) in the most efficient way (maximum dynamization). In this case the MPV is considered to be the information transfer from the engineering system to the human being. When only considering assumption 1 we have only one degree of freedom to improve the MPV over time and we will not reach its maximum. When several senses are combined the MPV gets closer to its maximum value and this happens in a shorter time. Fig. 8 displays this effect with the simplification that one sense only contributes 20% to the maximum MPV. This means that the senses are equally distributed regarding their impact.

Assumption 2 focusses on intensifying the number of senses addressed. Here the technical functionality of the component is more or less ideal and there is a shift towards the emotional impact. This addressing can now happen in a sequential way or in parallel. For a sequential way one sense is optimized and then the next sense will be added. In the parallel way, another sense can be added to the system any time during the 2nd stage and raise the MPV. The senses can then further be optimized even in an un-even development. By opening the possibility to think about addressing senses in parallel, the steepness of the S-curve for MPVs can be raised beyond the possibilities that a one-sense-only consideration would offer. Generally, this approach is more related to the 2nd and 3rd stage of the S-curve.

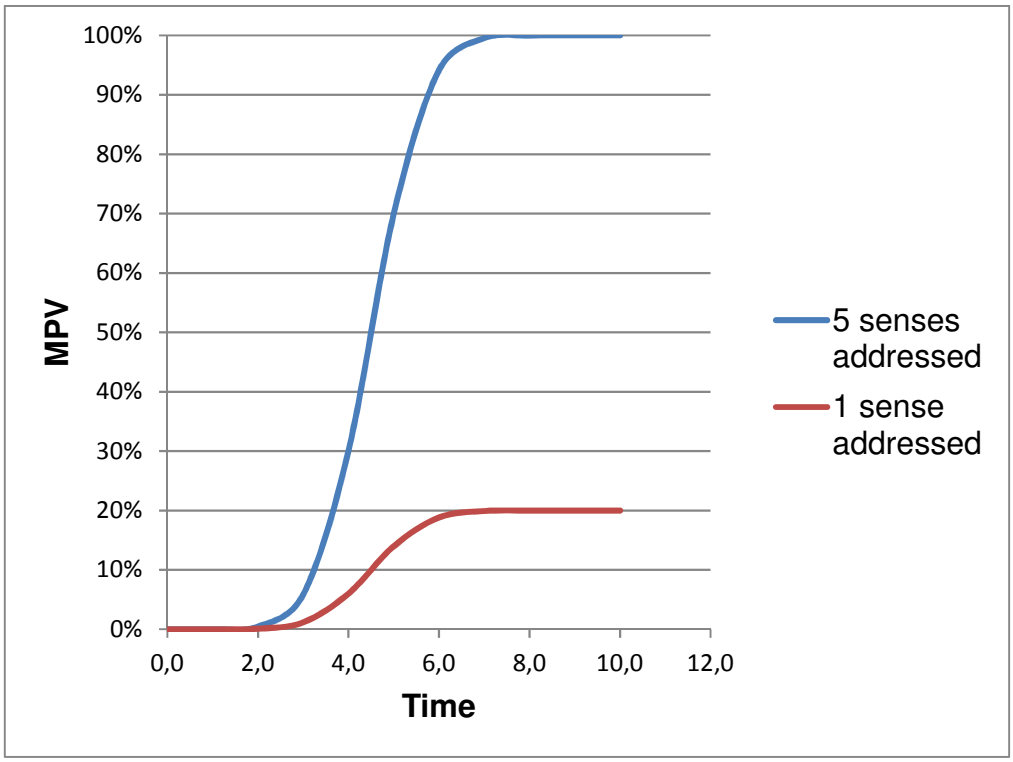


Fig. 8: Main Parameter of Value (MPV) model for addressed sense (Info transfer) (Assumption that one sense contributes only 20%. For display reasons, the 4th stage of the S-curve is neglected here)

Fig. 9 shows the advent of parallel application of the senses. For simplification, it is assumed that they all develop in the same manner over time , but differ in their effect to the MPV by the impact ratio. In chapter 6 (Fig. 29) the weights for the different senses are depicted. These values have been used in Fig. 9. One can see that addressing more than one sense at a time will generate a steeper slope of the S-curve and therefore lead to a higher MPV in a shorter time. Fig. 10 shows this for the example of the acoustic sense. The slope of the second stage is shown as well as the slope of all 5 senses addressed. With the angle between slope and x-axes a value for the innovation degree can be defined. Due to this the value of application of the trend of addressing of all human senses at a time will lead to a faster innovation (angle of the slope) with higher impact (MPV).

The defined assumption shows trends of the evolution of the senses per se. Of course, a manipulation by the conscious combination of senses addressed or by converting an unpleasant feeling into a pleasant or vice versa is possible and even probable in business applications. The methods of applying a trend to influence conscious and subconscious senses will be discussed later in this paper.

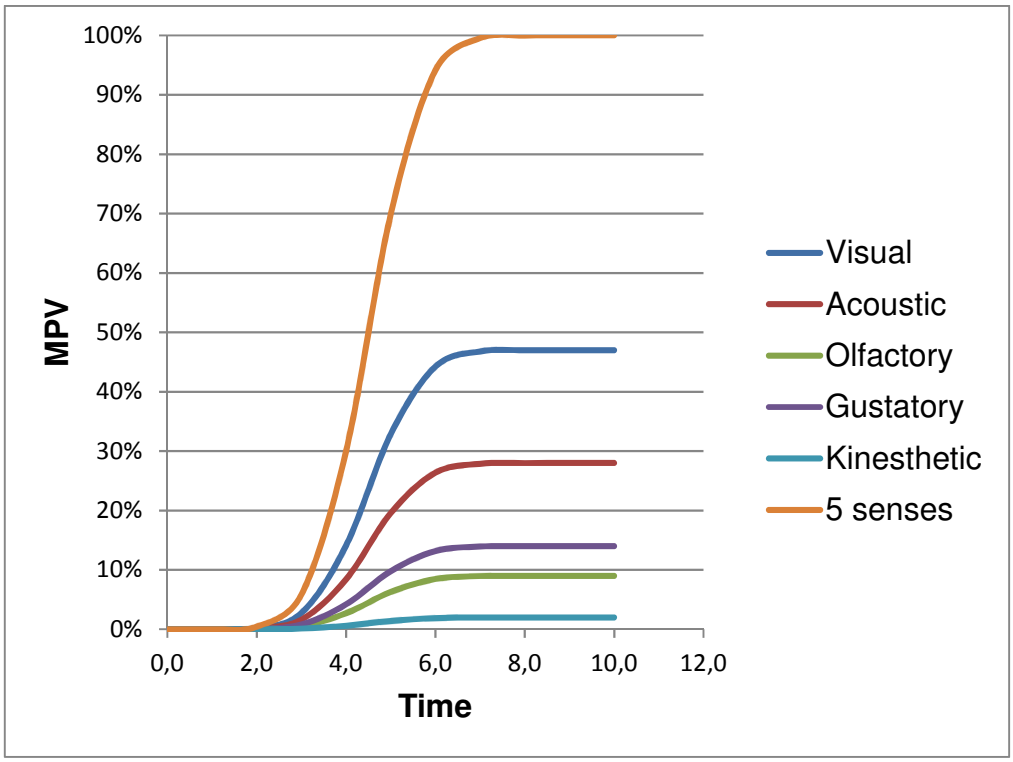


Fig. 9: MPV model (Information transfer) for the different senses

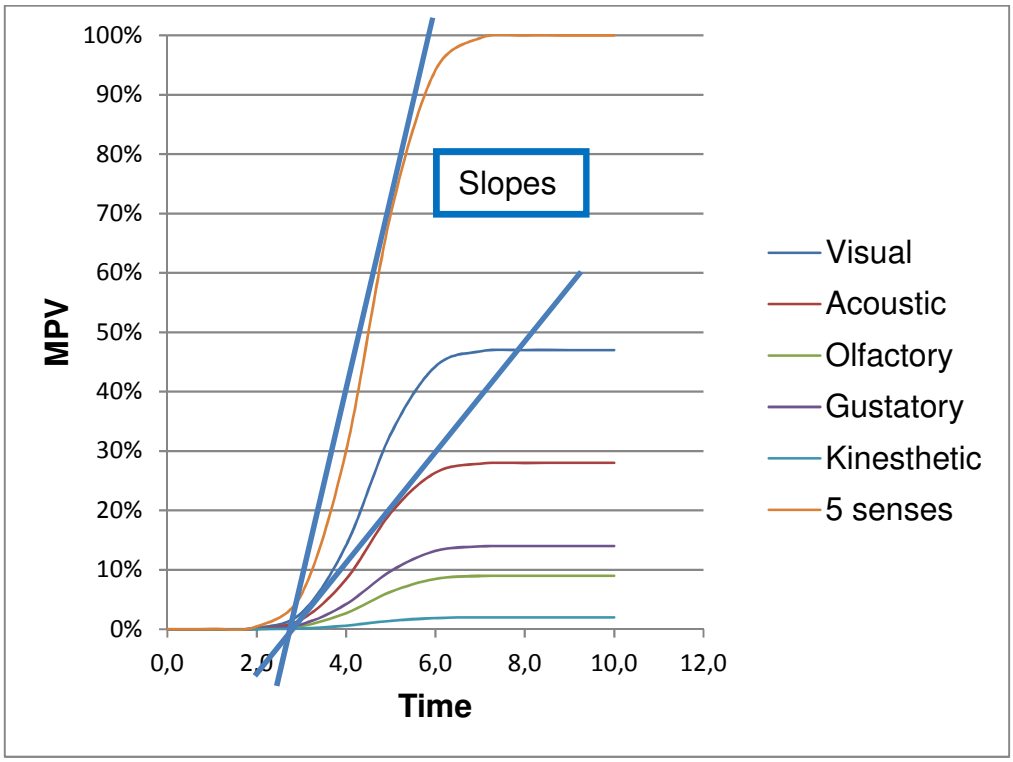


Fig. 10: Slopes of 2nd stage for innovation speed and MPV impact (Information transfer)

3. Goals and tasks of research

The assumption that components / systems evolve towards emotional ideality is hard to prove as there is no “old emotion” that can be conserved in an objective way. Therefore, as a first indicator we will look at the different human senses and how they affect our brain / thinking and how they were stimulated in the past. The research will detail the working principles of our brain, the working principles of our senses and the direction of their evolution. At the end an algorithm shall be developed how the trend can be applied in practice and examples or prediction and realization will be shown.

3.1. Principal function of our brain

The human sensors are connected to our brain where data evaluation is performed. The principal set-up of our brain functionality is shown in Fig. 11. It is basically divided into 2 parts: left and right. The right side is designed for our more creative, chaotic and subconscious capabilities. The left side represents our logic, number-oriented, systematic and conscious capabilities. Both sides are connected and interact.

Fig. 11: Brain functionalities: left side “logic”, right side “creativity”

Neuroscience has shown that the right side, i.e. the subconscious side, is operating approx. 100 times faster when processing data than the left side of our brain (the conscious part) [17]. This fast operation generates the “guts feeling” very fast but lacks the reasoning where this feeling is coming from. The left side needs much more time to generate the same result, but in this case the process of reaching the result is conscious.

Our sensors are attached with some preference to the different sides of the brain. Our distance senses (seeing, hearing) are more related to the left side (conscious, “logic” part) while the near senses (touching, tasting and smelling) are more related to the right side (subconscious). This has an evolutionary background. If a danger was registered by our senses in close proximity, an intermediate reaction was needed. There was no time for an extensive evaluation by our slow left brain side. Our distance senses offered

more time for a reaction and are therefore connected to the left side for a conscious and learning experience.

Psychology has shown that usually a person has a preferred side, dominating his characteristics and behavior [17]. The sense used therefore will affect the effectiveness and result of the information provided. The character of a person is not predictable. Therefore, it cannot be defined what sense have to be expanded in what order. Still it has been proven that increasing the number of senses that are combined will also increase their effect on the brain. [17].

According to the Trend of Engineering System Evolution (TESE) the system “brain” tends to bring both sides together as an equivalent system [12]. This is especially true for today’s time, where only very little sudden danger occurs in our life (unless you cross a road with lots of traffic).

3.2. Main Human Senses

Seeing (visual)

With industrialization, the design of components got more and more important besides pure functionality. Today a product must be designed well, even in an industrial environment. At least the colors must look appealing for a component and this is getting more and more a decision criterion for users and customers. Looking at a car advertisement in the 1960s, it was all about technical features: engine size, speed, acceleration, volume of the trunk, etc. Today it is about the feeling (Fig. 12). This is also true because design becomes a differentiating feature when there are alternative products. If there is only one product, design is not the key.

1960

2014

Fig. 12: Car advertisement past and today (magazine.volkswagen.de; bmwusa.com)

An interesting aspect is the color. The selection of color is not only judged by like / dislike, it can have an aspect of safety as well. Thus, the visual sense can have an

additional function. Colors can signal danger (red) or caution (blue) or safeness (green). But this is dependent on the culture where they are applied. In electric installation in Europe the color “red” signals danger – do not work on the electric system, in India “red” means the system is not in operation – you can work on the electric system. Therefore, when considering this sense, additional functionality has to be taken into account.

Another area is fashion. The functionality of clothes today is taken for granted. It distinguishes from the felt appearance: Does it “look good”? Since the functional evolution, fashion has concentrated on feelings. Usually the visual sense is more related to the left sector of the brain and thus refers more to conscious influence. Information is taken and consciously analyzed for the decision of pleasant / unpleasant [11]. Referring to the S-curve this means that from the 2nd stage on, design gets a delighter and driver.

Another aspect is the function „inform people“. People wearing luxury objects inform other people about the economic / social status of the owner or the group or subculture they belong to.

Apple work with their products a lot on visuals for the same reasons, and in addition, the visual interface is perceived as more intuitive since the brain is a strong visualizer.

Hearing (auditory)

The evolution of sound found its direction in music. Components are allocated with sound that makes you feel good and generates a pleasant feeling. You can see this with cars: the sound of an engine must correspond to its perception of delivering power and speed. The German Railway made a survey to find out in which train people feel safest. It was in trains with a dedicated locomotive that made a lot of sonorous noise (from the cooling fans) – the feeling of power – instead of a bee’s sound from distributed drives. Sounds are designed today to generate different emotions: sirens for emergency vehicles to generate awareness (using the unpleasant aspect of these sounds – loudness and yelling type), background music in shops to open the emotional channel of customers, (and retain them inside), etc. Usually the auditory sense, too, is more related to the left sector of the brain and thus refers more to conscious influence. Nevertheless music also considerably stimulates the right brain side as far as feelings are concerned. Information is taken and consciously analyzed for the decision of pleasant / unpleasant [11]. So, the two dominating senses (seeing and hearing) are related to our conscious perception.

Sensing (kinesthetic)

One of the tools we are mostly using subconsciously is sensing. When judging a component, we often take it into our hands, touch it, feel the surface, its density, humidity, weight, etc. This can mostly be observed in food shops. We take the product into our hands. We look at it and touch the packaging to get a feeling. This is essential for the final purchase decision (Fig. 13). Usually the sensing sense is more related to the right sector of the brain and thus refers more to the subconscious influence. Information is processed within milliseconds and generates a response of pleasant / unpleasant [11].

Fig. 13: Touching, feeling the product with our sensing sensor (rezepte-und-tips.de)

Touching something too hot or hurting is a direct threat to our body. And this threat is very near. Therefore, our body produces a subconscious direct reaction for protection purposes. Visual and auditory senses are more distance-related and therefore can afford to bypass the conscious mind, which takes longer for data processing, but allows more fine-tuned response.

Tasting (gustatory)

Babies and kids test their environment by trying how it tastes: can it be “eaten” (Fig. 14)? Food as the essential product to be tasted also has undergone a development. In former time food was seen as an energy provider with only little variation from day to day. Today taste is designed into products. Flavor enhancers are used to generate a certain taste. The best examples are burger chains where the food offered tastes the same all over the world (convenient food). The gustatory sense is more related to the right sector of the brain, comparable to the sensing sense, and thus refers as well more to subconscious influence. This is due to the fact that bad food can be life-threatening and is identified by its taste. The reaction to bad food must be immediate and therefore is subconscious.

Fig. 14: Kids test their components by tasting (mytoys.de)

Smelling (olfactory)

Smell has the most direct impact on the brain [11]. In contrast to the other senses the brain allocates a feeling to smelling right away. This feeling without the detour via emotions is based on the history of experience of a person. So it is possible that a smell that somebody likes a lot and considers pleasant (like) can be ugly for another person and generate a dislike (unpleasant) feeling (Fig. 15).

Fig. 15: Allocation of smell to a product – emotionally (weingeruch.de)

Smelling works in a similar way as tasting. It has a direct impact and therefore is subconscious as well.

3.3. TRIZ Trend Structure

Starting from the Gen3Partner structure of the Trends (Fig. 16), the suggested “Trends of Increased Addressing of Human Senses” fits best into the part of “Trend of Increasing Coordination”. Alexander Lyubomirskiy in his research has shown that the “Coordination of Images” form a fifth column besides the “Coordination of Shapes”, “Coordination of Rhythm”, “Coordination of Materials”, and “Coordination of Actions”. The suggested trends are adjacent to the visual trends.

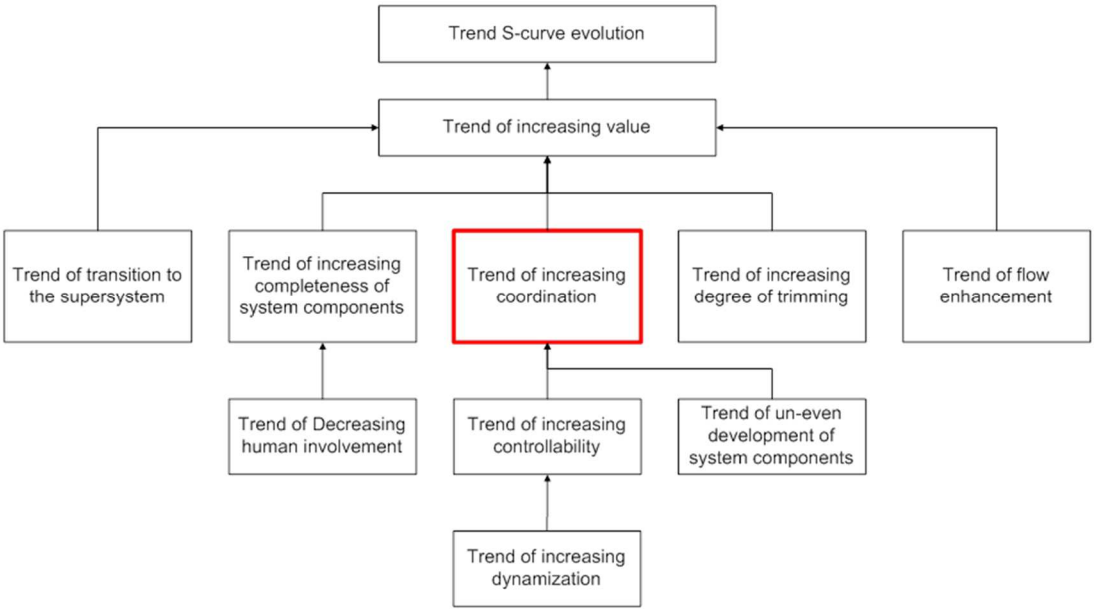


Fig. 16: Trends structure according to Gen3Partners

Looking at the structure of trends in Fig. 16. One can find the “Trend of decreasing human involvement”. This is a contradiction to the suggestion of this thesis stating an “Increased addressing of human senses”. This physical contradiction can be solved by the separation principle:

A decrease in human involvement is needed when it comes to operation of the engineering system. As soon as a human being is supposed to work on a system in terms of controlling it, providing energy, transmission or just using the operating agent, the human involvement shall be reduced. When it comes to an information transfer from the engineering system to the human being, the interaction (addressing of human senses) shall be increased, in order to raise efficiency. The later point is what this thesis is about.

The information level of an engineering system to a human being is very much dependent purpose and the life stage of the product. For example, the hard drive (HDD) of a notebook: it will have interaction while it is assembled and mounted into the notebook. The notebook user himself will never have an interaction with the HDD (unless he is knowledgeable in replacing it when there is a crash). When the notebook has reached end of life, the dismantler has again an interaction with the HDD. The information that the HDD shall provide are depending on the life stage and the corresponding requirements. E.g. at of life it could be information of shocks, damages, operational hours, etc. to judge if it can still be used or be recycled or be dismantled.

4. Review of the known approaches to the analyzed problem

In this chapter the evolution directions for each sense are discussed. For an adult, the senses can be put into an order of importance: 1. Seeing, 2. Hearing, 3. Tasting, 4. Smelling and 5. Sensing. They can also be expressed by the acronym VAKOG (Visual, Auditory, Kinesthetic, Olfactory and Gustatory) as described in [14].

Alexander Lyubomirskiy from Gen3Partners conducted deep research on the “Trend for Coordination of Images” which reflects a set of measures and principles to increase or decrease visibility in general. This is in very close relation to the major sense of the human being: “seeing (visual)”. One can leverage this methodology to hearing (auditory), sensing (kinesthetic), tasting (gustatory) and smelling (olfactory), which will be done in the next steps. In the end a combination of the coordination of the senses will summarize the trend to satisfy human senses. In this chapter, we will focus on the functions of four senses as the visual one has already been addressed in another publication.

4.1. Hearing / acoustic / auditory

Hearing or, more generalized, sound detection is a sense that is allocated to the ears. It can be rated by two parameters (Fig. 17):

- Loudness (amplitude)
- Harmony (coordination of frequencies)

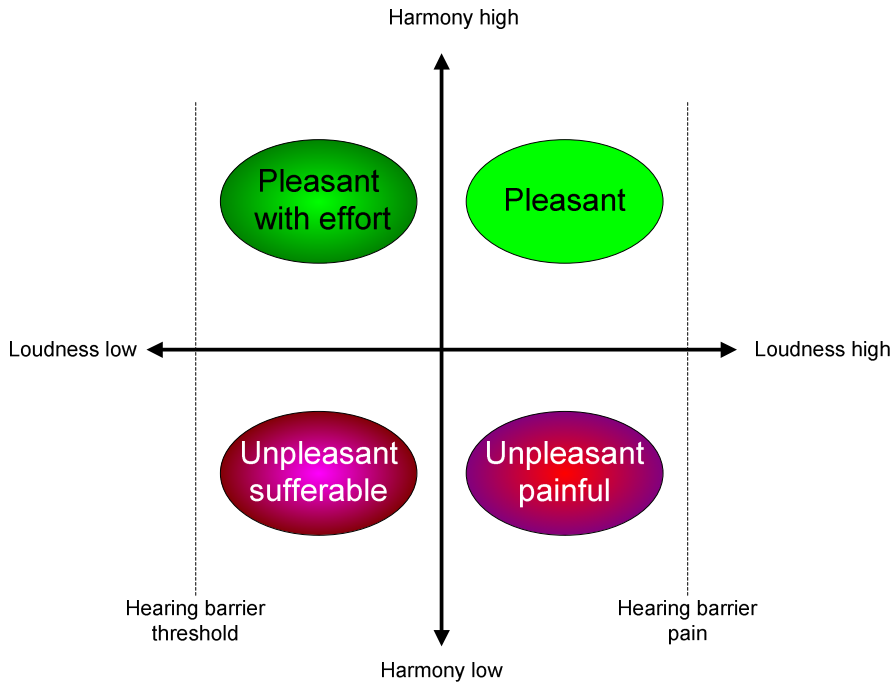


Fig. 17: Two basic parameters for hearing

Loudness (Wikipedia), physically defined as sound pressure level (SPL) or acoustic pressure level, is a logarithmic measure of the effective sound pressure of a sound relative to a reference value. Sound pressure level, denoted L_p and measured in dB, above a standard reference level, is given by:

$$L_p = 10 \log_{10} \left(\frac{{p_{\mathrm{rms}}}^2}{{p_0}^2} \right) = 20 \log_{10} \left(\frac{p_{\mathrm{rms}}}{p_0} \right) \ \mathrm{dB(SPL)}$$

Where:

- p_{rms} is the root mean square sound pressure, measured in Pa;
- p_0 is the reference sound pressure, measured in Pa.

Sound in its basic form is a sine wave. With a single wave at a defined frequency the loudness can be experienced. It starts at the hearing threshold and stops at the pain barrier where the loudness starts to hurt (Fig. 18).

Sound sources (noise) Examples with distance	Sound pressure Level L_p dB SPL
Jet aircraft, 50 m away	140
Threshold of pain	130
Threshold of discomfort	120
Chainsaw, 1 m distance	110
Disco, 1 m from speaker	100
Diesel truck, 10 m away	90
Kerbside of busy road, 5 m	80
Vacuum cleaner, distance 1 m	70
Conversational speech, 1 m	60
Average home	50
Quiet library	40
Quiet bedroom at night	30
Background in TV studio	20
Rustling leaves in the distance	10
Hearing threshold	0

Fig. 18: Loudness levels (sengpielaudio.com)

Starting from the basics of sound (loudness and harmony), they can develop into different directions according to Fig. 19. In this thesis, only changes of a direction are considered. Another possibility is imitation of a situation which means that the existing situation is reproduced with other resources. An example for the acoustic sense is an

electronic dog. Such a technical system uses imitation e.g. for burglar protection. Electronic devices imitate the sound of dogs to prevent intrusion into homes.

Electronic dog	

Another example are electric cars as they are nearly noiseless. This is an advantage, but many have been equipped with warning sounds to inform pedestrians who were accustomed to strongly rely also on sounds to detect the presence of a vehicle (https://en.wikipedia.org/wiki/Electric_vehicle_warning_sounds).

Referring to the goal of change for acoustics, the major separation, can be done into pleasant and unpleasant sounds. However, as already mentioned in chapter 2.2 one has to distinguish between the physical parameters that are changed and the translation into pleasant / unpleasant feeling. The effect of parameter changes can be two-folded. Depending on the individual status the signal can be visible (existing) or not and is has a quality (pleasant / unpleasant). For a kid a tone of 18 kHz can exist and be heard whereas his grandparents will not notice it (signal visibility). The type of signal (one tone, pulsed tone, siren, composition of frequencies, etc. again may generate different feeling. For young people, classic music generally will be less pleasant as for elder persons and vice versa rock music will be more pleasant to younger people as to elder persons. From a pure mathematical standpoint both music types follow some rules of harmony and thus coordination of frequencies.

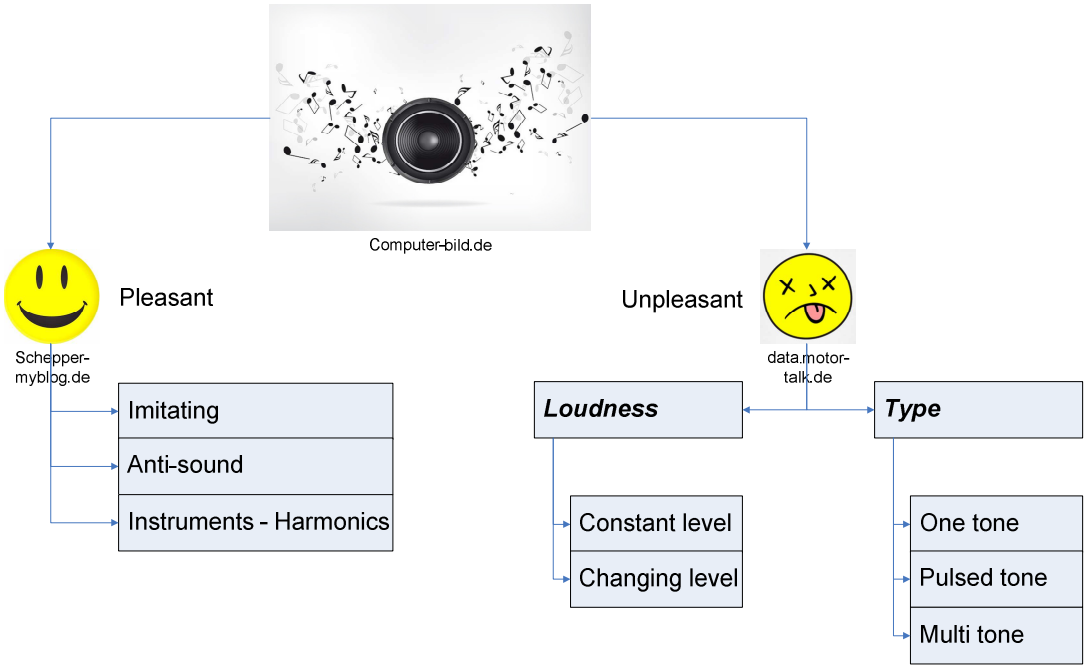


Fig. 19: Structuring of Sounds

In real life, a sound is always composed of a superposition of sine wave. Here human beings have an affinity to a composition of the sound. It must follow mathematical rules to express harmony and to generate a “good feeling”. In music, harmony is the use of simultaneous pitches (tones, notes), or chords. The study of harmony involves chords and their construction and chord progressions and the principles of connection that govern them. Harmony is often said to refer to the "vertical" aspect of music, as distinguished from melodic line, or the "horizontal" aspect. Harmony usually generates a “comfortable feeling” and disharmony an “uncomfortable feeling”. A harmonic sound with the right loudness is pleasant. If it is too silent it is pleasant but with effort as one must concentrate to get it. A disharmonic sound at low loudness is unpleasant but bearable. If it is too loud it becomes a painful experience.

Pleasant sounds

In the category of pleasant sound, we find imitating sound, anti-sound and instruments.

Imitating sounds

Imitating sound is often found in nature where e.g. one type of animal copies the sound of another species in order to warn enemies although they do not possess the features of the original species. Examples of imitation are:

The starling: He imitates the oriole. Orioles are birds that stay mainly on their own. A starling therefore imitates its sound to chase away the rival when it comes to secure bird’s nest area.	Starling
The black earth colubrid. She imitates the sound of a rattlesnake to protect herself.	Schwarzerdnatter
A ventriloquist imitates the voice of another person.	Armanda
The real sound of an airplane is imitated in a remote-control model	Mustang
Playback in music shows is another way of imitation	Playback

Anti-sound

Anti-sound or sound cancellation is used in technology to dampen the loudness of a sound. The principle is to generate the same sound artificially but with a phase shift of 180°. By this the waves extinguish each other. The same principle can be found with

Bolus at ships. There it is not to extinguish sound but water waves to reduce energy consumption for ships (reduction of deformation of the water surface).

Principle	Anti-sound

Instruments

A special effect of sound can be achieved by not only playing the base frequency of a tone, but by adding harmonics to it. This is what happens when playing a tone on an instrument (not necessarily an electronic piano that can play only the base wave as well). By this e.g. the tone takes on different colors. With different instruments playing together the super-positioning principle applies: As for an instrument the base tone is superposed with harmonics, the instruments themselves behave like harmonics.

One tone with different instruments	

Harmonics are a means to also express certain moods (like joy, melancholy, etc.) that can be used to bring people into a certain emotional condition in order to achieve desired reactions.

“The witty trout”, a song in 5 different variations	

Unpleasant sounds

In the category of unpleasant sounds two parameters can be changed: loudness and type of signal. Generally, loudness and type of signal are combined to achieve the attention of a person. In communication when a partner does not react, the typical reaction is to raise loudness. By this attention shall be generated. If this does not work the sound is alternated in its frequency as well. One can see this especially with kids when they cannot obtain attention from their parents.

Another field of application of unpleasant sounds is warning: fire, air-raid warning, police and emergency vehicles. In these cases, the unpleasant (harmful) sounds are turned into something useful: gaining attention.

Loudness

Loudness can be set at a constant, static level or at changing levels. Human beings usually tend to adapt to constant levels as the senses are mainly reacting on variation

(HNO Basiswissen). To generate more attention, the loudness can be raised and/or lowered in steps or continuously. Good examples of this are emergency horns.

Single-tone horn	
Sinusoidal changing air raid warming	Siren 103 dB
Tornado Chicago warning	

Type

Besides the loudness the type of signal can be changed. As differentiation one tone, several tones and pulsed tones can be used to generate an unpleasant feeling and thus create awareness. The best examples of this are fire warning devices that use trapezoidal tone changes and the sirens of police cars. Depending on the country they have two tones (e.g. Germany), pulsed tones (e.g. United Kingdom) or a combination of loudness change, multi tones and pulsed tones (e.g. United States).

Fire warning with trapezoidal change	
LAPD + NYPD + Boston PD + Paris Police + Madrid Police + Amsterdam Police + London Police cars on mission	

4.2. Sensing / kinesthetic

Looking at sensing, this is the first sense for near distance application. This sense is located in the skin and gives an impression of the properties of a material. The following exploratory procedures of the sense use were identified:

1. lateral motion on a surface
2. pressure on a surface
3. contour following of a surface
4. enclosure of an object

The ascertainable object properties are, among others: size, weight, contour, surface (hard / soft / slick), and temperature. The sensing is more focused on getting neutral information on an object and its properties. Size, weight, contour, surface and temperature represent physical parameters than can be changed. Again, they are translated through individual experience into a pleasant / unpleasant feeling and a “visibility” (very fine structures on a surface may be not recognized, depending on the abilities of the hand, for example).

Besides this property analysis two more attributes are allocated to sensing: the feel of pain and temperature. Both are protective senses, which serve to avoid damage to the person. The feel of pain is unidirectional. There is no correspondence in feeling for “joy” on the skin. The feel of pain can be separated into two main directions: pressure and temperature, which are physical parameters. The translation into pleasant / unpleasant and “visibility” is individual. A cook how is used to hot water may stick his fingers into 90°C hot water without recognizing it whereas for a normal person he would get himself burned.

The higher the pressure on the skin, the more pain, as a warning signal, will be felt. This is also a feedback for the allowed force to enclose an object (point no. 4 in the exploratory procedures).

The temperature part of this sense can be divided into trends of improving or decreasing the good feeling. The main parameters temperature and humidity are coupled. If temperature and humidity (physical parameters) are in a pleasant range it is perceived as positive (Fig. 20).

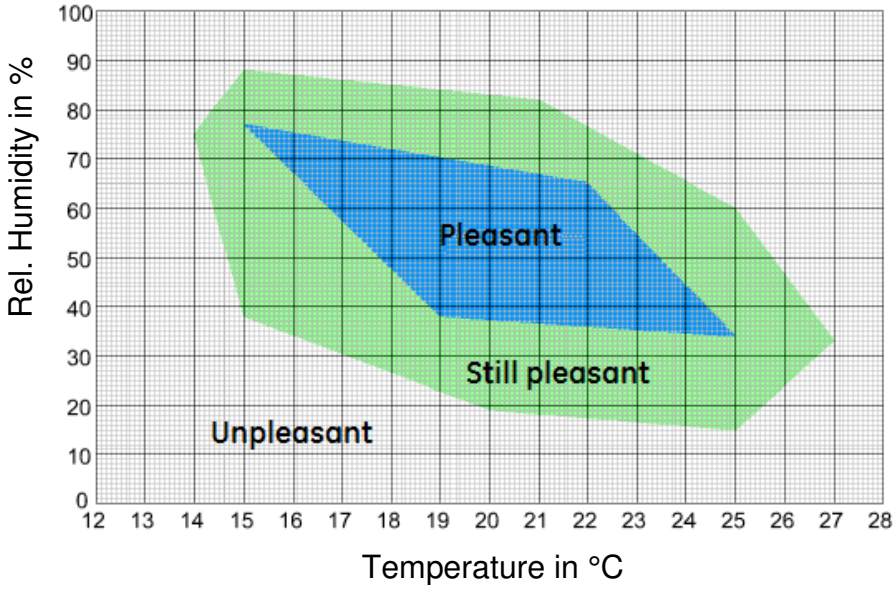


Fig. 20: Temperature - Humidity - Diagram

Within the TRIZ methodology the standard solutions Class 1 deals with this problem: “If the external environment does not contain ready substances required synthesizing a Substance-Field System, these substances can be obtained by replacing the external environment with another one, or by decomposing the environment, or by introducing additives into the environment.”

Examples here can be found in the automotive industry, e.g. heated car seats or heated steering wheels (Fig. 21). Another application is the introduction of air conditioning for

living / working areas (Fig. 22). A local application is for example tempered shampoo at the hair dresser's.

		
Heated steering wheel (motor talk.de)	Heated car seat (markenjury.com)	Heated car seat (auto-motor-und-sport.de)

Fig. 21: Heated car steering wheel and car seat

Fig. 22: Air conditioning systems for optimizing the sensing (onlineheld.de)

4.3. Tasting / gustatory

Tasting is done with the tongue. It has 5 general qualities:

- Sweet – triggered by sugar, amino acids, peptides or alcohol
- Salty – triggered by salt or some other minerals
- Sour – triggered by acidic solutions and organic acids
- Bitter – triggered by various elements
- Umami – triggered by amino acids, glutamic and aspartic acid

The 5 qualities are at the same time the physical parameters. The translation into the feeling is individual again. As well here is the "visibility" of the sense a topic. For people

how are used to very spicy food, non-spiced food might even not exist. They a chewing on something, but don't taste anything. The other way round people not used to spicy feed might feel "burning", not tasting anything anymore when the food has too much spice.

Tasting in its origin serves to judge food quality according to the criteria "eatable" and "uneatable". Generally, sweet stands for "eatable" and salty, sour and bitter for "eat with caution". Umami gives an impression of the nutritiousness of the food.

Tasting is essential in the food industry, not so much for technical goods (unless you are a baby who typically will try to eat everything). Two general trends can be observed for tasting (Fig. 23).

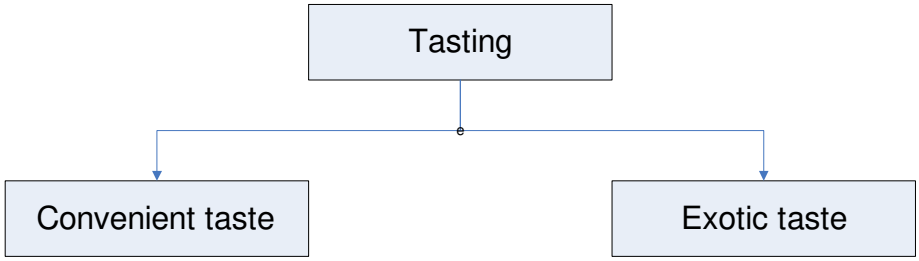


Fig. 23: Classification of tasting

Convenient taste

Convenient taste aims at making the same food taste the same way all over the world, independent of the local ingredients. For this purpose, a huge set of spices has been developed (flavor enhancer). The correct combination results in a reproducible taste. Worldwide acting food chains use this instrument to generate convenient food that tastes the same everywhere in the world (Fig. 24).

Fig. 24: Trend to convenient food worldwide (logos of companies)

Exotic taste

On the other side of the scale exotic taste is located. Here the aim is to create unusual tastes by combining the 5 qualities in various ways. An example for this direction is “molecular cuisine”. Here the food is composed according to physical – chemical principles. Melon caviar is an example (Fig. 25) where two tastes are mixed in an unconventional way.

Fig. 25: Melon caviar (“Elbulli melonenkaviar” by Palauenc05)

4.4. Smelling / olfactory

Smelling is the sense that directly goes into the brain. Similar to tasting, smelling serves to help judge whether something is positive or negative. As this sense has a direct emotional impact, a whole industry focusses on giving products and especially persons the right smell with fragrance or perfume. Chemical and biological ingredients (as technical parameters) are mixed to generate a like (pleasant) or a dislike (unpleasant) feeling (Fig. 26).

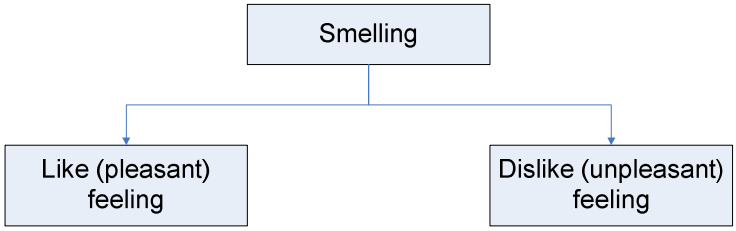


Fig. 26: Classification of smelling

Perfumes, in a narrower sense, are fragrant substances, which are meant to change the body odor or mask an odor. They serve the pleasant feeling and self-expression of persons.

Room odors are providing the interior with a special smell that can be distributed by sprays or continuous air fresheners placed in the room.

Odorant substances which are used in perfumes are also used to make numerous products attractive to consumers. Products that have a bad self-odor like cleaning

agents of hair tinting lotion are made pleasant using an odorant. Odorants are therefore also called functional perfumes.

In food industry, these functional perfumes are called flavors for generating taste. For example, vanilla is used both in desserts / sweets and in perfumes.

Like (pleasant) feeling

Technical systems are increasingly using odor ingredients to influence users. Examples (Fig. 27) are perfumed candles, air improvers in cars or rooms or additives to paint (odorant colors).

Fig. 27: Designing odor in a positive way
(m-m-o-online.de; raeucherfee.de; casa-rosa-online.de)

Dislike (unpleasant) feeling

The composition of bad smells is especially important for warnings and awareness creation. Examples are the sulfuric additives to odor gas to detect leakages (Fig. 28). Odoring of oxygen for welding in closed rooms to generate awareness of an increase in the O_2 concentration, which causes inflammability, or odoring of formaldehyde, 1.2-Dichloroethane or benzoyl with trichloronitromethane to raise awareness of the release of these carcinogenic gases.

This principle is also used in Standard Solutions class 4: Introduce a mark internally or externally (1.1.4; 1.1.5; 5.1.1.9).

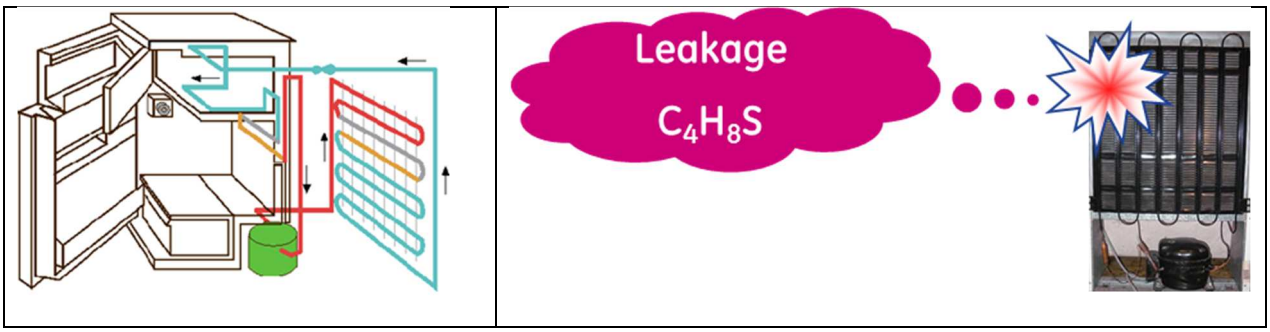


Fig. 28: Adding trichloronitromethane for leakage detection (bosch.de)

5. Methods of solving the stated problem

The previous chapter has analyzed the suggested trend of addressing of human senses and it was illustrated how it can develop according to the general trend of coordination. In this chapter the application of the identified trend in practical use shall be discussed. The question how to increase the impact will be discussed.

Tab. 2: Summary of physical parameters, impact, dynamization and effect for the senses

Sense	Physical parameter	Impact	Dynamization	Effect (depending on human)
Acoustic				
	Amplitude	-> visibility		
	Coordination of frequencies	-> pleasance		
			constant amplitude	->pleasence/unpleasance
			changing amplitude	->pleasence/unpleasance
			one frequency	->pleasence/unpleasance
			pulses frquency	->pleasence/unpleasance
			multi frequncies	->pleasence/unpleasance
			coordination of frequencies (harmonic sound or disturbing sound)	->pleasence/unpleasance
Kinesthetic				
	Size	-> visibility		-> information
	Weight	-> visibility		-> information
	Surface	-> visibility		-> information
	Temperature	-> visibility		-> information
	Pressure	-> visibility		-> information
			constant temperature	-> pain
			changing temperature	-> pain
			constant pressure	-> pain
			changing pressure	-> pain
			pulsed pressure	-> pain
Tasting				
	Sweet	-> visibility		->pleasence/unpleasance
	Salty	-> visibility		->pleasence/unpleasance
	Sour	-> visibility		->pleasence/unpleasance
	Bitter	-> visibility		->pleasence/unpleasance
	Umami	-> visibility		->pleasence/unpleasance
			combination of parameters	-> convinient food
				-> exotic food
Olfactory				
	Concentration of odor	-> visibility		->pleasence/unpleasance
	Type selection (flavors)	->pleasence/ unpleasance		->pleasence/unpleasance
			combination of odor & concentrations	->pleasence/unpleasance

Table 2 summarizes the senses analysis that has been done up to this point. The physical parameters of the senses have been identified. Their relation to visibility of the sense and their impact on pleasance / unpleasance has been shown.

It is still to be noticed, that there is no absolute threshold for visibility to a sense. E.g. the concentration needed to generate awareness for an odor is changes for different people. One person can already smell something whereas somebody else still does not realize the odor. This must be taken into consideration when defining the level of application for the parameters triggering the senses. Besides the visibility of the senses they can be influenced in four directions, according to Tab. 3.

Tab. 3: Application categories for the trend for human senses

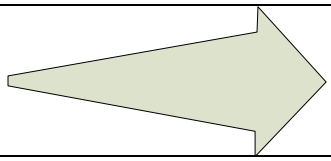
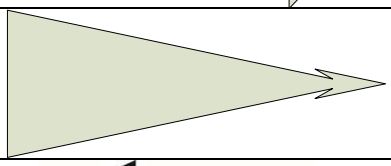
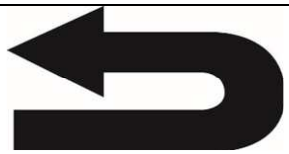
Increase of the sense impact:	
Decrease of the sense impact:	
Change of direction of the sense impact:	
Combine senses:	

Table 3 gives a direction of impact. This can be combined as well with usefulness or harmfulness. If it is useful or harmful depends on the purpose on wants to achieve. One can even make a symphony played by an orchestra a harmful (unpleasant) event if it is played much too loud. Therefore, the type of impact is not allocated to the impact.

In the following chapter the applications will be described in more detail.

5.1. Increase of the sense impact

In this case the impact that is given by a sense is reinforced in the same direction. From a TRIZ viewpoint it is the application of the mono-bi-poly trend with or without shifted parameter. For the example “sound”, this means that it gets louder and maybe multitoneal. For sensing, this would mean increased pressure, temperature or humidity. For tasting, the qualities (sweet, salty, sour, bitter and umami) would be raised in concentration. For smelling, the odor would be concentrated as well.

5.2. Decrease of the sense impact

In this case the impact that is given by a sense is reduced. This can be achieved in two ways. Either the signal is reduced itself or it is overlaid (hidden) by another signal. Examples of sound can be found e.g. in clocks. Mechanical clocks tend to tick, which can be confusing at nighttime. Therefore, they imitate the sound of leaves in the wind or a waterfall or seawater rushing onto a shore to hide the ticking. Or at the dentist: the sound of the drill is of a high frequency and enervating. By playing classical music, it can be dampened. For tasting, additives of another quality can hide the original one, e.g. when sugar or milk is put into coffee or tea. Adding taste to chewing gum or sugar to vaccines are other examples. For smelling, the same principle is applied: adding an odor to mask another one (see Fig. 27).

5.3. Change of direction of the sense impact

The change of direction of the sense impact is very much related to the previous point “decrease of sense impact”. If decreasing is exaggerated, then the direction from pleasant to unpleasant and vice versa can change. This application often can be seen with tasting and smelling.

Chocolate per se is bitter (try to taste 99% cocoa content chocolate). By adding sugar, the bitter (unpleasant) taste is turned into a sweet (pleasant taste). The same is true for coffee, tea or other food. This can be seen as well as camouflage: the sweetness masks the bitterness.

For smelling, unpleasant odors are superposed by pleasant odors. A whole industry depends on this principle: fragrance manufacturers. In the 17th century this trend culminated as people washed very little and needed to hide unpleasant odors behind well-smelling perfumes.

Changing the direction of the sense impact is always related to the threshold of a sense detection in comparison to the other senses. The dominant sense with overrule the other ones. We see this also in visuals: leaves are green in summer. In autumn, when the plants retrieve the chlorophyll, the leaves suddenly get colored in red and yellow or brown. These colors where there before but camouflages by the green chlorophyll.

Another way is to combine opposite functions of one sense. You can combine a hot coffee with cold ice cream to develop a different taste. This is not directly turning one sense into the opposite direction, but the parameters compensate each other.

5.4. Combine senses

The application categories 5.1 – 5.3 are standard procedures and well known. Besides the manipulation of one sense in the mentioned direction, a combination of senses is feasible as well. As shown in this chapter, the combination (assumption 2) and their dynamic development shows the greatest impact on the MPV. It offers more sophisticated opportunities. Therefore, in this paper, the combinations are treated in an own chapter (No. 6) and considered to be the result of the research.

5.5. Standard step for one sense application

Taking into account the results in chapter 5, it is possible to define a standard procedure of application for a one sense development.

1. The visibility has to be defined (shall a trigger be visible to a sense? To whom shall it be visible and to whom maybe not? What level of physical parameter do I need to generate for reaching the desired awareness?)?
2. The direction of the sense has to be defined (shall it be pleasant or unpleasant or change the direction? What level of physical parameter do I need to generate for reaching the desired awareness?)?
3. Do I need to combine with other senses (see Chapter 6 and consider steps 1 and 2 for the other senses as well)?
4. Formulate the way of implementation. If there occur contradiction / problem, use TRIZ tools to solve this.

An application could look like this:

We have an exhibit where we want to enhance the positive perception. The goal is to improve the pleasant aspect. The exhibit is a pure visual part.

First question is if my exhibit is visible. Do visitors see it, are they impacted? If no I can increase visibility but putting the exhibit at a better place (increase visibility) and even intensify the impact (by using colors, etc.).

So I can add other senses like e.g. acoustics (music, advertisement speech, presentation). I add a pleasant sound with the right loudness and in harmony. I can add good smell that reflects the exhibit aura. I put the exhibit in an environment with the right temperature and right humidity. By the combination, the pleasant consciousness can be raised.

Of course, the translation of the physical parameters (right loudness, good smell, etc.) must be reflected with what is anticipated by the visitors as pleasant. This will depend very much on the type of visitors (age, business or not, social status, etc.).

6. Results of performed research

The trend suggested is the “Trend of Increased Addressing of Human Senses”. It states that engineering systems that are designed to have an interface with a human being evolve to address more and more senses over time, starting form one sense, dynamizing it and / or subsequently adding others. Fig. 29 shows the relation between the addressing of senses. The major ones are visual and auditory, e.g. the more conscious senses. They are also related to a far distance approach. The source / object of consideration can be at a distance that is greater than the human range. The three more subconscious senses are kinesthetic, olfactory and gustatory. They are also the near distance senses, where olfactory can act over a longer distance as well.

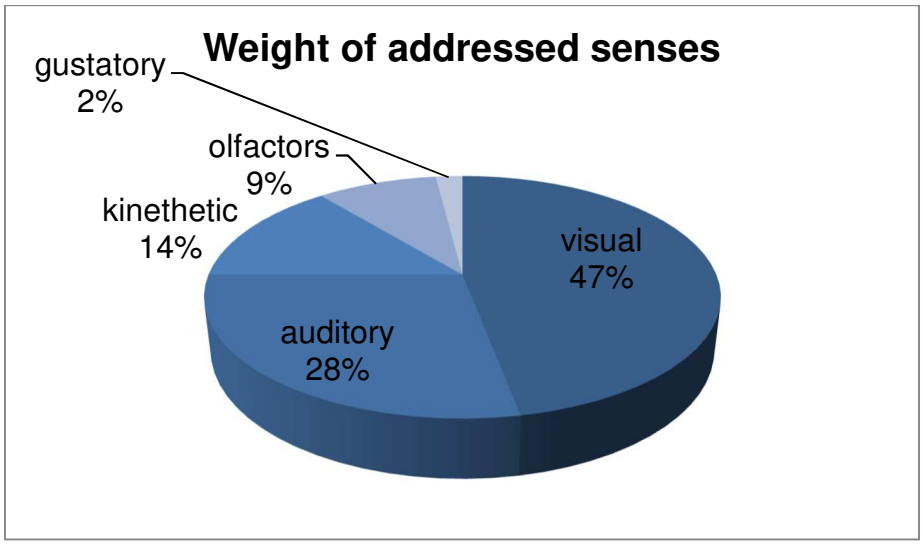


Fig. 29: Senses and their relation [17]

In the last chapters, the different senses and their parameters were discussed. In this chapter the gained knowledge is put together into an algorithm in order to apply the increased addressing of human senses as a part of the trend of coordination.

The algorithm is divided into 2 parts:

- Addressing of a sense itself (according to chapter 5.1 – 5.4)
- Combination of different senses

This means there is a multi-dimensional operational area: it is not only to work on one sense and apply the rules of coordination, but as well to combine multiple senses at a time. And there is no need that the different senses evolve in the same direction. It could be that one sense is improving pleasance while another will evolve towards unpleasance. An example for this are virtual reality (VR) games. Before usage the real room in with you can move is programmed. In the VR room sound is added that is getting louder and more aggressive when you move too near to the boarders of the real

room. The visual part is designed to get more attractive, the acoustic part goes into the opposite direction (Fig. 30).

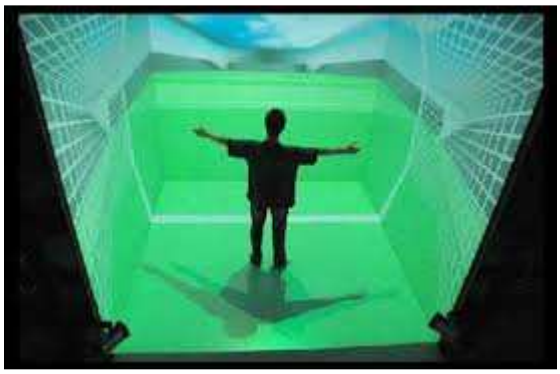


Fig. 30: Virtual Reality room with borders (in the real world) (HPI.com)

The two parts of the algorithm are connected in the way displayed in Fig. 31.

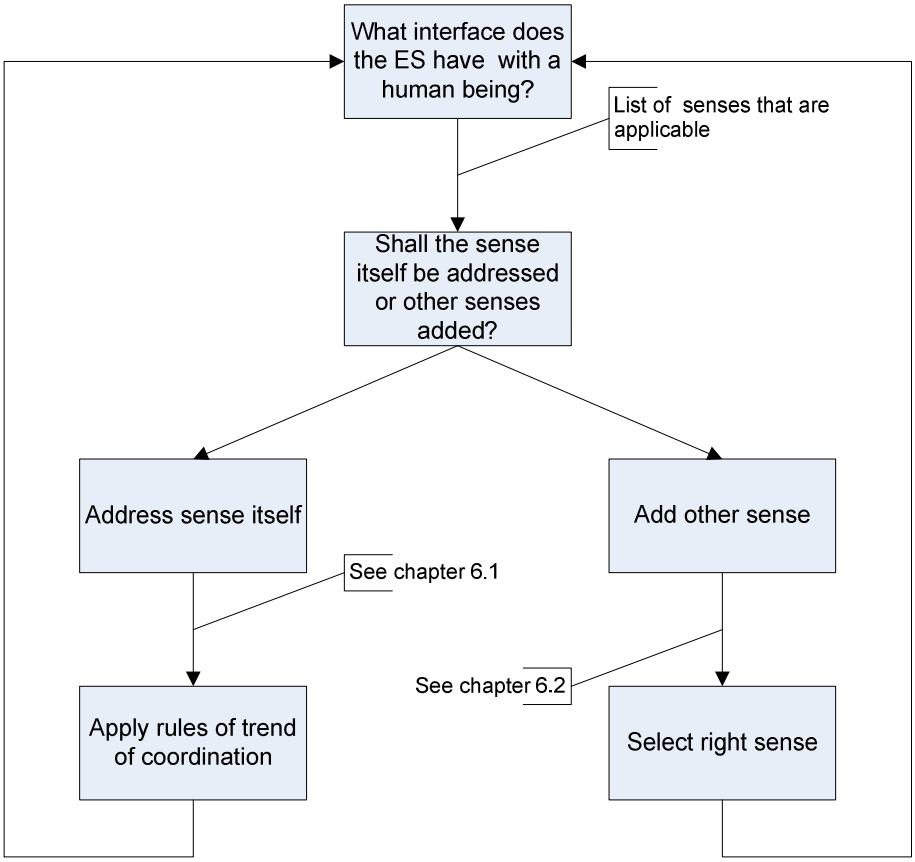


Fig. 31: High level algorithm for the suggested trend of increased addressing of human sense

1. The first step is to identify the human senses that the ES addresses
2. The second step is to decide whether the sense shall be intensified (in direction pleasant or unpleasant) or if another sense shall be added
3. The third step is

- in case of addressing the sense itself: apply the rules of the trend of coordination (see as well 6.1)
- in case of addressing another sense: select the right sense to add (see as well 6.2)

4. The last step is to repeat the procedure if necessary or needed or whished

In the next sections step 3 is detailed.

6.1. Working on one sense

In case one sense shall be intensified, the trend of coordination can be applied. It can be spread into four major areas:

- coordination of shape
- coordination of rhythm
- coordination of materials
- coordination of actions

For each sense the parameter(s) identified in table 2 are taken and then the direction of intensivation is defined: towards more pleasant or unpleasant or change from pleasant to unpleasant and vice versa. This is context sensitive. For temperature for example a value of 90°C is great for someone who wants to go to a sauna. For a working area, this temperature would be much too high. Tab. 4 shows some examples.

Tab. 4: Application categories for the trend for human senses

Sense	**Physical Parameter**	**Impact**	**Direction**	**Technical example**
Acoustic	Amplitude	Loudness (visibility)	Improve pleasance (from too silent to louder)	In a car, the entertainment system adjusts loudness to the environmental situation (improve pleasance)
Acoustic	Coordination of frequencies	Harmony (preference of type)	Change of direction	At a political demonstration, the speaker is overruled by protesting parties with whistles. This can be seen as camouflage (move to unpleasant)
Acoustic	Coordination of frequencies	Harmony	Change of direction	Adjust high frequencies to lower own to make hearing better for older people
Acoustic	Coordination of frequencies	Harmony	Improve pleasance	Add to an instrument more, different instrument (from melody to orchestration)

Increased addressing of human senses as a trend

Sense	Physical Parameter	Impact	Direction	Technical example
Olfactory	Concentration	Primary scents Modifiers Blenders Fixatives (visibility on concentration level)	Higher density	Put perfume on the body to improve the good smell (improve pleasance). Add odor to a gas to detect leakages (improve unpleasance). Take chewing gum to camouflage bad mouth odor
Olfactory	Chemical mixture	Coordination of flavors (visibility on concentration level)	Improve pleasance	The 12 basic flavors of a perfume (heart, head, soil)
Taste	The five (six) taste senses	The five (six) taste senses (visibility on concentration level)	This is a two-dimensional challenge: one of the taste sense can be intensified or they can be combined (as well in opposite direction)	Chinese food is famous to combine sweet and sour. Combine strawberries & pepper. Radicchio salad is combined with Balsamic vinegar. Eyran drink with spicy Dürum. Pork roast with crackling (crispy) combined with dumping (smooth)
Taste	The five (six) taste senses	The five (six) taste senses (visibility on concentration level)	Intensification of a sense (or more taste senses)	Spice(s) for one or more taste sense(s)
Taste	Temperature	Pain	Optimize to best pleasance or opposed function	Hot coffee with an ice cream
Taste	Hardness	Pain	Optimize to best pleasance or opposed function	Bavarian cream: a sweet dish where the top is burned with a gas flame to make it crusty (versus the creamy bottom)
Kinesthetic	Surface roughness	Pain	Improve pleasance	Clothes from linen -> cotton -> wool
Kinesthetic	Surface roughness	Pain	Improve pain feeling	Razor wire or glass pieces on the top of a wall to prevent surpassing
Kinesthetic	Surface / vibrations	(visibility on amplitude level)	Improve pleasance	Transfer music by vibrations on the skin
Kinesthetic	Discharge	Pain	Improver pain feeling	Electric fences to prevent trespassing
Kinesthetic	Pain, Temperature	Additive to VR	Transfer to VR	Device for making a person feel correlated to the virtual reality (VR)

6.2. Working on with multiple senses

Fig. 32 displays the clustering of the human senses into the more conscious and subconscious ones. A system addressing one sense will strive to add a sense from the other cluster in order to address both the conscious and subconscious areas, e.g. both sides of the brain. This leads to higher general awareness and influence. The next step is to add another sense to deepen the effect and so on. Fig. 33 shows a flow chart on how this can be written in the form of a generic algorithm.

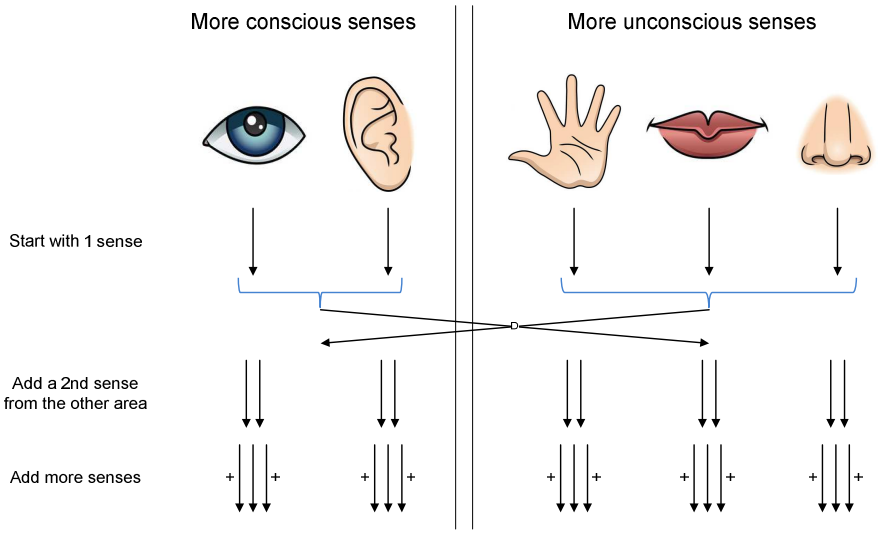


Fig. 32: Increased addressing of human senses

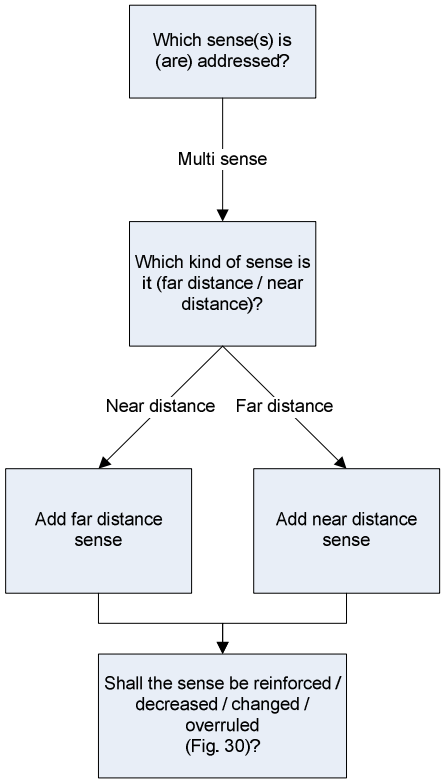


Fig. 33: Algorithm of increasing addressing of the number of human senses

1. The first step is to identify the human sense(s) that is (are) addressed. If a sense shall be expanded with supplementary senses, then the question is: Does the sense belong to the far distance senses or to the near distance senses?
2. Step 2 is to complemented with a sense from the other bin, e.g. the one it does not belong to itself. This procedure can then be applied over again.

The drivers for this trend consist of two steps (Fig. 34):

- Move from addressing only one side of the brain to both sides of the brain (conscious and subconscious)
- Move from activation of part of the brain (senses) to address all brain (sense)

This procedure can also be used to identify gaps in the development and thus detect opportunities for further development. By analyzing the history of a product one can identify which senses have been addressed and how they evolved over time. Then the question can be raised which senses are missing and how they could be addressed. This is then the predictive aspect which gives development directions.

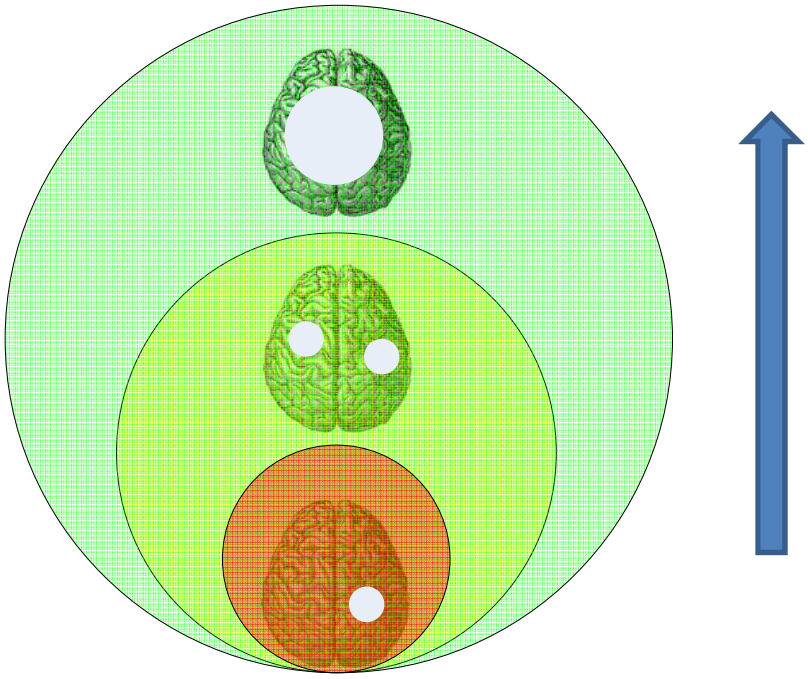


Fig. 34: The trend follows to address more and more parts of the brain

The aim of the suggested trend is to make the engineering system address both the conscious and subconscious mind. This is also comparable to the Trend of Deeper Integration: starting from the existing addressed part (conscious or subconscious), the missing part is added and then expanded to integrate all senses. If nothing exists, I would start with a conscious sense for the technical engineering system.

The objective is to bring together the tangible and intangible impacts of our senses.

7. Practice of application

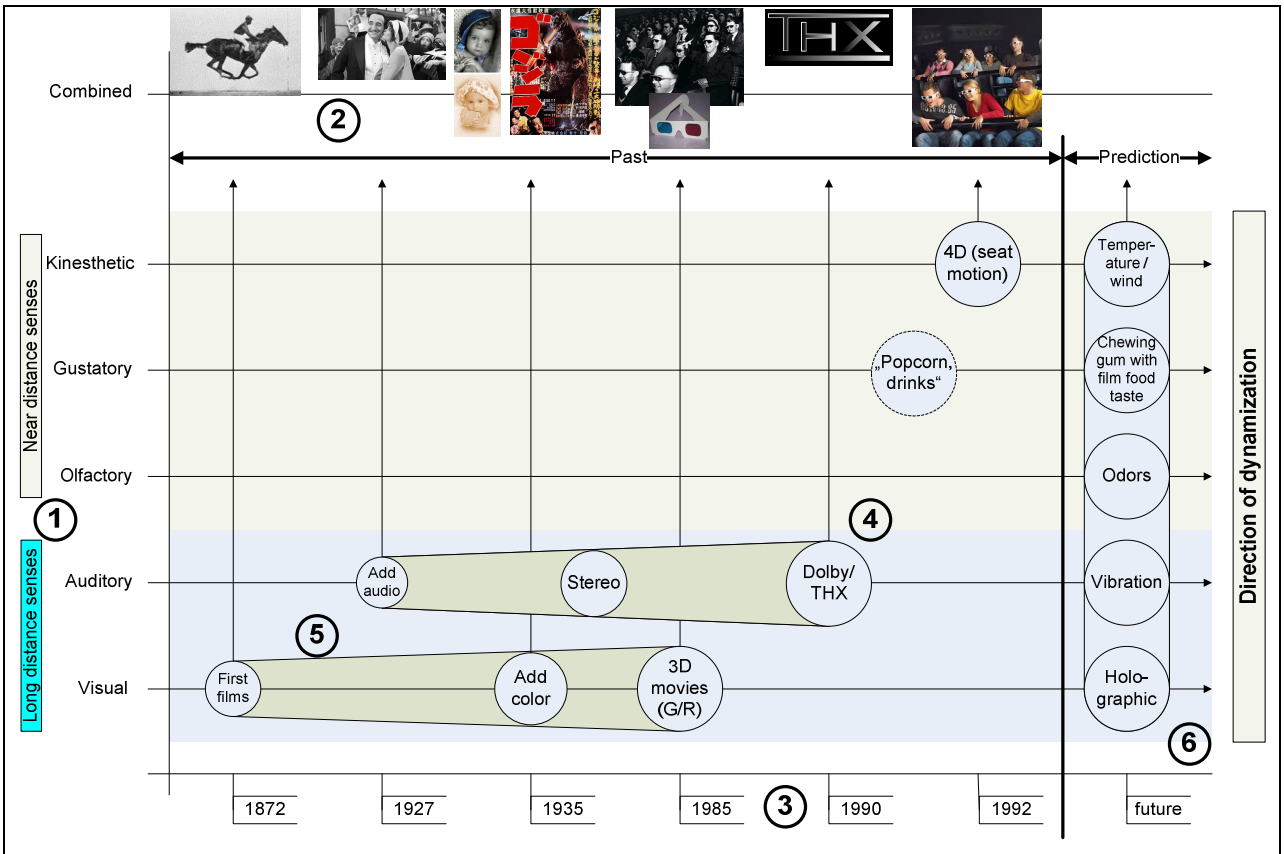
In this chapter two approaches of the trend are discussed: The strategic approach where you do not have a specific problem but still want to figure out in which direction the system shall evolve and the tactical approach where there is a problem and the trend shall help to find a solution.

7.1. Strategic usage of the trend of increased addressing of human senses

The procedure described concentrated on a strategic approach: I do not have a problem, but I would like to predict the development direction of my system.

To make a quick, but still effective design of an innovation that takes advantage of the senses, table 2 can be used as a morphological box. From every column one feature is taken and combined with the features of the other columns according to the way described in chapter 4.

In the following, one example of combinations and its development over time is stated (Fig. 35). This allows to systematically check for a development direction. The example shall explain the methodology and how to read the example. In the Annex, more examples are displayed as one-pagers.



Around 1872 the first films (visual) were made. They were black and white, no sounds and the quality was

poor. Around 1927 sounds (audio) were added and 5 years later (~1935) the first color films (visual) were available. In 1985 3D movies were developed, but it took 15 years (until 2000) to develop a better technology (polarized light instead of red/green separation) to make them accepted (visual). Around 1990 the sound was improved by moving from stereo to surround sound with noise suppression (audio). Around 1992 the first 4D movie including air blasts or movable seats (kinesthetic) came on the market. In parallel selling sweets and drinks came en vogue in cinemas (gustatory), although this does not directly have to do with the movie itself.

The prediction is that odor will be added to movies once corresponding ventilation systems will be available. Or chewing gums with different tastes, which correspond to the meals that are served in a movie, will be available. Another path is movies where you can interact with the plot (e.g. seeing it from different perspectives).

Fig. 35: Example for the application of increased addressing of human senses (others see Annex)

The example is about cinema movies. On the y-axis, the senses are displayed, sorted by far distance and near distance (1). On the top line examples of combinations are displayed (as far as available in pictures) (2). The x-axis displays the time of introduction of the technology (3). At the intersection of the sense and the time the technology that was introduced is displayed (4). The display of a funnel on one sense shows how the sense addressing itself has developed (dynamized, raised or diminished) (5). On the right side a section is displayed with a prediction how the system will evolve (6). Below the graphic an explanation is given.

In the following section a list of examples for the application of the trend is listed. Each of the examples is detailed in the annex.

Cinema movies (from visual & hearing -> visual, hearing, smelling, touching) (a-a-ah.de)	
Advertisement (from only smelling -> smelling, visual, sound) Combination of both the conscious and subconscious part and various senses (ndr.de)	

Soap (from kinesthetic -> kinesthetic, smelling, visual) Combination of both the conscious and subconscious part and various senses (decoration.de)	
Elevator controls (buttons) (from kinesthetic -> kinesthetic, visual, sound) (her.huerdenlos.de)	
Police cars / fire brigade (visual & sound) Both are addressing the conscious part (autobild.de)	
Fun park (combination of visual [lights], hearing [music], touching [labyrinth], smelling, tasting [food]) Combination of both the conscious and subconscious part and various senses (private)	

Pop concerts (from only hearing -> hearing, visual [show] -> tasting [food]) Combination of both the conscious and subconscious part (snow-online.de)	
Dinner in the dark (from visual & taste -> non-visual & taste) Combination of both the conscious and subconscious part (dialog-im-dunken.de)	
Perfumed candle Combination of both the conscious and subconscious part (werbetopshop.de)	
Birthday cards Combination of both the conscious and subconscious part (pinterest.com)	
Shower heads Combination of both the conscious and subconscious part (pearl.de)	

Besides these examples that have a history, there are other products that can be evaluated.

- Showers and faucets: They have provided pure kinesthetic sense up to now. Adding odor to the water or light to give information what temperature the water has could be a future feature.
- Door bells: They have provided kinesthetic feeling up to now. A more recent development has been the addition of video screens (visual & audio). The next evolution step could be to connect the bell with a light guide that leads you through the building to the door where the bell belongs to.
- Diapers could change their color when they are full or dispense a better odor.
- On a menu, food is usually described in words. The next level could be to show pictures of the dishes and to display the plates with odor and as a 3D image.
- AUDI combines the kinesthetic feeling of pressing a switch on the car dashboard with the sound of switching (Fig. 36). Both must form a unique, reproducible feeling. The smell of a new car is designed as well. When buying a car with leather seats, the car must have a light odor of leather (being aware that the interior of a car is closed and thus the odor accumulates over time and must not be too strong).

Fig. 36: Combining kinesthetic and sound of a switch on a car dashboard at AUDI [24]

7.2. Tactical usage of the trend of increased addressing of human senses

A tactical usage of the trend would be if you have a problem, you need to solve it and the trend shall provide directions.

Fig. 37 displays an algorithm for problem solving with the help of the trend of increased addressing of human senses.

When working on an innovation one of the first questions that could be asked is, whether the problem has to do with addressing human senses. If one or several senses are addressed, then they have to be identified. In the following process, they must be addressed first. In case no sense has been addressed, the need to do so must be identified. If there is no need proceed with other / supplementary TRIZ tools (not part of this thesis).

If one / multi senses need(s) to be addressed, two questions must be asked in parallel: to which category does / shall the sense belong: near / far and what shall be achieved: intensifying the information or raise consciousness? Intensifying the information means that the transfer is insufficient, but already reached consciousness. Here the first action to take is dynamizing the existing sense and add appropriate other ones, especially from the adjacent category, to get extended access to the brain. For raising consciousness, the near senses are generally better suited, so start with them and complete by the far sense category first. Then start to dynamize.

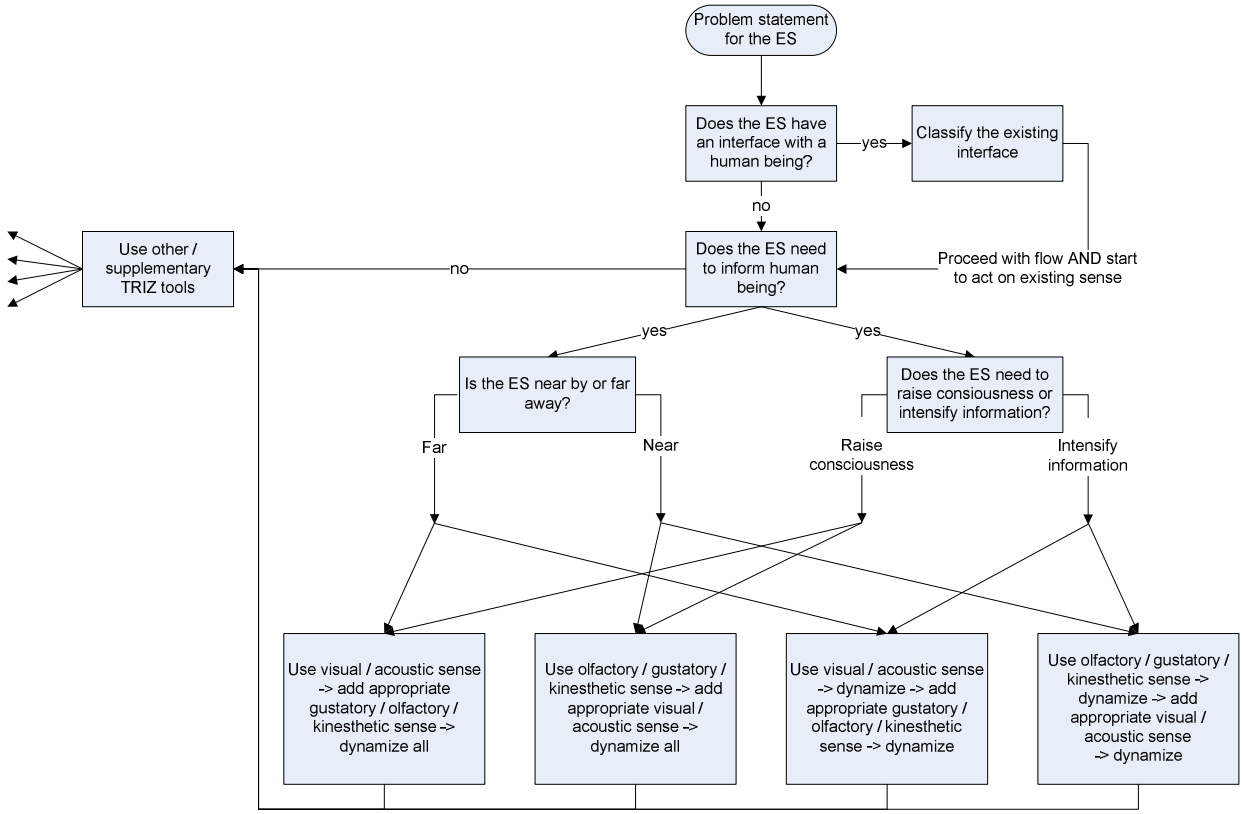


Fig. 37: Flow chart for trend application if the starting point is a problem

It is always a challenge to get real examples from companies where a problem had to be solved. Therefore, only two examples can be shown in this paper. For the prediction, examples were easier to provide as the prediction was done by the author, rather than by the technology owner in industry. Confidentiality is always an issue.

MR example

The first example regards a problem of GE healthcare and their MR (Magnet Resonance) technology. An MR is often used as diagnostic device in healthcare industry (Fig. 38). The machine is big, loud, vibrating, narrow and in a “cold” looking room. It is not very inviting to be put into such a machine. Adults can overcome their negative emotions by just overriding them with their conscious, logical capabilities. For young kinds, this is difficult. Usually the mother tries to calm them down, but that is not always successful. The problem is: How to turn the “frightening” environment of an MR into a positive feeling for kids?

Applying the problem algorithm of Fig. 37 leads to the following process:

Does the MR have an interface with the human being? Yes, it has an appearance (visual), makes noise (acoustic). The smelling sense might be stimulated by the general odor of a hospital evoking subconscious reminders of other times in a hospital (birth, illness, etc.). The feeling that the kid has when lying on the bar (kinesthetic) causes a neutral to negative emotion. It comes on a secondary level as this sense will only be addressed when the kid is in the machine. The other senses are active when entering the room (the smelling sense might be active even already when entering the hospital). There is no gustatory momentum.

Does the MR need to inform the patient? – No the MR itself does not need to interact with the patient. The doctor / examiner gives the directions to the patient.

Is the MR nearby or far away? The MR is nearby. Does it need to raise consciousness of intensify information? It does not need to raise consciousness and needs to intensify (here decrease) the information flow from MR to patient. The perception caused by the MR through its visual, acoustic appearance needs to be changed into the opposite direction. Instead of frightening, the MR shall invite to be used and shall spread positive curiosity.

The algorithm recommends to “use olfactory / gustatory / kinesthetic sense -> add appropriate visual / acoustic sense -> dynamize all”. In this example the senses are already involved as discussed above. We need to dynamize them which means to turn them into an opposite function.

Visual: How can we turn the appearance of the MR into something “inviting”. Kids love to discover. They love to climb and crawl and explore things. Can we change the environment of the MR by making the room an adventure / jungle place where the MR is included (using standard inventive principles class 1)?

Acoustic: How can we change the noise the machine is making? We integrated the noise of the machine into the sound of a jungle place (principle of nested dolls). The jungle camp generates interest in the kids.

Olfactory: How can we change the hospital smelling? We introduce a little bit of high concentrated substance: odor that will enclose the basic hospital smell (standard inventive solution class 5).

Kinesthetic: How can we change the neutral to negative emotion that lying on the scan table is causing? Instead of changing the scan table we decided to color is so that in the jungle you are lying on something harder. By this the expectation corresponds to the feeling (coordination of rhythm).

Gustatory: In the jungle, there are pictures of fruits. The kid is shown real fruits before he goes into the machine and he is told that after the examination he will get them to eat. (Principle of pre-action)

The result of this solution can be seen in Fig. 38. The resistance of kids to get examined has reduced by 80%, sedation is not applied anymore and the total examination time (including preparation and post actions) could be reduced by 15%.

Fig. 38: Original MR (top) and “adventure camp” MR (bottom) (GE Healthcare)

AUDI example

The car manufacturer AUDI introduced a new driver assistance system. It was monitoring whether the car crosses the road guides if no turn signal is set. In this case the car assumes that the driver might have fallen into a micro sleep and need to wake up the driver again, or in case of no sleep to focus the attention back to the road.

Does the car have an interface with the human? Yes, visual, acoustic, kinesthetic, olfactory are all included.

Does the car need to inform the human being? Yes, this is definitely needed.

Is the car nearby or far away from the human being? And does the car need to raise consciousness or intensify information? The car is nearby and needs to raise consciousness and intensify information.

The algorithm recommends to “use olfactory / gustatory / kinesthetic sense -> add appropriate visual / acoustic sense -> dynamize all”. In this example the car applies already lots of acoustic and visual senses. Therefore, another sense might generate more consciousness. The choice went on kinesthetic: Vibration of the steering wheel.

Examples by the author

An example on my own shall be given. My grandson has now been in a kindergarden for two month. He loves playing with the toys there. As the group includes elder kids as well they also have FIMO, a modeling clay (Fig. 39), available. The young kids tend to eat the modeling clay. It is not poisonous, but still parents do not like their kids eating that material. On the other hand, it is very hard to control all the children. An alternative would be to not use modeling clay anymore.

Fig. 39: FIMO modeling clay (frutsels-hobbysite.info)

We thought about another solution using the approach of increased addressing of human senses. FIMO is per definition colored so using this sense as a warning does not make sense. Using sound when FIMO gets in touch with saliva will generate a reaction. The question was if this would generate more interest instead of a warning. Kinesthetic

is also not an option: Kids need to take FIMO into their hands to form sculptures. And adding a smell is excluded as well: if the odor is negative, kids will not play with FIMO. As a last idea, gustatory came into play. It can also be derived from separation in space. FIMO should be used (for playing) and not be used (eating). The locations (space) for both are different. So, we added highly concentrated spice to FIMO. The kids played with the modeling clay as usual, but as soon as they took it into their mouth they rejected FIMO due to the bad taste.

I discussed the developed algorithm with a soap manufacturer. We looked at the historical development of soap (see Annex, example 3) and applied the algorithm. During its evolvement, soap already gathered the application of 4 senses. So we asked how the gustatory sense could be addressed and whether it needs to be addressed. The answer was: it should be specially to encourage kids to use soap. The idea was born to include a packaged sweet (tasting) or toy (kinesthetic) into the soap. So, over time when washing the hands the sweet will appear. The idea was derived (FOS) from Kinderueberraschung who are using a similar principle (Fig. 40). This product is under development (needing regulatory approval from authorities).

Fig. 40: Kinderueberraschung principle to be transferred to soap (eurogast.kinnast.at; twitter.com)

Cable tie bonding (company HellermanTyton)

Cable ties are an important fixing part for cable in automotive industry. For standard application on wiring harnesses, machines exist where a value for the force that the tool applied to the cable ties can be selected. This is working very well for production. When it comes to the setup of a novel cable / wire chain, more flexibility is needed with the bonding machine (Fig.41).

Fig. 41: Cable bonding machine (directindustry.de)

Applying the problem algorithm of Fig. 37 lead to the solution of using both a light signal going from green to red according to the force applied by the machine and to combine this with a vibration signal on the handle.

Lego Fun-Snacks

Lego is well known for their Product: one of the most structured toys and even industrial means that allows to build built any part with a basic set of highly shape coordinated bricks. Legos address the kinesthetic sense (feeling the bricks), the visual sense (colors) and partly the acoustic sense (there is a reproducible “click” sound when

Fig. 42: Combination of Lego brick shapes (kinesthetic + color) and eatable flavor (tasting) (lego.wikia.com)

attaching the bricks to each other). With the slogan building anything Lego and Kellogg's offered a combination in order to address the taste sense as well (Fig. 42). The flacks are pressed into Lego brick forms with different taste. You can use them to build physical models and you can eat them. As the bricks have with different colors as well different taste you can compose your taste as well.

Wall paint

A wall paint usually addresses only one sense: the visual. But why not combine it with other sense? Giving the paint a higher viscosity allows to generate reliefs on the wall that can be addressed by the touching sense. Can it as well stimulate the olfactory smelling sense? Add some odor that the room always in its full volume smells nice? There is a pain existing that includes a perfume (Fig. 43) for kinds rooms.

Fig. 43: Combination wall paint and odor (geurverf.nl)

7.3. Expanding the suggested trend to other applications

7.3.1. Expanding human senses with technology

In 2007 Darrell Mann defined a trend of increased usage of senses [15]. In his view, it was about using the senses from a human perspective, not to develop an engineering system that addresses the senses.

In the introductory chapter 1, the human senses were defined and senses in the area of animals were mentioned, too. Another way of addressing the human senses is to use

technology and to make accessible other senses existing by transforming them into the five human senses. Fig. 44 shows the principle. The principle displayed in Fig. 6 is transformed by introducing the technology converter that changes different physical signals into information readable by the human senses between the environment and the 5 human senses.

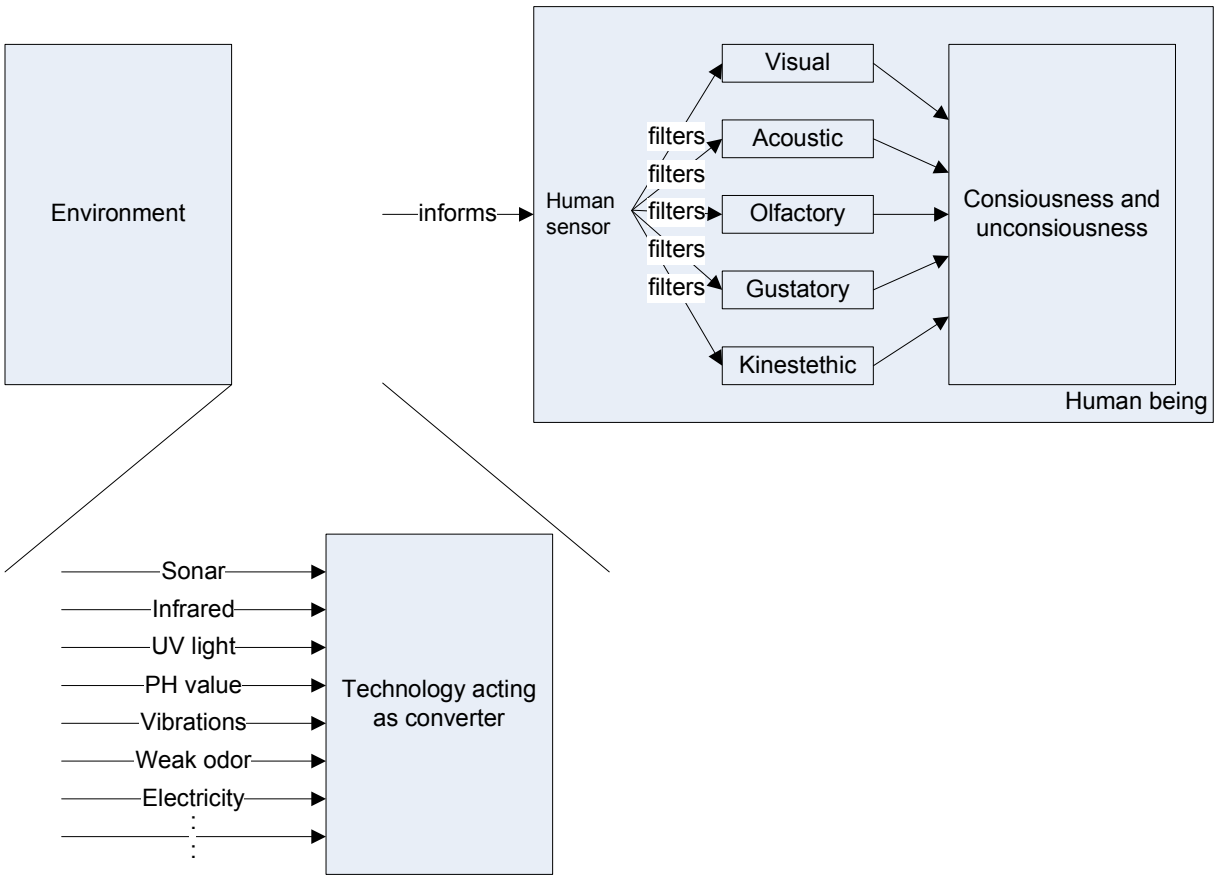


Fig. 44: Transformation of animal intangible senses into senses tangible for humans with the help of technology

An example of this is an IR (Infrared camera) -> visual color pictures determining the temperature and temperature differences. Here two actions happen: temperature as a near distance sense can be turned into a far distance sense and a kinesthetic sense is turned into a visual sense. Sonar is another example. US (Ultrasound) is turned into a detectable signal for human beings with a frequency shift down to the human audio range. Thus US can be “heard” (e.g. at whale watching). This principle can be applied to various physical phenomena.

7.3.2. Senses of an engineering system

Up to now only the senses of a human being have been in the focus. Another way to think about it is to ask: how do engineering systems sense a human being? The most

obvious example for this is the computer. Looking at today's systems we find that a computer (or smartphone / tablet) has a keyboard (or touch screen), a camera and a microphone. The keyboard or touch screen is used very often, so the system sees the finger as a major component. It can also see the user (gestures e.g. for the WII) or hear the human being. From the viewpoint of a computer as the engineering system, the human being looks as displayed in Fig. 45. It will feel him (kinesthetic), hear him (audio) and see him (visual).

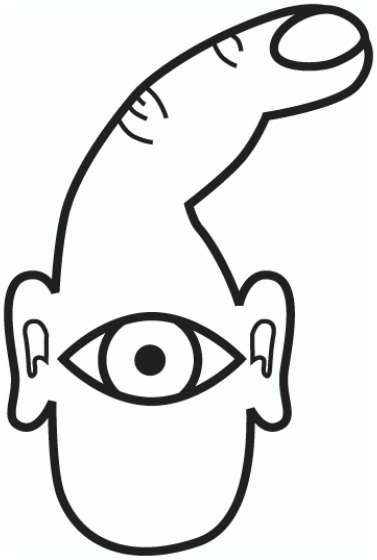


Fig. 45: How a computer as an engineering system sees a human being [28]

This change of view point can then lead to further ideas like: which other sense of a human being (or animal) can be used for interaction?

8. Personal contribution of the applicant

Oliver Mayer has developed the idea of the trend starting from the “Trend of Image Coordination”. He evaluated the senses and their parameters and effects on a human being. He developed algorithms for application and demonstrated the trend on various examples. He applied the trend on FIMO modeling clay. Young kids (< 4 years) not only play with FIMO, they taste and eat it as well. In order to avoid this, highly concentrated spice was added to the clay. This solved the problem (see chapter above).

9. Conclusion and recommendations on application

Trends show a system evolvement towards ideality. In the end, ideality is reflected by the user, a human being. Humans have 5 senses as interfaces with their environment (Fig. 46). The information of the senses is captured as emotion, which in a second step might be translated into feelings as well. Feelings can be generalized into the three parameters: like, neutral and dislike. The focus of the feeling on that scale helps to shape the further activity of the person.

For the different senses (except “seeing/visual” as this was already done by TRIZmaster Alexander Lyubomirskiy) different parameters that generate a like / dislike have been identified. The evolution of “addressing senses” staring with one sense only and its dynamization has been discussed. The step from one sense to two senses, from the conscious and the subconscious area to various senses has been described. The value of addressing human senses with respect to MPVs has been demonstrated. Algorithms have been developed for the practical application. Examples of applications have been given in a strategic and a tactical manner.

The applicability and value of the trend of increased addressing of human senses has been demonstrated.

Fig. 46: The 5 human senses: Art painting by Hans Makart
Wikipedia; left to right:
Touching (Kinesthetic), Hearing (Auditory), Tasting (Gustatory), Smelling (Olfactory), Seeing (Visual)

10. List of published works on the topic of the thesis

- Trend of increased addressing of human senses - Focus on Sound -, TRIZfest 2016
- Trend of increased addressing of human senses - Focus on Near Field Senses -, ETRIA 2016
- Trend of increased addressing of human senses, TRIZfest 2017
- Journal paper under preparation

11. References

11.1. Specific References

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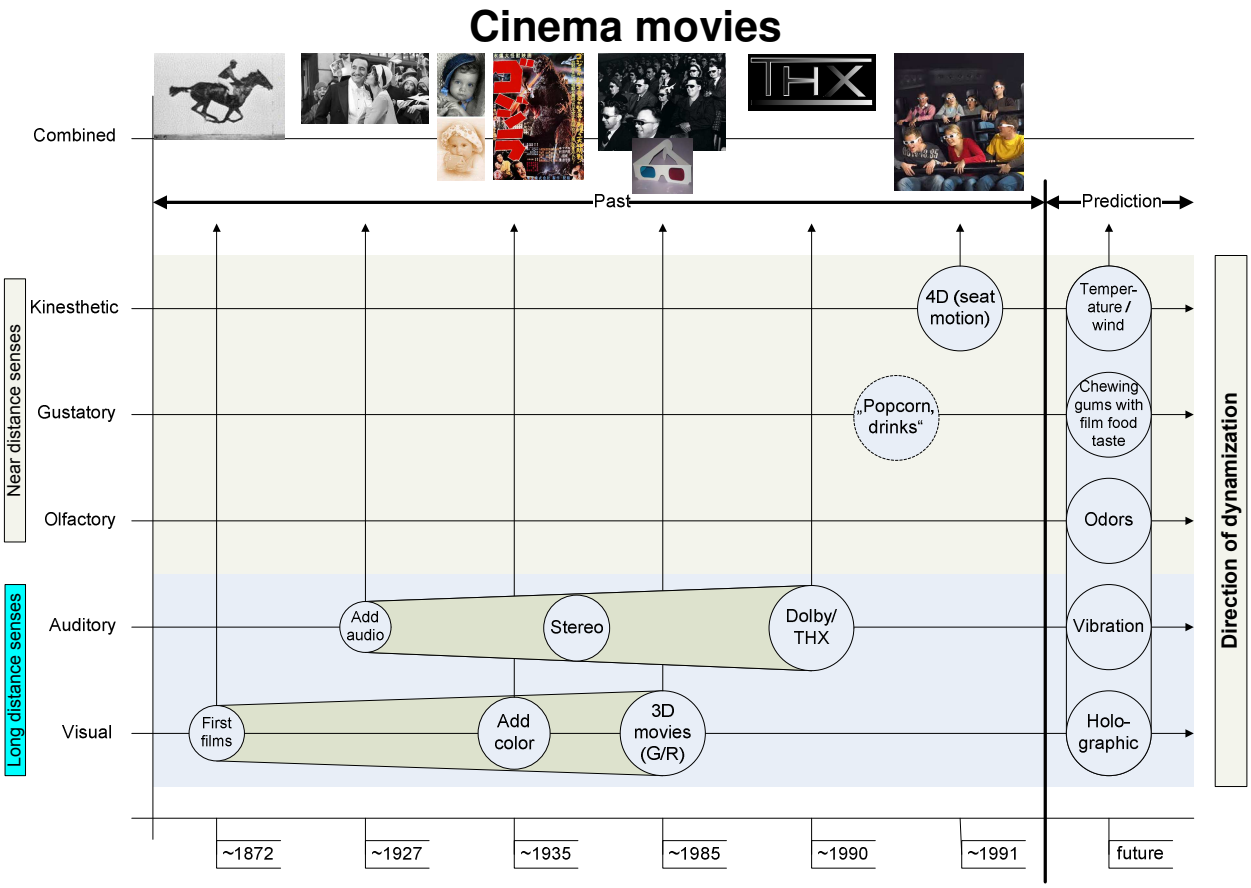
[27] Multisensory optimization: http://www.neurosense.com/services/sensory/

Annex

Examples of development of “Increased Addressing of Human Senses as a Trend”
(The explanation on how to read the examples can be found in chapter 7.1)

Remark: The exact addressing of the year of implementation is difficult. Different sources name different dates, which makes the allocation of the exact date impossible. I took the date when the implementation started to get commercially successful. It might be that in some cases the invention date differs from what is stated in the charts. The more the event is in the past, the larger the deviation from the actual introduction date may be. As the goal is to demonstrate a general development over a period of time, this inaccuracy is scientifically acceptable.

Examples:

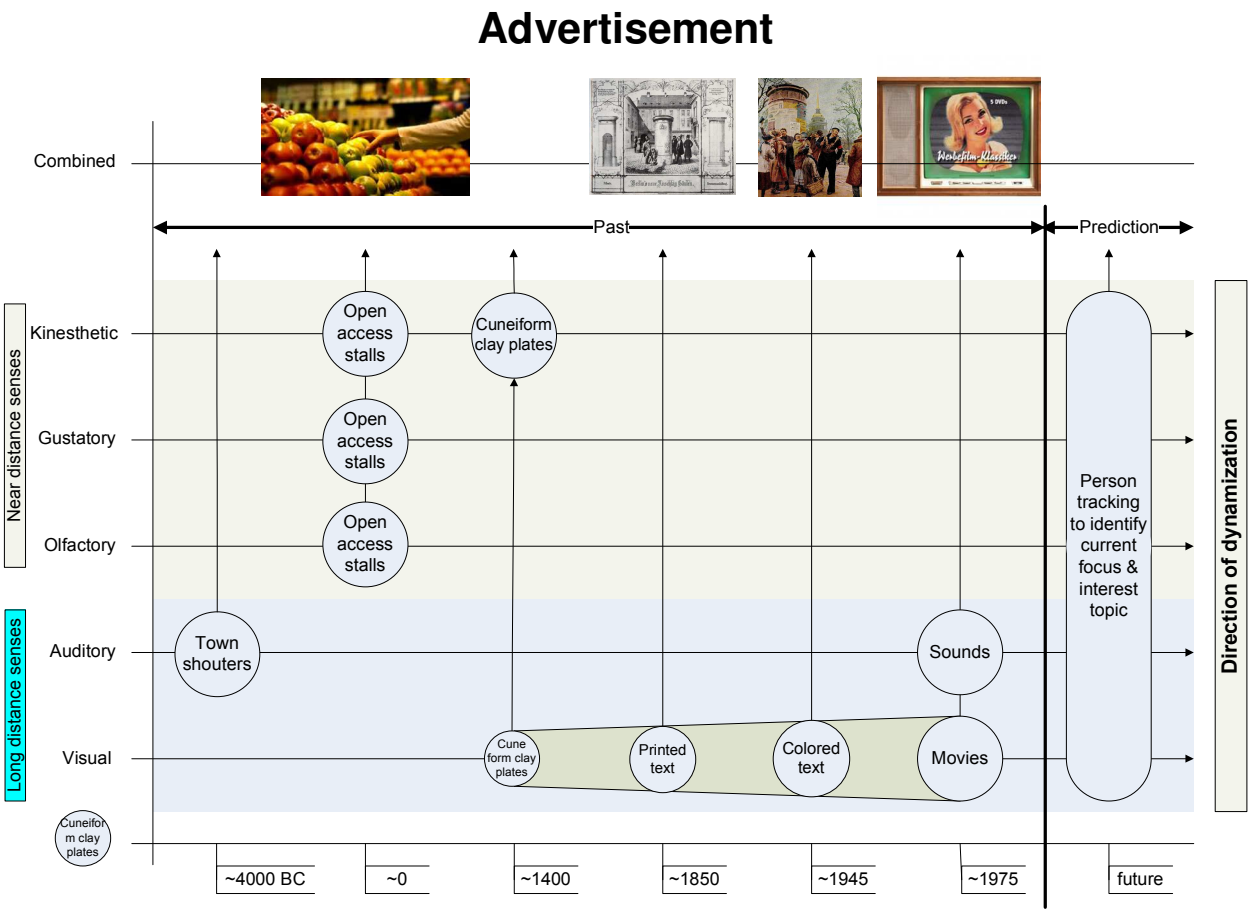


Around 1872 the first films (visual) were made. They were black and white, no sounds and the quality was poor. Around 1927 sounds (audio) were added and 5 years later (~1935) the first color films (visual) were available. ~1985 3D movies were developed; but it took 15 years (until ~2000) to develop a better technology (polarized light instead of red/green separation) to make them accepted (visual). Around 1990 the sound was improved by moving from stereo to surround sound with noise suppression (audio). Around 1991 the first 4D movie including air blasts or movable seats (kinesthetic) came on the market. In parallel selling sweets and drinks came en vogue In cinemas (gustatory), although this does not directly have to do with the movie itself.

The prediction is that odor will be added to movies once corresponding ventilation systems will be available. Or chewing gums with different tastes, which correspond to the meals that are served in a movie, will be available. Another path is movies where you can interact with the plot (e.g. seeing it from different perspectives).

Sources:

Eadweard Muybridge - Die Animation besteht aus folgenden Einzelbildern (aus: Bewegung von Mensch und Tier, Platte 626, Vollblutstute Annie G. im Galopp), Gemeinfrei, https://commons.wikimedia.org/w/index.php?curid=1228779; Toho Company Ltd. (東宝株式会社, Tōhō Kabushiki-kaisha) © 1954 - movie poster made by Toho Company Ltd. (東宝株式会社, Tōhō Kabushiki-kaisha), Gemeinfrei, https://commons.wikimedia.org/w/index.php?curid=3648684; The National Archives UK - Flickr: The Fifties in 3D, OGL, https://commons.wikimedia.org/w/index.php?curid=23100598; Snaily - Eigenes Werk, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=1612671; George-Lucas-Firmengruppe - http://vector4u.com/mylogo/THX%28205%29.eps, Logo, https://de.wikipedia.org/w/index.php?curid=6211942; Bavaria Filmstudios, Grünwald b. München; http://www.focus.de/kultur/kino_tv/filmstarts/the-artist-tonfilm-killed-the-stummfilm-star_did_37905.html

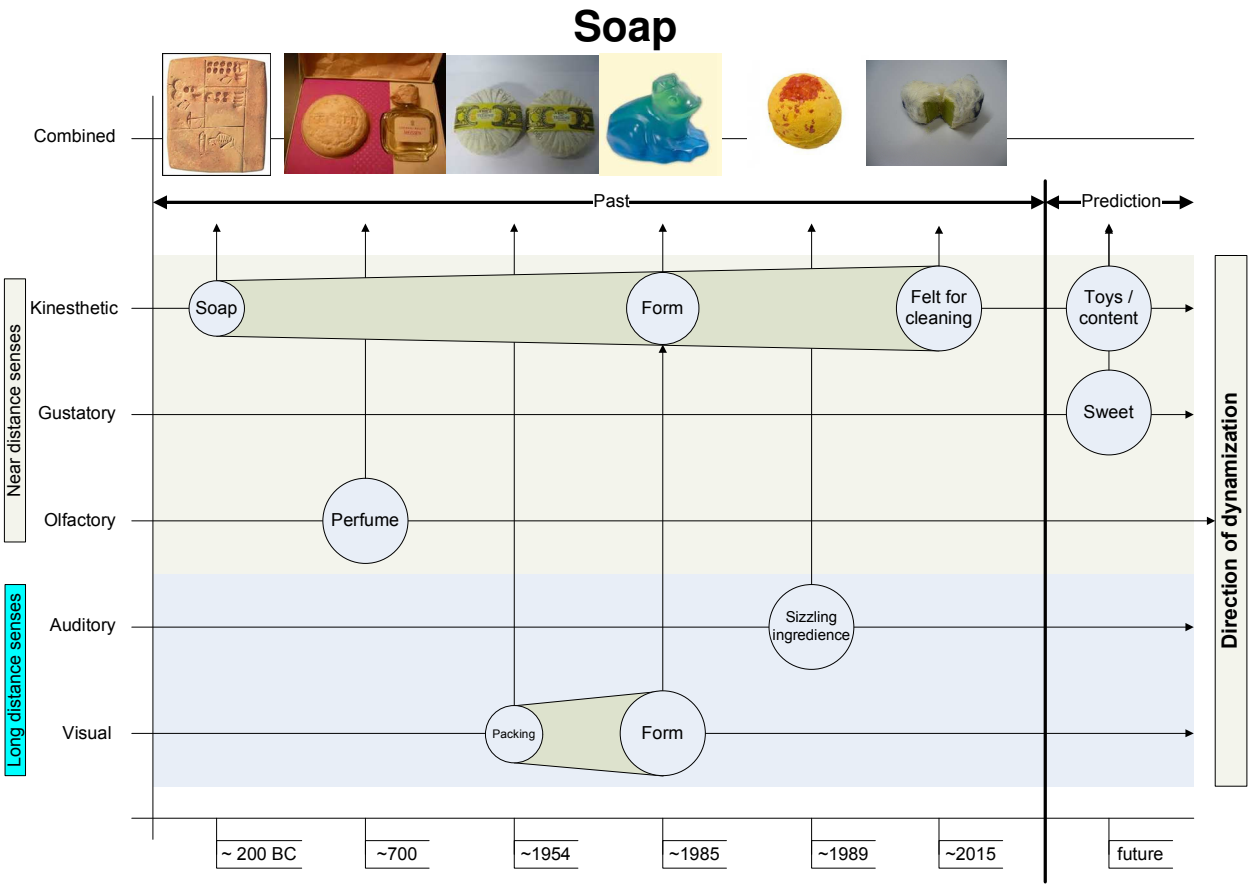


~4000 BC town shouters started to include advertisement in their portfolio in Egypt (audio). Around 0 AC cuneiform clay plates were used to write text on for advertisement purposes. As they had a rippled surface they were visible & kinesthetic. It took ~1500 years until Gutenberg invented paper printing which was then used for advertisement. The advertisement as we interpret it today started ~ 165 years ago with the introduction of the advertisement pillar (Litfaßsäule). Color (visual) was introduced in printing at that time. After ~1945 advertisement was expanded to films including visual and audio.

The prediction is that in the future goods will be presented in a way that makes it possible to touch them (kinesthetic), smell them (olfactory) or even taste parts of them (gustatory) – as sometimes done today with new eatable products in a food store – and to have an information system operate in parallel, explaining (e.g. for food) where the food comes from, what the nutrition values are, how to cook it, etc.

Sources:

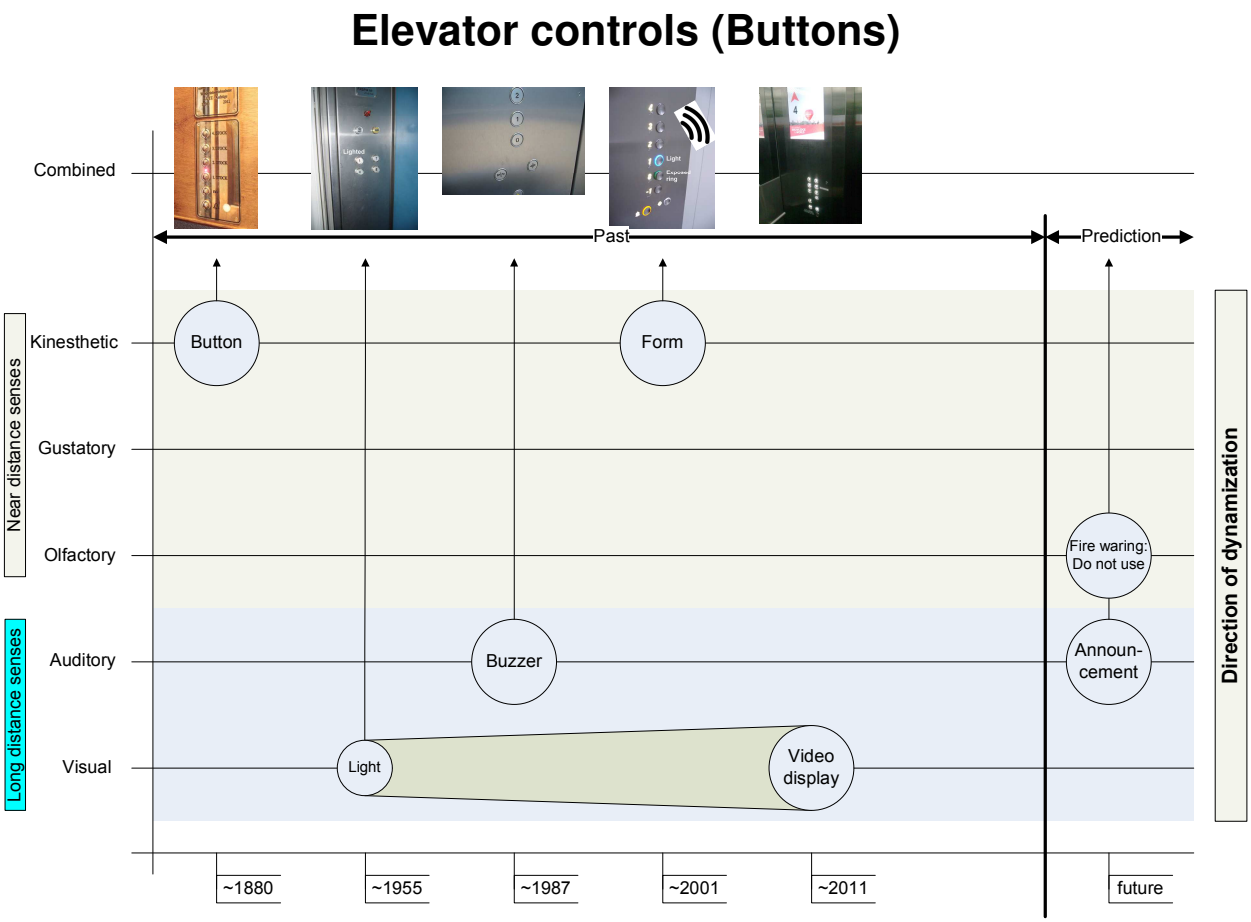
F. G. Nordmann - Künstler: F. G. Nordmann, PD-alt-100, https://de.wikipedia.org/w/index.php?curid=607439; LepoRello - Eigenes Werk, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=8682884



Soap has been known since ~4500 BC but only the Romans understood that soap can be used for cleaning (~200 BC). Before that time soap was taken as medicine (kinesthetic). From ~700 on perfumes (olfactory) were added to soap in the Arab world, which then swapped over to Europe via Spain and Italy. From the ~1950ies on, packaging was added to soap in order to improve the visual and kinesthetic effect. ~1985 the visual and kinesthetic effect was reinforced by producing soap in various shapes. In ~1989 sizzling materials were added to soap in order to get an auditory impression. Another kinesthetic additive to the soap is felt. It allows better cleaning and touch feeling to the soap introduced in 2015.

The prediction is that parts that do not dissolve (e.g. toys, encapsulated sweets) are included into soap (“Kinderueberraschung”).

Sources:
A. Eugster - Eigenes Werk, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=18407285

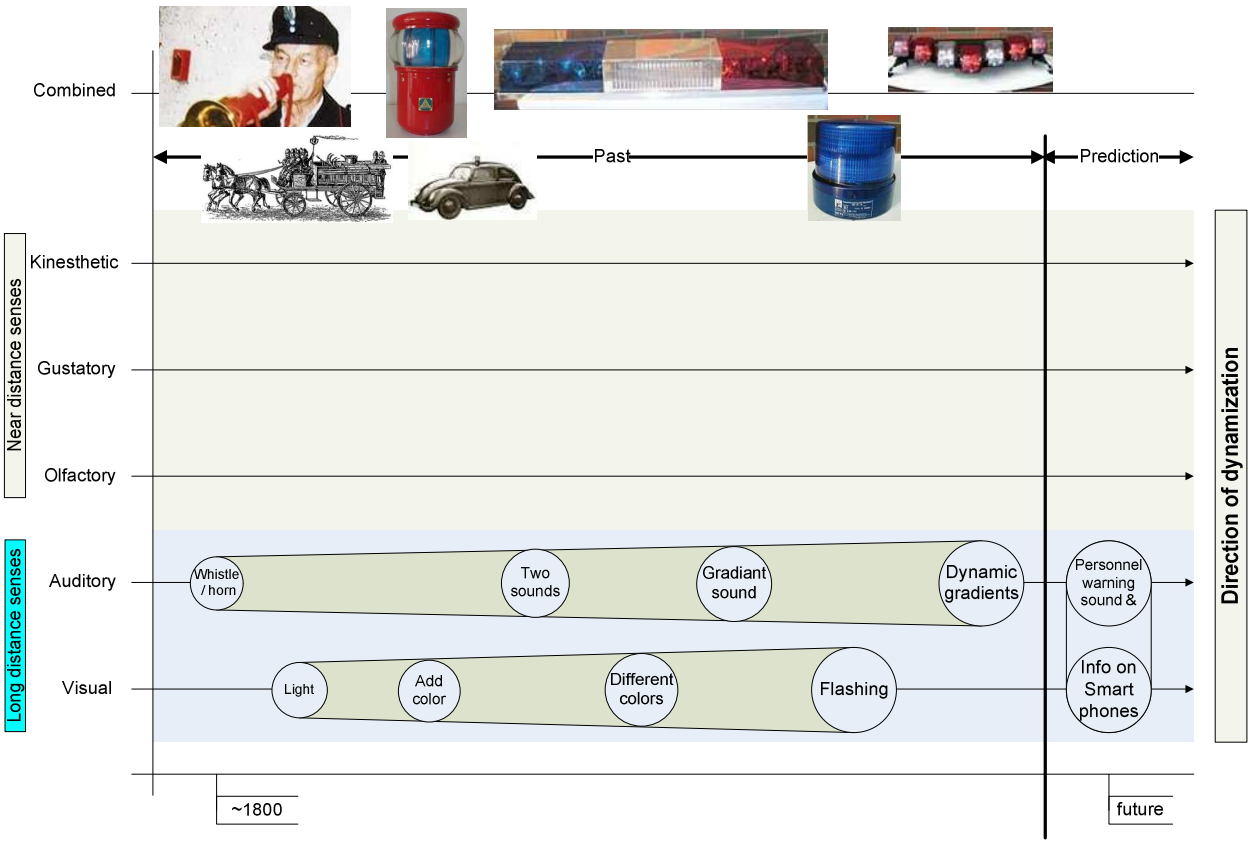


Elevators have a tradition since 1853 when Mr. Otis showed how a safe elevator can be constructed. The first full electric systems were introduced around 1880. The electric controls first consisted only of a push button (kinesthetic). The next level (~1962) was the lighting (visual) of the button. From ~1995, a buzzer sound was added when the button is pushed (audio). Another improvement was the change of the shape of the button to add e.g. information about ground level / lobby. The latest improvement is adding a display for additional floor information.

The prediction is that in the future additional audio information will be given in the form of announcements when pushing the button. In a department store additional odors could be released (e.g. when the perfume department or the food department is selected) to prepare the person. Another thought is that in a store you do not select floors anymore but the products you are looking for. The lift takes you to the right floor automatically and then guides you to the desired place by guiding lights in the story floor.

Sources:
Ralf Roletschek/Wikipedia

Police cars / Fire brigade

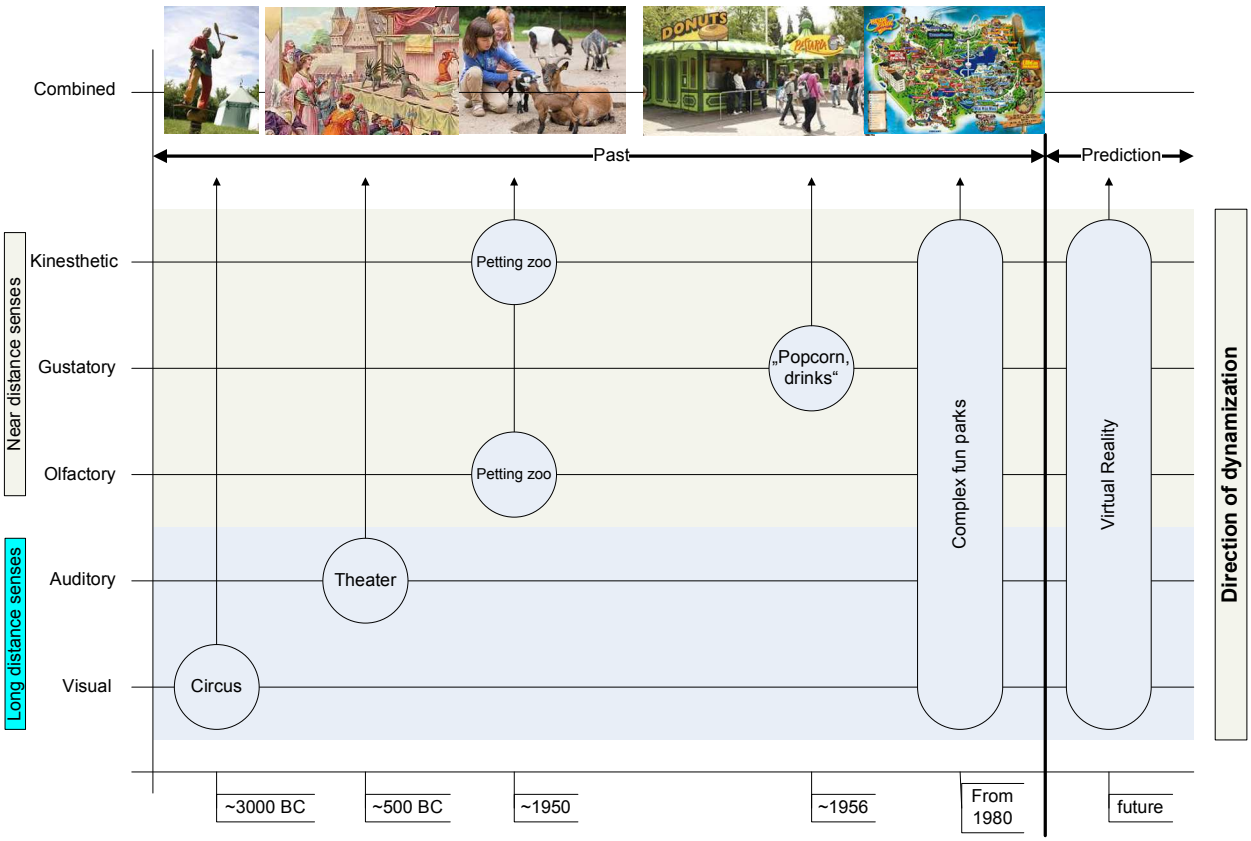


In the early 1800s fire brigades started to use whistles and horn (auditory) in order generate attention. This was intensified by visual effects like torches. When electric light came up, the bulbs were encapsulated in colored glass. During WWII the color blue was defined as the emergency color. Blue light scatters much more in the atmosphere so it is more invisible over longer distances than red light (especially from the air, e.g. for combat pilots). In order to generate more awareness, two sound systems were designed. In the end the usage of multicolor head lights was introduced to generate even more attention. Sounds were dynamized from two frequencies to gradient sound and with varying types of different flashing.

The prediction is that in the future when a police car or fire brigade are on their way you will get a notice displayed on your smart phone or in your car directly as warning information (personalized warning).

Sources:
DRK-Dietzingen-Historie des Blaulichts.de; Blaulicht-sammler.de; mainpost.de; www.feuerwehr-mr-cappel.de_Chronik_Blaulicht

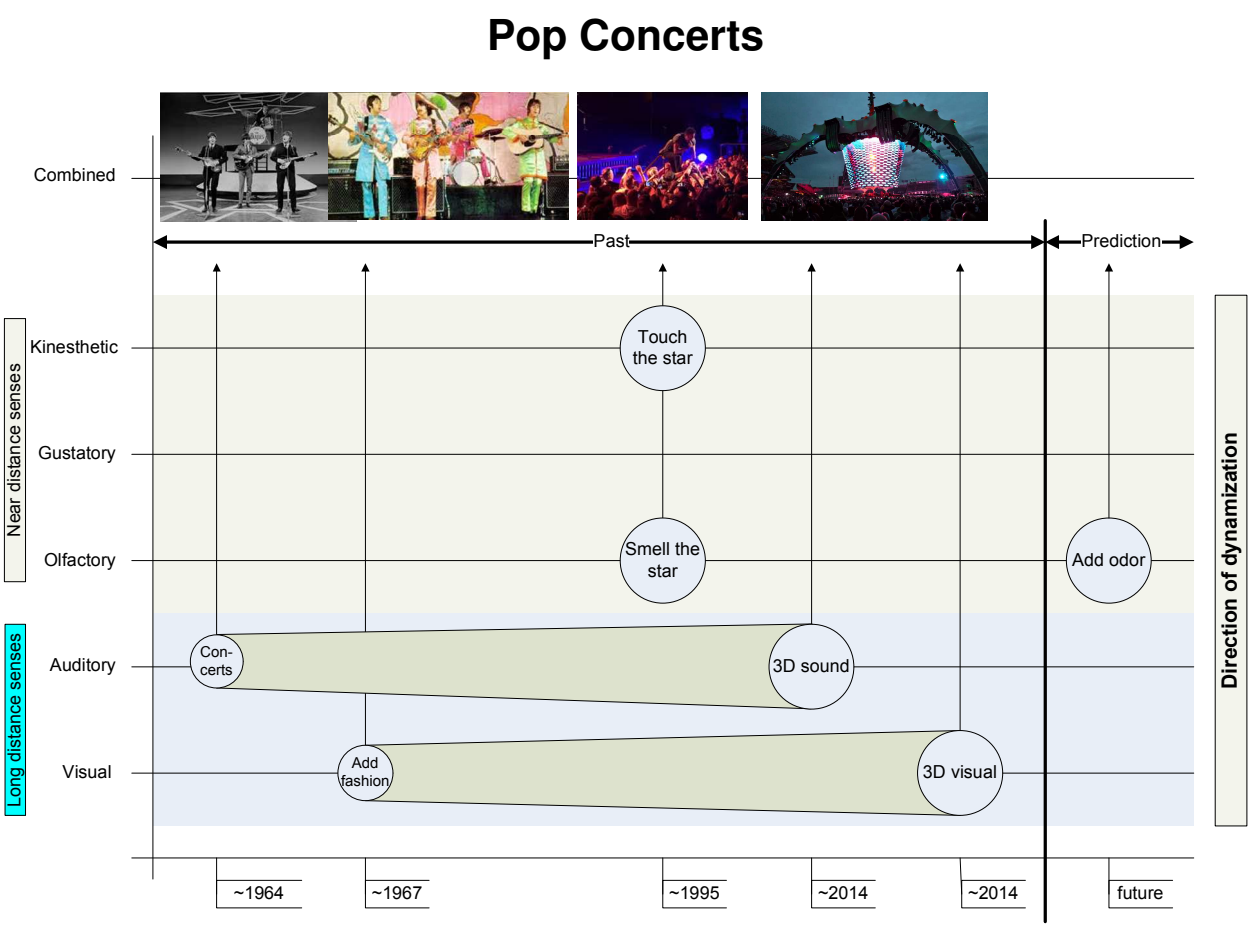
Fun Park



Entertainment of people has always been an important aspect / factor. In ancient times the circus was the element of addressing the need to entertain people by gladiator fights or artistic presentations where the visual aspect was in the foreground. Theaters focused more on the auditory with sophisticated texts. The next step was to include the spectators in the plots and let them be part of the action. This was the basis for the development of fun parks in the 19th century (no, Disneyland was not the first one, Wiener Prater or Tivoli in Copenhagen are much older). They started by combining cabaret shows (combination of circus & theater) with petting zoos (adding kinesthetic & olfactory). With the introduction of more controllable technology the well-known amusement rides were introduced and combined with food, beverages, sounds, etc. Today in a fun park all senses are addressed in order to provide maximum involvement.

The prediction is that in the future the really existing environment will be replaced by virtual reality in order to generate even more exotic full senses feelings.

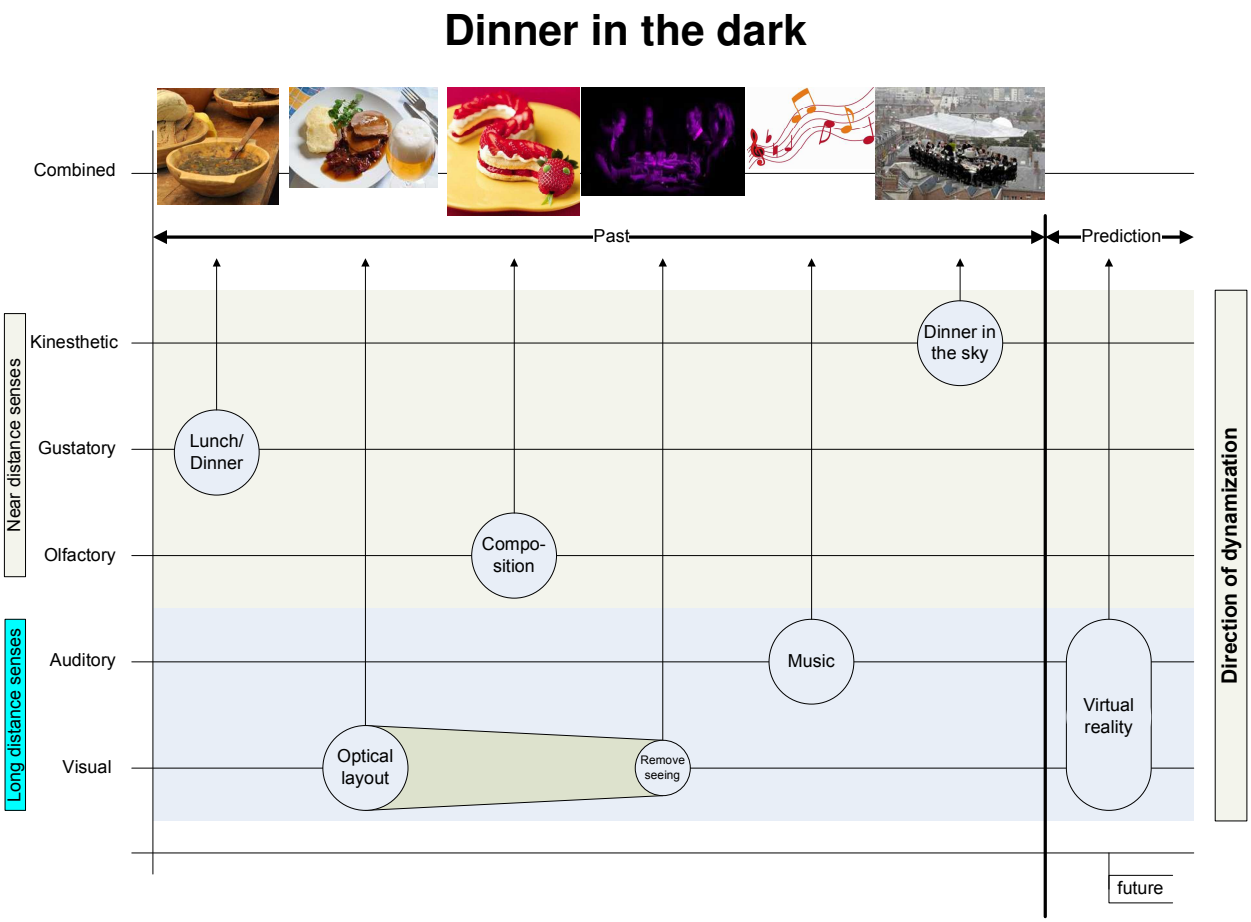
Sources:
catawiki.com; europapark.de



Pop concerts evolve to address all senses, too. In the 1960s concerts focused on music. The musicians did not deliver a show (visual). This changed fast. ~1967 e.g. the Beatles performed in colorful dresses and added visual effects. The next level started in the mid 1980s. It was the stage dive of musicians. The direct contact with the lead singer is adding a kinesthetic and olfactory aspect to the concert event. The usage of fireworks and flame throwers is another way of adding a kinesthetic feeling. The band U2 in 2014 started to change the auditory and visual aspect of a concert. Instead of having a front stage they made a 360° stage allowing a 3D impression.

The prediction is that in the future other kinesthetic and also odor aspects will be added.

Sources:
Wikimedia.org; ispauldead.com; pintertest.com; kenlevine.blogspot.com

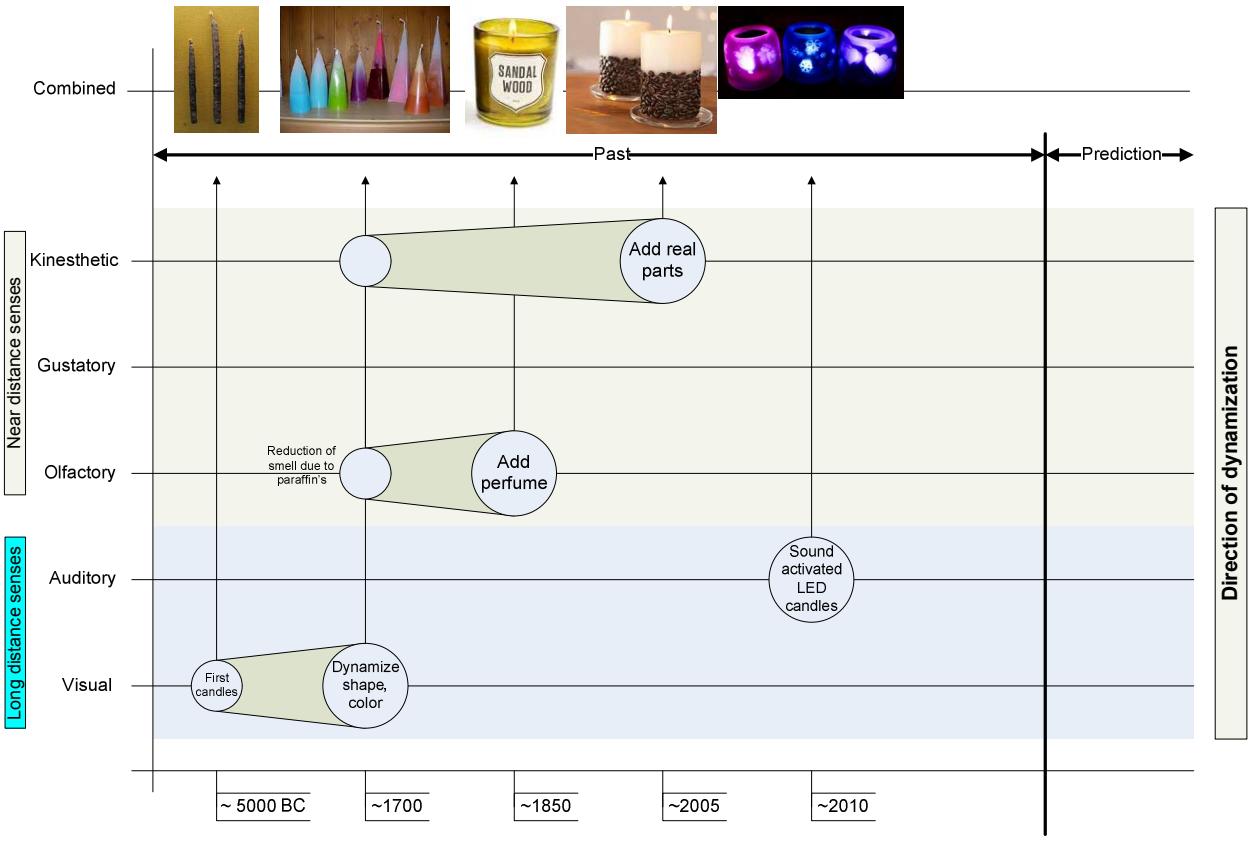


Dinner in the dark is an event whose aim is to reduce one sense impact and to become open for other senses. Normally a meal today is an optical, gustatory and olfactory event. At dinner in the dark the visual effect is reduced by eating in the dark without seeing. As seeing is one of our main senses this forces us to concentrate more on the other senses. The auditory sense is stimulated by talking and adding music. The kinesthetic sense is revealed by lifting people up to the sky.

The prediction is that in the future not only the visual sense will be reduced but other senses as well: audio, by having total quietness, kinesthetic by being suspended in the air instead of sitting on a chair. Or the other way around: generate visual and audio impressions artificially (virtual reality) that are “synchronized” with the food composition of the meal.

Sources:
Rezepte-und-tipss.de; http://german.china.org.cn/culture/txt/2013-02/20/content_28009779_3.htm; mittelalter-heute.de; blog.gilly.ws; http://lynn-in-ecuador.de/sinamune-mein-projekt; dialog-im-dunkeln.de; dogonnew.com

Perfumed Candles

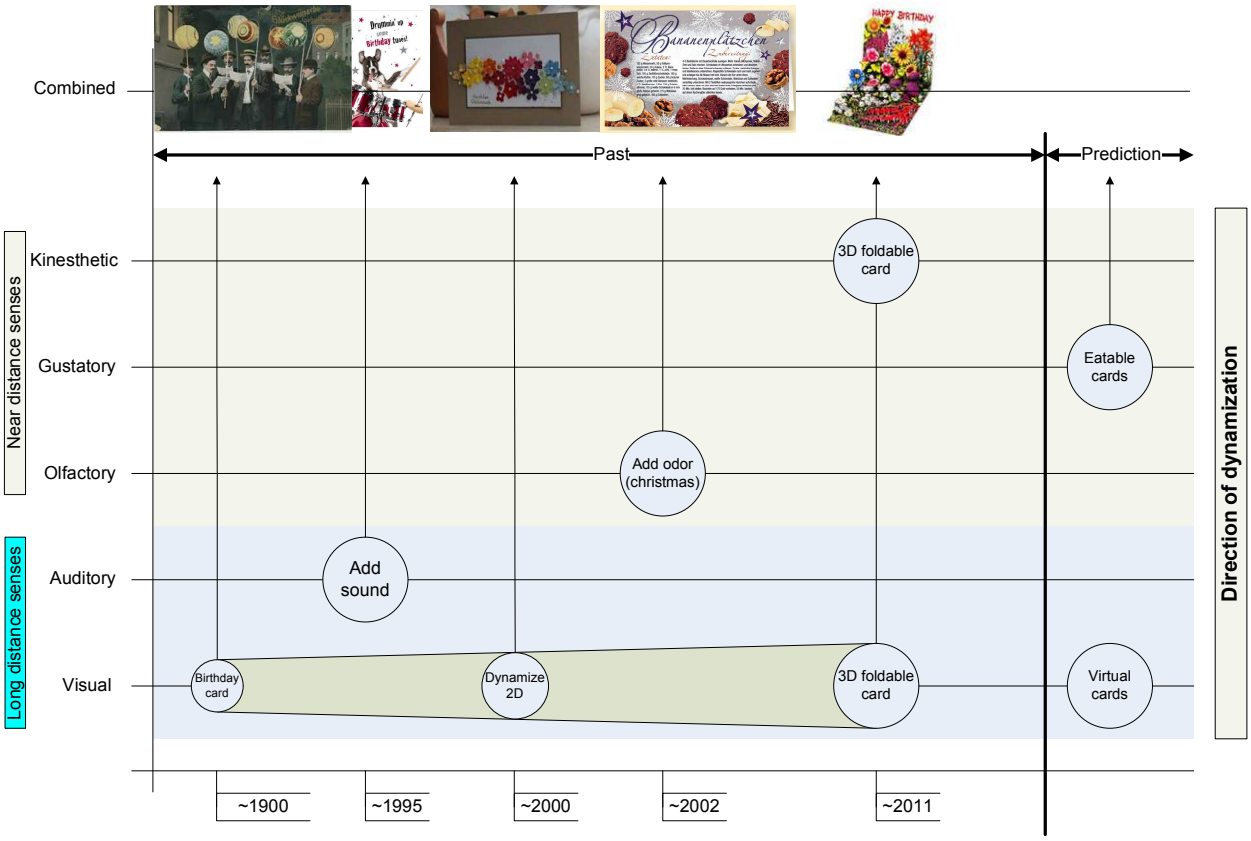


Candles have been manufactured since ~5000 BC. Their only purpose was to deliver light. Candles made from tallow remained the principle source of lighting for centuries. In the 1700s with the change to use wax and paraffins the modelling of candles was made easier and the harmful effects of breathing in the vapors and fumes could be eliminated. The shape was dynamized and color could be added to the candles. With paraffins it was also possible to add perfume (olfactory). This situation remained unchanged for ~ 150 years. In the last 10 years, perfume was supplemented with the real sources of the perfumes (e.g. smell of coffee and add coffee beans on the outside of the candle for visual and kinesthetic). The candle as such today is turning from a mechanical system into an electric system (LED). Here an auditory component is added that allows switching on and off the LED candle by hand clapping.

A prediction for the future is not given for this example.

Sources:
wikipedia.de; kerzenidee.de; varnheinberg.de; creadoo.com; mootes.ch; tschibo.de; alibaba.com

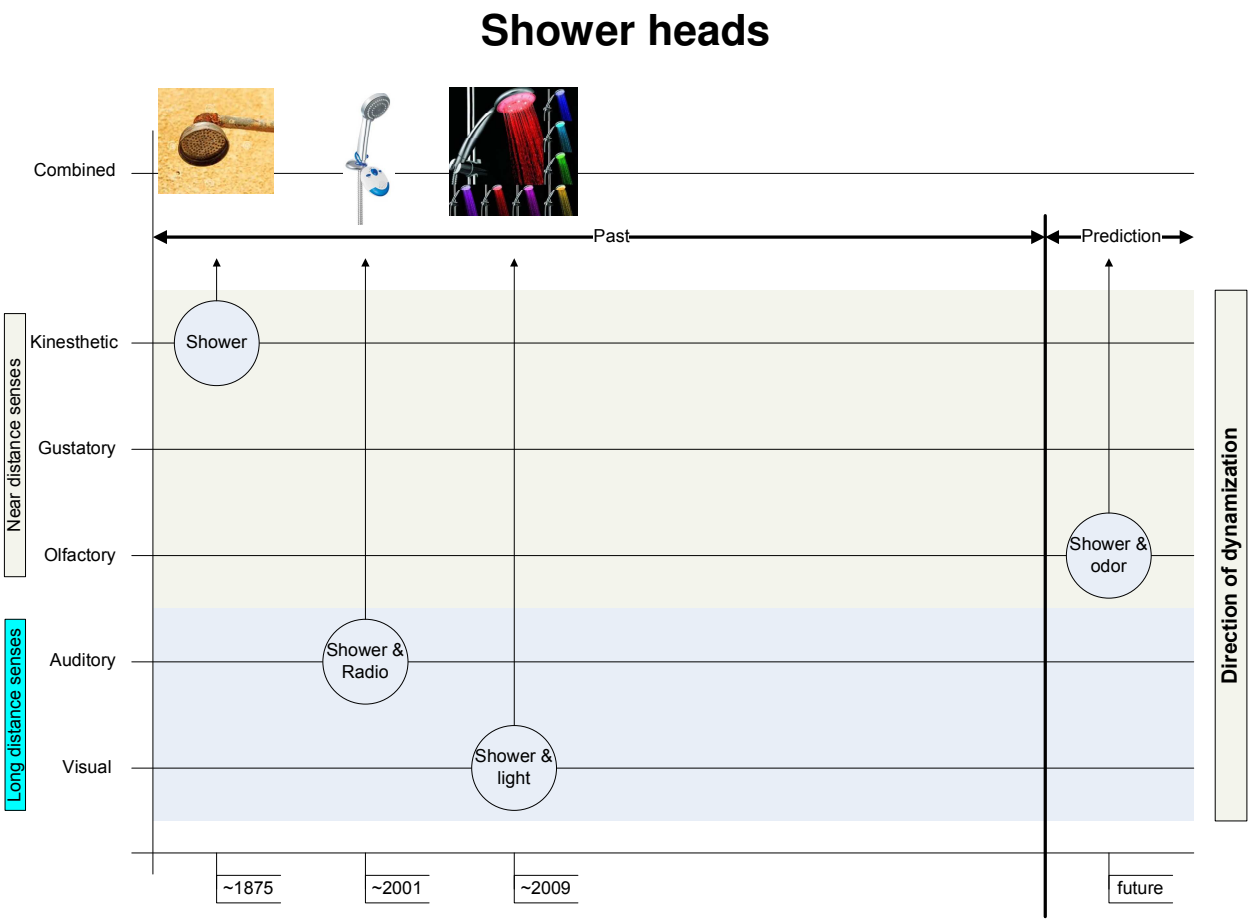
Birthday cards



The first postcards are report to have been sent ~ 1450s. Birthday cards got popular at the beginning of the 1900s. Since then they have been a means to address the emotions of a person. Around 1995, with the introduction of electronics, sound was added. So when opening a birthday card, the song “Happy birthday to you” was played. The next level was the dynamization of the front going from 2D -> 3D. This also had a kinesthetic effect. From ~2002 on odor cards have been available. The card paper is saturated with a perfume or during Christmas time, with an odor of bakeries. For some years cards have been available that unfold and fold upon opening and closing together with sound. This allows a real kinesthetic and auditory effect.

The prediction is that in the future we will see cards combining all the described features + being eatable, which represents the gustatory aspect.

Sources:
tolle-geschenke.de; flickr.com; alle-karten.de; geschenkeonline.org; pinterest.com



Showers per see have been known since the beginning of human times. Once people understood that water is not a carrier of sickness, the technical system of a shower was introduced at a facility of the French army (around 1875) to improve hygiene conditions. In early 2001 the combination of shower heard and radios became popular. With the introduction of LEDs, colored showers were introduced to simply generate a good mood or to indicate the water temperature with colors.

As perfumes are often used in bathrooms as well, the prediction is that in the future we will see odors being directly injected into the water stream of a shower head (olfactory).

Sources:
obi.de; pearl.de; logbuch-shurkam.de