

Multidisciplinary team collaboration and communication are not easy

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Abstract

Since the beginning of the 21st century, different fields such as business and engineering have regarded design as an important strategic advantage to innovation because of the nature of design thinking and methods—team-based collaboration, visualizing knowledge, and the user-centred approach, among other characteristics. A good example is the collection of opportunity-defining and problem-solving methods that currently are marketed as ‘design thinking’ and have become the rage in the business press—Harvard Business Review, Business Week and Rotman Magazine, to name a few. At the same time, the design profession is shifting from a design-centric practice to a multidisciplinary design practice that includes more disciplines for research, problem setting, and problem solving. The complexity of today’s design problems—the global economy, rate of change in new technologies, the challenges of sustainability development—requires diverse design teams, comprised of multiple disciplines as well as multiple cultures, to look at broader and different perspectives and larger scopes of investigation. Furthermore, the participation of multiple disciplines is especially relevant at the earliest stages of the design process or at the “fuzzy beginnings”, as different authors relate to them.

Due to the multilayered and multifaceted interactions between team members, effective communication and collaboration among people in multidisciplinary design teams becomes critical to ensure a project’s success, in particular, and for innovation, in general. Yet, team communication and collaboration are difficult. Each discipline brings its own knowledge and perspective to the process, which must be integrated to create a successful design solution. Engineers, for example, tend to be very focused on failure and on technological reliability. Designers, on the other hand, have a tendency to rely

heavily on 'intuition, fit, and feel' when confronted with new problems, and focus on user and context, while business managers are trained to think first and foremost about the needs of the firm and focus on marketing criteria. These differences between design team members can create high levels of skepticism. However, the inevitable conflicts among these differing mindsets have the potential for triggering truly innovative contributions.

This paper explores the communication process between multidisciplinary team members during the initial stages of 18 different design project scenarios, in order to develop a frame of reference for multidisciplinary design team collaboration and communication. Field-focused interviews were conducted with distinct groups of stakeholders from the business, design and engineering professions, using participatory design research methods. Five clusters emerged to be representative of all the design project scenarios narrated by the interviewees. One important characteristic in all clusters was the role of the design managers who were central to the communication flow between key players in the process. They filtered the information from the client, decided which solutions were presented to the client, and selected the team players and the disciplines involved in the project. Consequently, the experience and skill level of design managers was critical in ensuring clear, effective communication among team members, and in fostering new ways of thinking integrated with new tools for the collective creativity.

Keywords: Design Thinking, Multidisciplinary teams, Design Management, Communication Process, Collective Innovation, Design Process.

1. Introduction

In today's dynamic and changing world, design problems are unstructured and ill-defined by nature. Reed (2002) defined an ill-defined problem as one that addresses complex issues and thus cannot easily be described in a concise, complete manner. Complex design problems include issues such as sustainability challenges in products with differing regulations as they are assembled and manufactured in different countries, optimizing the features of an existing car to a new model, a new banking business model, or the visual labeling of universal health-related drugs. In addition, no problem ever exists in complete isolation. "Every problem interacts with other problems and is therefore part of a set of interrelated problems..." explained Ackoff (1974, p. 21). Because of this interconnectedness of problems, the design problem-solving process has to be a multidisciplinary endeavor—functional disciplines working in close collaboration across functions, instead of looking in narrow silos like ergonomics, finance, human factors, product design, or marketing, to name a few. (Martin, 2006; Olson et. al., 2001). Discipline-specific thinking allows for different perspectives to enrich the design process, but also propitiates differences in perception that make negotiations and collaboration difficult. Engineers, for example, tend to be very focused on failure and on technological reliability. Designers, on the other hand, have a tendency to rely heavily on 'intuition, fit, and feel' when confronted with new problems, and focus on user and context, while business managers are trained to think first and foremost about the needs of the firm and focus on marketing criteria. These differences can create high levels of scepticism within teams. Conversely, the inevitable conflicts among these differing mindsets have the potential for generating truly innovative contributions. The challenge is to foster collaboration among all the parties involved while creating effective communication. "Collaboration is a process through which parties who see different aspects of a problem can

constructively explore their differences and search for solutions that go beyond their own limited vision of what is possible” defined Gray (1989, p.5).

The participation of multiple disciplines is especially relevant at the earliest stages of the design process or at the “fuzzy beginnings”, as different authors relate to them. In the fuzzy front end of the design process is when considerations of many natures come together such as exploration and selection of technological opportunities, understanding of users and contexts of use, etc. The goal of the explorations in the front end is to decide what is to be designed or what should not be designed (Sanders and Stappers, 2008). Therefore, it is crucial that the multiple disciplines involved in the design team interact at the earliest possible stage of the process, so that no disciplinary perspectives are overlooked. (Gill and Lilly, 2007).

The objective of this paper is to understand how multidisciplinary teams collaborate and communicate during the initial stages of the design process, from design problem setting to initial problem-solving proposal. This paper, then, is a qualitative research study looking at the communication process or communication flow (activities and interactions between team members) utilized during eighteen different design situations or scenarios by multidisciplinary design team members. The interviews with the professionals were one-on-one and the interviewees were asked to describe the communication flow among stakeholders during the initial stages of a memorable design project, whether the project was successful or unsuccessful. The interviewees were asked to select an example that involved groups comprised of designers, business managers, and/or engineers.

The paper is structured by first giving an overview of the method that was followed during the interviews; and secondly, by analyzing the eighteen design situations described through

diagrams in order to identify patterns and relationships in the flow of communication between team members. As Albarn and Smith (1977) put it, “The diagram can present at a glance what a verbal description can only present in a sequence of statements. It is the ideal mode for describing relations between things.” (1977 p.69). The analysis and synthesis of the diagrams resulted in five clusters of communication and collaboration processes within multidisciplinary teams. At the end, the research findings will generate a frame of reference for successful collaboration and communication within multidisciplinary teams, as well as conclusions and recommendations for the design manager.

2. Methodology

Focused one-on-one interviews were conducted with business, engineering, and design practice professionals from the consumer product industry, service industry, and government agencies in the Dayton and Columbus, Ohio areas. Focused interviews are helpful in finding out in-depth information about a specific situation—important considerations, consequences and feelings (Zeisel, 2006).

Participants were asked to describe the communication flow between stakeholders during the beginning stages of a design project of their choice that involved groups comprised of designers, business professionals and/or engineers, i.e. to describe the different communication activities and interactions that design team members went through during the process from design problem formulation to initial problem-solving proposal. The methodology used for the interviews was to voice record their descriptions (after signing a consent form) and to give them the option of generating a visual narrative of their experience. The interviewees were eighteen professionals: general managers, marketing managers and creative directors with backgrounds in industrial design, interior design, graphic design, marketing strategy, public relations and communications,

mechanical engineering and industrial engineering. Table 1 shows the different interviewees by discipline, team members in the design project described (D=Designer; E=Engineer; B=Business; F=other Fields), the interviewee's work title and type of company, and the design project. They were given a number to make it easy to refer them later when analyzing their design descriptions. The interview combined brief questions concerning the interviewee's discipline, area of specialization, and number of team members by discipline together with open-ended questions, such as reflections on working with other disciplines or how they personally learn about a problem. Primarily, interviewees were asked to explain the communication process from the very first moment they were assigned to work on a design problem until the moment when the design team was ready to provide the initial solutions or recommendations to the client. In other words, the communication process from problem formulation design to initial problem-solving proposal. Additionally, they were given the choice to visually map out the communication process through participatory research methods—generative techniques used to create context awareness by eliciting visual responses from the participants (Sanders, 2005).

Table 1. Interviewees by discipline, team members of the design project/ scenario described, interviewee's work title, company and design project described. D=Designer; E=Engineer; B=Business; F=Other fields.

INTER.	TEAM	INTERVIEWEE'S WORK TITLE	COMPANY	DESIGN PROJECT
D1	1D&1E&3B	Creative Director	Marketing Comm.	Company's Website
D2	1D&4B&3F	Interior Designer	Architecture Firm	High School Library
D3	3D&5B	VC Designer & Faculty	Graphic Design Firm	Signage system for Public Libraries
D4	2D&3E	VC Designer & Faculty	Freelance Artist	Invention Proposal
D5	3D&2B	VC Designer & Writer	Marketing	Adverstising
D6	1D&3F	Ind. Designer & Faculty	University	Interdisciplinary course development
D7	6D&3E&2B	Industrial Designer	Industrial Design Firm	New video game handheld device
B1	5E&5B	Marketing Director	Product Company	New gas hose
B2	1D&3B	VP Marketing & Comm.	Government	Community Report
B3	3D&3B	COO	Marketing	New market
B4	1D&2B	General Manager	Marketing Comm.	Branding
B5	2D&2B&3F	Product Manager	Interactive Media Co.	Animated intro for several newscast
E1	1D&3E&4F	Chief Mech. Engineers	Governmental R&D	Walking machine
E2	3D&3E	Mech. Engineer Faculty	University	Thesis Project
E3	1D&3E	Research Scientist	University	Interface design
E4	3D&3E	Industrial Engineer	Industrial Design Firm	Vending machine
E5	1D&4E&1B	Mechanical Engineer	Welding Firm	Environmental display
E6	1D&2E&2B	Engineer Manager	Welding Firm	Locker system

With this generative technique, participants are asked to make visual maps of their experiences using a set of visual material (such as images, words, shapes, stickers, etc.). They can also add their own drawings, sketches or scribbles. The visual responses of the participants reflect their engagement, inspiration and empathy for the experience (Sleeswijk et. al, 2005). This way, the

making of the map, serves as a vehicle to inform and to inspire memories of the process that they are describing. Sixteen of the eighteen interviewees chose to create visual narratives (Figure 1). In general, all the communication flows described were mapped out as a series of non-linear but chronological events.



Figure 1. Example of visual narratives generated by the interviewees. From left to right: from a creative director (D1), a chief mechanical engineer (E1), and a production manager (B5).

3. Responses and analysis

At the completion of all the interviews, the data collected included: eighteen audio recordings of the eighteen design project scenarios plus answers to the open-ended questions of the interview and the visual narratives supporting the interviewee's verbal descriptions. The data collected were abstracted into diagrams to provide a visual perspective that allowed for the emergence of relationships. As mentioned before, diagrams can present at a glance what a verbal description can only present in a sequence of statements (Albarn and Smith, 1977). But, why abstracted? An abstraction is not only a way to summarize information but it also recognizes the problem at hand to be a dynamic situation. "Problems are abstractions extracted from messes," stated Ackoff, and he defines messes as "...dynamic

situations that consist of complex systems of changing problems that interact with each other." (1979, p.90). The communication process between design team members is a highly interactive process that arises from the relationships and interactions across the parts, not from individual parts in isolation. How the parts of a system and levels of analysis are defined is a matter of perspective and purpose (Beinhocker, 2007). The interviewees only offered the individual perspective of each interviewee, but her/his description of the communication process included the interactions between members as well as the purpose of those interactions to the process.

3.1. Communication activities identified

A general communication process emerged after a first draft of the abstracted diagrams of the eighteen design project scenarios. In all of the scenarios described, the communication process started with an expressed need from a client (individual or team) who searched for recommendations and/or solutions to a design problem. The client was usually from outside the design company, but sometimes it was management from other departments of the same company. During this research, the design company is referred to as the team of professional designers, business and/or engineers that participated in the design project that the interviewee described, regardless of the "real" type of association. The initial flow of information occurred between the client and the representative(s) of the design company, usually the design manager or project manager. During preliminary meetings the client and the design manager defined the perceived needs or design problem. Then, the design company initiated its own process of generating ideas and/or design opportunities in a more or less collaborative and inclusive way in order to present recommendations or possible solutions to the client. So, in general, the communication process in all design scenarios could be broken down into the following three communication activities (see Figure 2):

- 1.The communication interactions between the client and the design company for the purpose of defining the problem or perceived needs.
- 2.The communication interactions between the team members of the design company for the purpose of generating ideas and opportunities.
- 3.The communication interactions between the design company and the client for the purpose of presenting solutions and/or recommendations.

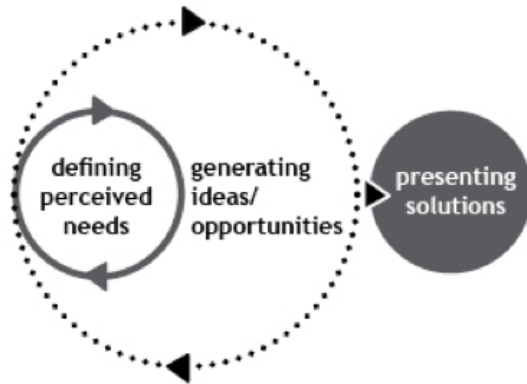


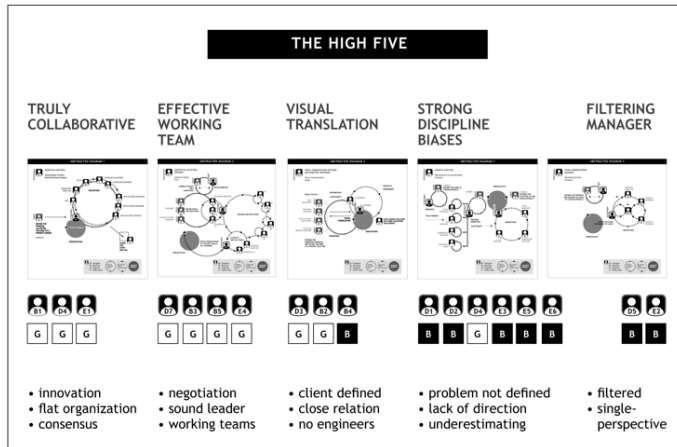
Figure 2. The three general communication activities identified in the communication process of the eighteen design scenarios described by the interviewees.

3.2. Abstracted diagrams—the high five

Each design project scenario was diagrammed considering the following characteristics: which members and disciplines participated and when in the communication process (hierarchy of the design team and communication flow) and their approach to a design problem (how it was formulated and by whom). From the 18 design project scenarios diagrammed, five clusters emerged to be representative of all scenarios. The similarities and commonalities were based on the communication activities in relation to the client, the design manager, and the participants; and the approach to design. The high five clusters that came into view were named Truly Collaborative, Effective Working Team, Visual Translation, Strong Discipline-Biases, and Filtering Manager after their approach to design. Figure 3 shows a summary of the five clusters, with a thumbnail of the five abstracted diagrams representative of the 18 design project scenarios, and the interviewees that correspond to each model with their consideration of the design project success (G for good process and B for bad process). The measure of success of the communication flow was mainly determined by what the interviewee expressed. For example, the marketing director (B1) expressed the success of the design project described by saying “we were able to present new innovative concepts to management in just three days”; while a very unsuccessful design project scenario was expressed by the creative director (D1) saying “it was a nightmare of process and outcome”. At the bottom, figure 3 offers a brief summary of each cluster’s approach to design.

Figure 3. Five clusters emerged to be representatives of all the 18 design project scenarios.

G = good process, B = bad process.



3.3. Truly Collaborative

This cluster represents the design scenarios described by a marketing director (B1), by a visual communication designer (D4), and by a chief mechanical engineer (E1). It stands for the most successful communication flow because (1) it was specifically expressed as most successful by the interviewees, and (2) it had three critical issues common to effective teamwork: shared leadership, fast and creative start, and consensus on the team's recommendations, (Katzenbach and Smith, 1993). The common characteristics of this cluster are:

- Approach to design: search for innovation from a well defined problem
- Consensus: whole team agreed on a presentation for decision-making
- Learning process for all
- Flat organization
- Extensive use of drawings and sketches for idea generation, use of a collective visual perspective of the project for conceptual development and the use of rough prototypes for presentation that elicited stronger connections between the team members.
- A scribe for every meeting

Clearly defining the objectives for solving the design problem was one of the key assets for good team collaboration in these three design project scenarios. In general, the flat hierarchy and the clear awareness and understanding of all the roles and skills present at the table were important to the success of the communication process, as the interviewees expressed. The attitude and disposition of the participants were fundamental to the team's achievements—the visual communication designer (D4) expressed that the project was built through “education, communication, culture, and research... became a learning experience for the entire group and the process generated new opportunities.” The comment that new opportunities arose from the team's collaboration process was also a general one to all three scenarios. Sharing leadership was another key asset, according to the chief mechanical engineer (E1). This participant pointed out the importance and relevance of the success of the design project, to having different field-based perspectives in the team with an overall agreement in the fundamental constraints of the project, and to having a clear knowledge of users.

3.4. Effective working team

The second cluster represents four design project scenarios described by an industrial designer (D7), by a Chief Operations Officer (B2), by a product manager (B5), and by an industrial engineer (E4). They all happened to be also the design managers of the project, except for the industrial engineer E4. This group stands for another successful communication flow as the interviewees specifically expressed it. The common characteristics of this cluster are:

- Approach to design: effective working teams to develop somebody's vision.
- Hierarchy: Leaders of the fields implied in the project (design company's team) were involved in the initial meeting with the client's team.
- Designers and engineers in two separate working teams generated ideas individually and presented them collectively.
- Different disciplines performing separate tasks.
- Design manager decided which ideas were presented to the client
- Design manager followed a well-defined working process.
- Extensive use of the client specifications and research and the design manager's design brief to define the design problem.
- Drawings and 2D/3D sketches, made mostly by designers, were used for discussion and conceptual development between the diverse disciplines.
- Interactive collaboration through PowerPoint Presentations (PPT) and marked-up pdf files.

In summary, the design manager developed the design brief and set the agenda with the client, assigned tasks to leaders of working teams, and decided which recommendations were presented to the client. Consequently, depending on the skill level and expertise of the design manager, the project might be successful, like in these cases, or a failure, as we will see in the

description of the group of scenarios named filtering manager. According to Katzenbach and Smith (1993), working groups have a strong, clearly focused leader; are individually accountable; the group's purpose is the same as the broader organizational mission; generate individual work products and discusses, decides, and delegates. On the other hand, teams have shared leadership roles; are individually and mutually accountable; have a specific team purpose that the team itself delivers; develop collective work products; discusses, decides, and does real work together; encourages open-ended discussion and active problem-solving meetings; and runs efficient meetings.

3.5. Visual translation

The third cluster represents three design project scenarios described by a visual communicator designer (D3), by a marketing and communications director (B2), and by a general manager (B4). The latter didn't consider the communication process to be successful, although shared the same process as the other two, whom considered it to be profitable (the client's expectations were met, although the visual communication designers involved weren't specially happy with the end results). The common characteristics of this cluster are:

- Approach to design: visual translation of a solution to a marketing problem. The client conceptually defined (with words) the solution and its expectations were of an attractive and easy to use visual product.
- Close collaboration between client and designer
- Design participants felt the need to "educate" the client about visual literacy
- Heavy involvement of visual communication designers
- Client team outnumbered the design team on average of 3:1 ratio
- No engineering participation
- Extensive use of 2D mock-ups mounted on boards (original

drawings and sketches or computer printouts) for feedback and discussion. They also served the client for its internal communication process.

These scenarios portrayed the many cases where design is built client driven (from the client's expectations down to a final product) instead of user driven (from users needs up to final product). In the three cases, the client had a clear idea of what they wanted, could communicate it verbally, but the outcome of the idea was a graphic product, so they needed a graphic designer to produce it. In the scenario described by the visual communication designer (D3) the client commissioned a graphic design solution to a marketing problem. This was the same case of the scenario described by the marketing and communications director (B2), where the client decided the need of a graphic design solution, mainly because that was the solution used by the leading companies in the client's sector. So, the role of the visual communication designer was to visually interpret the idea in a set of sketches and drawings, until client's approval, instead of utilizing the designer's "visual translation" skills to define the problem and look for a solution together. Overall, in all three scenarios, designers had to get around the many constraints the client's idea imposed, including their expectations. For the designer to make a meaningful visual representation, she/he has to have clear information of what the client is looking for, which problem she/he is trying to solve, and not working from the solution. As the general manager (B4) put it, "...you have to 'educate' the client to prioritize information, understand what we do beyond pretty graphics, and to prevent solutions that generate bigger problems."

3.6. Strong discipline-biases

The fourth cluster stands for an unsuccessful communication process, because, in general, the different team participants in the design project had their own agenda, set of priorities, and

expectations of what the solution should look like, that made collaboration very difficult. This cluster represents six design scenarios described by a creative director (D1), by an interior designer (D2), by and industrial designer (D4), by a research scientist (E3), by a mechanical engineer (E5) and by a mechanical engineer manager (E6). The common characteristics of this cluster are:

- Approach to design: "Organize this. Make it look good."
- Problem not defined
- Lack of direction—no specific budget, not clear who was the final decision-maker within the client's team
- Research not formally done: project commissioned without testing the feasibility of its content
- Strong cultural biases between disciplines
- The company's management formed the design team
- Wide use of word lists (list of needs, list of goals, and list of ideas)

"I just want something similar to this," said by a client to a designer, pointing at an example of a website, a periodical, an environment or a logo, is a very common situation in the design practice, specially in the visual communication design and interior design practices where the search for innovation is not a key factor as it is in the industrial design practice. Business owners, marketing directors or business management from the client team tend to point to a solution of their liking, usually by just considering the aesthetics of that solution, assuming that the designer's role will be to design a creative tweak to that desirable solution. On the other hand, the command "make a working model from this drawings" is what mechanical engineers receive more often than not from the client's design team, as the analysis of this scenario shows.

The clash between disciplines is the most common characteristic

with all six scenarios in this cluster. For instance, the way that an interviewed engineer started the collaboration with a designer was: “Content is 99% done, please make it look better” (E3). And, the way two interviewed mechanical engineers (E5 and E6) first heard about the design problem was: “Given the design drawings, please make a working model.” The design problem in both examples was defined with the sole perspective of one discipline without considering the other disciplines’ constraints and perspectives, or, in another words, underestimating the relevance of the other disciplines. Also, in three out of the six situations management personnel outside the design team made final decisions about recommendations to the client, which also speaks to the general lack of understanding of the design process and the roles and skills of the disciplines involved from business professionals. Business professionals tend to narrow the scope of the design process to a production process without including the strategic thinking and conceptual development characteristics of it. Reflection of this idea is the business management tendency (cases D1, D2 and D4) to select design team members based on the production needs of different parts of the design problem, rather than based on their domain perspective and team capabilities. This way, members of the team are set to compete between their different sets of priorities instead to collaborate.

In sum, regardless of the domain discipline describing a design project, common factors to an unsuccessful communication flow in multidisciplinary teams during the initial stages of the design process are: the lack of a cohesive team, the lack of awareness and understanding of the roles and skills of all the stakeholders, and the lack of a well-defined problem.

3.7. Filtering manager

The fifth cluster represents two design scenarios described by a visual communication designer (D5), and by a mechanical engineer (E2). This is another representation of an unsuccessful

communication process, in this case, due to self-willed design management. The common characteristics of this cluster is:

- Approach to design: Ideas filtered by one individual/single perspective

These two scenarios described by D5 and E2 reinforced the importance of the experience and skill level of the manager in any design project, as previously discussed in the effective working teams cluster. Design managers can go beyond filtering ideas, to “kill” them, as reflected in the scenario described by the visual communication designer (D5): the design manager constantly killed all the ideas that were not in his comfort zone of communicating them to the client. Filtering or killing ideas can also occur because a strong ego is not accepting ideas from others.

4. Conclusion

Successful multidisciplinary design teams recognize and define information relevant to their purpose, consider problem-solving methods, resolve alternatives, and test solutions, through developing collaborative ways of thinking and communicating results. The frame of reference for successful communication and collaboration within multidisciplinary teams is formed by the concepts that described why, with the complexity of today’s design problems (where), it is required the integration of multidisciplinary teams (who) to discover, understand and define the design problem, and develop strategic solutions, especially at the initial stages of the design process (when). Because multidisciplinary team collaboration is difficult, design thinking, with its reasoning and resolution tools, is what will hold the frame together to solve complex design problems. For innovation to emerge within multidisciplinary teams, the Institute of Design at Stanford (2009) believes that “...having designers

in the mix is key to success in multidisciplinary collaboration and critical to uncovering unexplored areas of innovation. Designers provide a methodology that all parties can embrace and a design environment conducive to innovation. In our experience, design thinking is the glue that holds these kinds of communities together and makes them successful.”

This paper has identified the critical new role of design managers as catalyst of not only ensuring clear, effective communication among team members, but to foster new ways of thinking integrated with new tools for the collective creativity. New ways of thinking that combines a truly horizontal and interdisciplinary structure, a commitment to maintain a focus on people’s needs and customers and other stakeholder values, and a system that begins with an emphasis on qualitative methods of discovery are the foundation for successful multidisciplinary design teams. (Cagan and Vogel, 2002). Further research will be required to redefine the expanded field of design management, from new innovative methods of creative problem solving, to new areas of team building expertise.

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