# Contextualizing Design Thinking with Multiple Intelligences

## The Global SUGAR Program as a Case

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# Motivation

The world has massively changed over the last ten years. Under the umbrella of Digital Transformation (Vega & Chiasson, 2019) and Digital Innovation (Nambisan et al., 2020), new technologies have arisen in the past decade. Information is available at our fingertips via a Smartphone, which has led to a new communication culture between people and organizations. Artificial intelligence is becoming a mature technology that not only influences standardized work routines in daily life but also adds value through the ability to identify patterns that have been invisible to humans in large data sets (Haefner et al., 2021).

As part of this transformational process, firms have changed their business models from a product-driven approach towards a service-driven one, digital platforms, and even digital ecosystems (Anthony et al., 2019). For example, Netflix revolutionized the movie and TV industry by introducing the most famous cloud-based video broadcasting platform. As a global motor vehicle manufacturer, Tesla redefined the future's mobility by focusing on autonomous and purely electrical cars while traditional car manufacturers still lag behind in this area (*Tesla*, 2018). Facebook shaped communication among people of all cultures through their messenger applications in unforeseen ways.

This new generation of companies consistently reshapes business from a national and continental focus towards a global claim. In such multinational organizations, employees work more and more in intercultural and interdisciplinary teams (Molinsky & Gundling, 2016). Further, the time for developing new products and services is getting faster as well (Smith & New Product Dynamics, 2000). While in the past, typical development cycles took months or even years, today technology enables cycle times of days or weeks shaping and responding to increased digital services in the global economy.

Along with these developments, society has changed as well. Although these trends have already existed for decades, sustainability and ecology are of increasing global importance (Neshovski, 2021; NZZ, 2021). As a result of industrialization, climate change progresses much faster than centuries ago (UN, 2021). The effects are becoming visible in our daily lives, such as global warming causing economic damage in unforeseen ways (WWF, 2021). Change has also happened in the educational sector (Govindarajan & Srivastava, 2020). The balance of teaching has evolved from a largely analytical approach to one that incorporates emotional and social intelligence (Miller, 2015). Due to globalization and the increasing role of technology, children and young adults have to acquire early in life skills to be able to socialize with others (Miller, 2015). Especially artificial intelligence

technology will compete with humans on highly standardizable activities and tasks in the future. Scientists predict that the ability to socialize and be creative is a competitive advantage of humans over machines. Starting in kindergarten, kids and young adults learn besides foundational courses, like math, physics, and languages, soft skills in teamwork, collaboration, and communication. The same is observable for life-long learning trajectories.

Due to the recent global pandemic crisis, all of these developments have accelerated.In schools and universities, the adoption of online teaching formats happened virtually "overnight." (Anbarci & Hernando-Veciana, 2020; Govindarajan & Srivastava, 2020) The business world responded similarly in a reaction never seen before: online and home office work have become ubiquitous. Many experts argue that this change will last forever, altering our ways of working and knowledge acquisition permanently (Fogarty et al., 2021).

As a consequence of this change, the educational sector, including kindergartens, schools, high schools, and higher education institutes, must address society's evolving needs for future work skills. The World Economic Forum predicts that 50% of all employees will need reskilling by 2025 (Whiting, 2020). Our next generation of talent must be fit for global collaboration, readily trained for new work paradigms, and have a high intelligence for emotion and resilience (Davies et al., 2020). At the forefront will be training in critical thinking, problem-solving capabilities and solving complex problems while being creative (Whiting, 2020). By 2030, our future workforce must be able to tackle mostly non-repetitive, cognitive and highly skilled tasks (Willcocks, 2020) since machines will progressively take over repetitive activities. Due to workforce specialization, new capabilities also need to be consistently developed, via continuous learning, and this will require tolerance for ambiguity, self-motivation and the ability to collaborate.

The following article will focus on the SUGAR network (*SUGAR Network*, 2015). SUGAR network is based on a global Design Thinking program where high standing universities, their students and corporate partners collaborate to solve complex challenges set by the corporate partner. Part of the networks' mission is to educate students beyond the corporate challenge of addressing the mega-trends mentioned. The article will highlight the different development stages of the network (and will take) to educate people with intelligence needed by the world—through design thinking.

# The SUGAR program for Design Thinking education

SUGAR's current quest is *"SUGAR wants to create impact by uniting universities and industries across the world to promote an alternative education, where students have ownership of the projects and are encouraged to be passionate about learning. SUGAR provides a platform to share knowledge and empowers students to solve real-world problems based on human-centred, conscious [[,] and responsible design."(SUGAR Network, 2015)*. The shared vision of all participating faculty members can be framed as a "mission-based learning" approach (Yueh-Chun Shih & Nian-Shing Chen, 2002). Students of all disciplines work together on existing and real problems and thereby discover and apply appropriate science theories. As stated by Shih and Chen, mission-based learning approaches embrace risk-taking, persistence and learning by error (Yueh-Chun Shih & Nian-Shing Chen, 2002).

In the following, we will briefly describe the SUGAR network's historical roots, including its members. Further, we will describe SUGAR's Design Thinking approach that guides all participating members, and the global network's organizational structure. Finally, we will show three concrete project examples of the past.

## Historical roots and members

The SUGAR network established itself in 2010 as a "sister program" to the famous Mechanical Engineering 310 (ME310) program at Stanford University (Tamara Carleton, 2019; T. Carleton & Leifer, 2009). Among the first participating universities were the Hasso Plattner Institute in Potsdam (Germany), the University of St.Gallen (Switzerland), Javeriana University in Cali (Columbia), and Aalto University in Helsinki (Finland). The mission was twofold. The first aim was to manifest a new educational paradigm among the participating members. The second objective was to grow the network (if possible) to all continents to reach out to as many students as possible. The network grew to 18 core university members on all continents except Africa in the subsequent years. The wider network counts more than 25 members (*SUGAR Network*, 2015), brought together by shared values in design thinking pedagogy. Part of SUGAR's philosophy is that member universities do not have to belong to a specific scientific discipline. Instead, the network is open to facilitate every scientific direction like computer sciences, mechanical engineering, business administration, design, and architecture (Wiesche et al., 2018).

Thereby, the network has collaborated on more than 220 projects with industrial partners from all industries globally over the last ten years. Our analysis revealed that the top four sectors are automotive & mobility, software, consumer products, and pharmaceutical. Such well-known organizations as Takeda (pharmaceutical industry), BMW (automotive industry), SAP (high-tech), Electric Mobility Norway (utility), and UBS (financials) have participated.

## SUGAR's approach to Design Thinking

SUGAR's pedagogical approach roots back to the Design Thinking teaching philosophy at Stanford University (Tamara Carleton, 2019; Uebernickel et al., 2020). While it seems complicated to conceptualize what Design Thinking is in general (Micheli et al., 2019), the SUGAR approach has two distinct dimensions that are characterizing: (1) the mindset and cultural understanding of Design Thinking and (2) the activity/process layer of Design Thinking (curriculum) (Brenner et al., 2016).

By looking at the first dimension, "mindset and cultural understanding", the SUGAR approach is based on six principles partially described by Micheli et al. (Micheli et al., 2019) in their seminal work.

*Human-centeredness:* Being human-centered is interpreted in the SUGAR philosophy to mean that the human being, as the receiver of innovation outcomes and person affected them has to be at the center of all design considerations. Many authors such as Brown (Brown, 2008) support it is the most essential feature of design thinking. The Design Thinking project team should anticipate the individual's full context and surroundings by involving the human being in all design considerations. A clear distinction between a human and a user or customer is essential to make. The notion of a user provides a limited view on a human that is willing to use a dedicated product or service, while the human itself is not constrained by this. In SUGAR projects, this opens the possibility to anticipate a more extensive problem space for identifying new opportunities and designing comprehensive solutions. Qualitative field research is a standard methodology to realize human-centeredness through common techniques like interviews, observations or self-immersion sessions.

*Iteration and experimentation:* SUGAR projects are iterative and foster experimentation throughout the process (Uebernickel et al., 2020; Wiesche et al., 2018). As part of the curriculum, each SUGAR

project has to go through at least seven iteration phases. Each iteration cycle takes approximately 3-4 weeks (Uebernickel et al., 2020). The first three iteration cycles aim to expand the problem scope and deepen the problem understanding, while the last four iterations focus on developing a solution.

*Ambiguity and failure:* Solving wicked and complex problems requires dealing with ambiguous situations (Buchanan, 1992) and failures in between. SUGAR teams experiment and iterate often with a "trial and error mentality" (Micheli et al., 2019) to gain insights into the "real" problem and to identify valuable solutions. Failing in each project's context is seen as an active engagement in learning. The faculty regularly initiates reflection sessions with each team to facilitate the learning. The explication of failure situations in these sessions helps gain valuable insights for the project.

*Prototyping: "Ideas are not real, be real. Prototypes allow you to get in touch with your reality."*[1] Prototyping stands in SUGAR projects for doing and thinking simultaneously. Building solutions in the form of prototypes offers the team the possibility to explore ideas, communicate solutions, test them with people, and refine them on the go. Since SUGAR project teams deal with complex problems, it is often difficult to share ideas across team members or potential users and customers. In such situations, materialized ideas in the form of prototypes, can help overcome these barriers. Furthermore, prototyping is facilitating a process of thinking at the same time. While building a prototype, people think about their doing simultaneously, which helps to see flaws and potential improvements early in design development. On average, each team is building up to 40 prototypes as part of their project (Uebernickel et al., 2020).

*Interdisciplinary collaboration:* The complexity of today's problems requires diverse-disciplinary expertise and perspectives to analyze the solution's situation and development. Therefore, SUGAR project teams are always composed of team members with diverse educational backgrounds (Tamara Carleton, 2019). Interdisciplinarity ensures different angles on the problem like a business, technical, or marketing view. Typically, the participating universities are providing this dimension.

*Intercultural collaboration:* The SUGAR network believes in the power of intercultural collaboration (Brenner et al., 2016). By their nature, most challenges are complex and require consideration from different perspectives. Thereby, people with diverse cultural backgrounds help analyze problems more thoroughly with a "360-degree" approach. In some situations, teams might perceive these different views as contradictions and cumbersome to talk about, but the cultural-based differences help to understand and explore the problem with greater depth and comprehension.

Secondly, the SUGAR network curriculum follows a semi-standardized process model (Tamara Carleton, 2019; Uebernickel et al., 2020; Wiesche et al., 2018). Each of the seven phases represents one iteration. The process model enables the network to collaborate across universities, faculties, countries, and language borders. It synchronizes all participating universities' main activities throughout the nine-month program. Furthermore, it provides a clear structure for the engaged corporate partners too. While the core activities are defined, the outcomes and methods are not. These depend on every phase and the specific corporate design challenge. Moreover, the particular education background of each student matters. The stages are as follows:

*Design Space Exploration Phase:* As part of the design space exploration, the Design Thinking team focuses on the problem context and design challenge provided by the corporate partner. The aim is to

[1] Reference: slidedeck from Alexander Grots

gain a profound understanding of essential project stakeholders, relevant technological and societal trends, as well as existing knowledge through a process called “instant-expertise”. This approach involves activities of needfinding, benchmarking and problem framing, and draws on methods such as observation, interviews and data mining.

*Critical Function Phase:* In this phase, the project team approaches the first insights and opportunity fields gleaned from design space exploration through prototyping. The team is pushed to think about specific functions or features of a design idea instead of focusing on larger systems. Each specific feature represents a critical function addressed by at least one prototype that is simple and quickly created. The simplicity is essential because most prototypes will fail. Why? Because in this early project stage, the Design Thinking team is mostly basing its knowledge on assumptions that are challenged by these prototypes. A careful analysis of the failures will eventually lead to meaningful learnings for the project team to align designed outcomes with human needs.

*Darkhorse Phase:* The darkhorse phase challenges existing project boundaries that might limit the Design Thinking team in finding creative solutions. It aims to foster potentially groundbreaking solutions by pushing the team to think about the unthinkable. The guiding motto is dissent and not consent within the team and potential customers. This stage’s outcome is usually several futuristic prototypes that challenge the status-quo and contain insightful elements for a possible design solution.

*Funky Phase:* The funky phase intends to lineate the previous three stages’ results into a few general solution concepts. The most promising critical function and darkhorse prototypes are selected and inform the development of larger systems and concepts based on user testing and feedback. This stage further marks the inflection point between the diverging and the converging phase in a Design Thinking project.

*Functional Prototyping Phase and X-is finished Phase:* Both stages aim to refine the system solutions from the Funky prototyping phase. Generally, the Design Thinking teams increase the funky prototypes’ resolution and fidelity. Frequent user testing happens during these phases, but with the intention directed largely toward feasibility and viability testing rather than desirability testing.

*Final Prototyping Phase:* The final iteration of a SUGAR project is the final prototyping phase. This phase aims to use a high fidelity prototype to see the most relevant functions and features. Part of the prototype is technical systems, such as computer programs and mechanical components, as well as the business model, form and interface designs, and marketing details.

Across these seven phases, SUGAR curriculum follows a standard Design Thinking routine that is typically described in an iterative process of five steps (Brown, 2008; Wiesche et al., 2018)). The process starts with the problem definition. As part of this, students explore the boundary conditions of the given challenge, which can involve constraints and assumptions. Typically, the teams use standard mapping techniques to gain a comprehensive overview. The Needfinding and Benchmarking follow this step. The focus shifts towards achieving empathy for the environment, users and stakeholders to gather real data (Köppen & Meinel, 2015). Students conduct field research techniques such as interviewing, observation and immersion sessions. These sessions happen in the field, whether the needed participants are located in the neighborhood or other regions and countries.

Combined with the Needfinding and Benchmarking, teams conduct regular synthesis sessions. The aim is to distil new knowledge from the gained data pool. Typically, students search for new insights,

opportunities or contradictions. As part of the third step, the teams turn the outcomes into several "how might we questions" (HMW) (Berger, 2012) for the ideation step. By considering all the knowledge, each team conducts intensive ideation sessions to find potential solution ideas for each outcome of the synthesis step. The number of proposed solutions can easily exceed several hundred for average projects. Exciting or useful ideas are prototyped as part of step four by the student team. The notion behind the prototyping step is to make ideas tangible. This tangibility aspect helps communicate the results with their group and test them through prototypes. Finally, the student team tests selected prototypes with users and stakeholders. The aim is to verify or falsify the design team's underlying assumptions. Testing failures are opportunities to change existing beliefs and help the design team to learn and reflect.

## Organization of the SUGAR network

The SUGAR network is a global movement. Rather than the lead being taken by a designated institution, the network itself takes this position. The network trusts in its self-organizing capability. Each participating university is responsible for acquiring corporate partners to get involved in the Design Thinking program. Contracts between the network entities, like corporate partners and universities, are organized decentrally.

A team of students consists of 6-8 students who join from two universities on a micro-level (Tamara Carleton, 2019). Such a team collaborates with a corporate partner on a given design challenge. Each team is supported by a teaching team (usually two faculty members) every week.

Enablement, enactment and communication are the three underlying teaching principles. Large group meetings (LGMs) are conducted once or twice per week at every university. The intention of such meetings is to enable the student teams to understand the given problem space and solve it later as part of the design process, by means of methods, tools and theoretical knowledge. LGMs aim to teach students the essentials of Design Thinking. Small group meetings (SGMs) strongly focus on coaching and enactment by supporting the teams to overcome any mental barriers of the knowing-doing gap. In each SGM session, specifically adopted techniques are practiced together with a faculty member for a given design challenge. Lastly, slightly unorganized design sessions (SUDS) aim to build an open-innovation mindset among the entire student group at each university. These sessions promote social and agile interactions, where strong bonding between students, faculty and corporate partners can grow over time.

Besides the project outcome in the form of a prototyped solution to address the given problem, students have to provide two other main deliverables as part of the curriculum. The first deliverable is the documents . The documentation consists of a final report and one or two reports on the work in progress at key milestones. The intention is threefold. First, the documents validatet the project progress and its final state. Second, students demonstrate their experise in writing scientific-based documents with high quality. Third, students use the reports to reflect on their learning progress. While bringing the project into a sequence, students think about their doings and can draw additional learnings.

The second main deliverable, are presentations. Students have to present verbally and visually to an audience their project progress three times throughout the course of the project. Typically two of the three presentations happen in an international setup where students from all SUGAR member nations

meet together and exchange through a presentation on their project progress. This format, somewhere between a hackathon and a symposium,sharpens the students' presentation and communication skills.

## Project examples and successes

Since the SUGAR network's foundation, companies and student entrepreneurs have brought 44 successful product and 131 service innovations into the market[2]. Table 1 shows the four different project outcomes and implementation results..

| Outcome type | Description | Examples[3]/ Industries |
|---|---|---|
| Startups | Startups are freshly established organizations based on the SUGAR project outcome. Either set up together with the corporate partner or entirely funded by a third party. Students are usually involved in some degree in the startup. | ● Vimcar<br>● Visense<br>● Swissify<br>● Mimi |
| Corporate products or services | The SUGAR project outcome is translated into a corporate product or service offering. Often student team members get hired by the corporate partner to drive further implementation. | ● Wheeboo<br>● Miira |
| Non-for-profit products or services | Similar to the previous category, SUGAR project outcome are transferred into a non-for-profit product offering. | ● Resilyou[4] |
| Influence products and services | The majority of SUGAR project outcomes influence existing corporate products and services by either enhancing particular product features or adding new product components. | ● Software<br>● Banking & Insurance<br>● Automobile<br>● Lighting<br>● Utility |

**Table 1:** SUGAR network outcome types

In the following, we briefly describe three exemplary product and service innovations from the first and second category: Flemo / Vimcar, IRIS / Visense and Yanmar. The interested reader can find more projects on www.sugar-network.org.

### Flemo / Vimcar (Startup)

The project Flemo was initiated in 2011 by the Universities of Modena and Reggio Emilia (Italy) and St.Gallen (HSG) (Switzerland) together with a corporate partner from the automobile industry. Together, they defined the following design challenge for the student team *"Redesign the user experience for current and future automobile customers in the context of mobility and connectivity."*[5] The project team invented a modern and fully digital car sharing and fleet management solution for private and professional customers in 2011 - called Flemo. At this time, the group decided to implement the fleet management component for small and medium-sized enterprises (SME) as a startup in Germany. The two founders' conviction and passion for revolutionizing SMEs' market drove

[2] Based on a internal analysis
[3] Vimcar (www.vimcar.de), Visense (www.visense.io), Wheeboo (www.wheeebo.com), Miira (www.miira.ch)
[4] A project with the protestant church in St.Gallen (Switzerland)
[5] based on internal documents of the University of St.Gallen and University of Modena and Reggio Emilia

the decision. The value proposition of Flemo is helping SMEs manage carpooling more effectively and efficiently by saving operational costs and potentially even state taxes.

Today, Vimcar has established itself in Germany and the United Kingdom. The company manages more than 100,000 cars every day. According to Vimcar, more than 160 employees of 26 nationalities work at their Berlin headquarters (Vimcar, 2021). Interestingly, the first part of their initial idea - the sharing of private cars within a city - is independently and successfully realized by getaround.com in the United States of America (*Getaround*, 2021).

## IRIS / Visense (Startup)

Visense started as a SUGAR project in 2019 as a collaboration between the Hasso Plattner Institute (HPI) at the University of Potsdam (Germany) and the University of St.Gallen (HSG) in partnership with the automobile manufacturer BMW Group. The interdisciplinary team of computer scientists (HPI) and business students (HSG) started with the design challenge to establish a data-driven working model in BMW's factories (Haskamp & Uebernickel, 2020). The aim was to further reduce machine downtimes at the production floor. As Haskamp and Uebernickel state, such a downtime can cost up to US $22,000 per minute (Haskamp & Uebernickel, 2020).

Applying the SUGAR network's Design Thinking process helped the interdisciplinary student team investigate BMW's factories many reasons for machine breakdowns and the opportunities to prevent and/or fix them. Based on more than 60 interviews, 15 company visits and over 30 prototypes, the team invented a new, fully automated monitoring solution, to detect quickly repetitive failures at the production floor (Haskamp & Uebernickel, 2020). The production engineer and production quality manager benefit greatly from this invention, as they usually have great difficulties in comprehending intricate failure patterns in automobile production. The product consists of specially designed high-resolution cameras combined with a secure artificial intelligence module to detect failures visually and based on machinery data.

Nowadays, Visense operates in Germany (Potsdam) and Switzerland (Schaffhausen) as a newly founded startup. The three founders are former students of the SUGAR project at the HPI and HSG.

## Wheeebo (Corporate Product)

The project Wheeebo started as a SUGAR network project in 2016/2017 as a collaboration between the Kyoto Institute of Technology (Japan), Swinburne University of Technology (Australia) and the engine manufacturer Yanmar (Japan). As a design prompt, the student received the following "*Explore new opportunities for products and/or equipment relating to water leisure that provides a 'wow' experience for the user*." Guided by the Design Thinking process and mindset, the team did comprehensive field investigations in Australia and Japan. The intercultural and interdisciplinary design team analyzed several opportunity fields through intense prototyping and testing.

**Picture 1:** Wheeebo - The final product of Yanmar

After numerous iterations, water sports seemed to be the field with the most potential for innovation. In both countries, the team quickly identified that surfing on the water is naturally only possible if the wind is blowing. Furthermore, people need a lot of practice in windsurfing. As part of their ideation and prototyping sessions, the team invented Wheeebo (Picture 1) (*Wheeebo/Yanmar*, 2020). Wheeebo is a surfboard that does not require wind. A small water turbine below the disc propels the board. A sensor array can detect shifts of the user's center of gravity and drives the board in the desired direction. With Wheeebo users are able to drive approx. 3-4 hours around without additional power charge (*Wheeebo/Yanmar*, 2020). Yanmar implemented this idea immediately after the final prototype was finished. The product is now available in Asia.

## The evolution and revolution stages of the SUGAR program

While the SUGAR network's genesis happened two years before the network was founded in 2010, the roots of the movement reach much further back in history. The engineering curricula, including the design practices, was likely put into practice during the 1960's. (T. Carleton & Leifer, 2009). A constant cycle of evolutionary and revolutionary phases has taken place in Design Thinking development since then. In general, prolonged growth periods that are usually "quiet" and with "modest adjustments" are defined as evolutionary stages ("Evolution and Revolution as Organizations Grow," 1998). Evolutions stand for stability. According to Greiner, such a phase lasts between 6-8 years ("Evolution and Revolution as Organizations Grow," 1998). In contrast, revolutionary stages require effective teaching and curriculum adjustments. External factors are triggering revolutions and force us to change beyond the obvious and ordinary ("Evolution and Revolution as Organizations Grow," 1998). Such external triggers include growth of the network with the addition of new universities, the availability of new digital tools (like Slack and Miro), or global trends such as those described in the introduction.

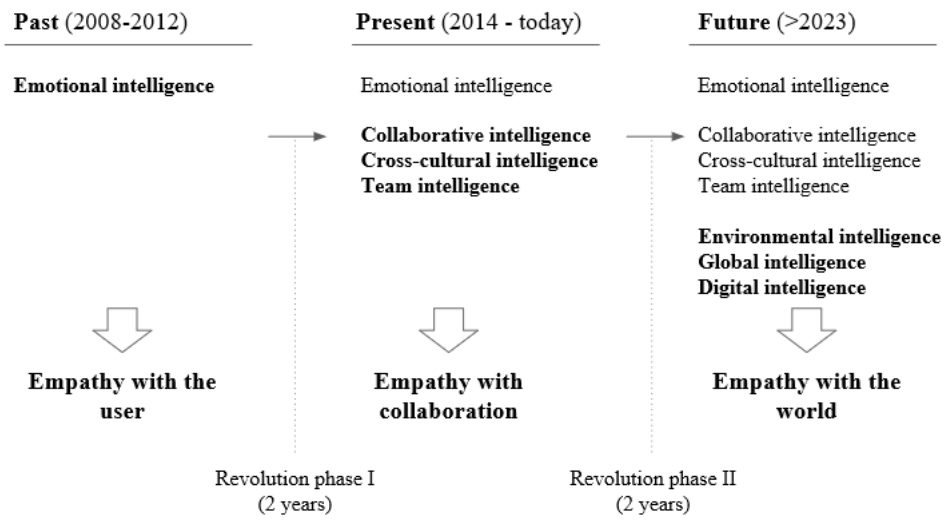


**Figure 1:** Modes of intelligence as part of the SUGAR program

We will describe the evolution and revolution stages of the SUGAR network in the following. The starting point for our analysis is the year 2008. The "past" represents the time between 2008 and 2012 (5 years), the "present" stands for the period from 2014 until today (7 years) as the future defines the year 2023 and onwards. The transformations in between will be described as revolution phases.

Our focus is primarily on students' learning objectives as part of the curriculum. In analogy to Gardner's multiple intelligences (Gardner, 2011), we define each evolution phase of the SUGAR network with its respective, intelligence types to focus our teaching efforts. Each intelligence type requires a set of skills and capabilities for students to learn. In this context, we understand intelligence as the individual's ability to adapt effectively to the environment (Ang et al., 2013). We explore the past, the present and the future of the SUGAR network through dedicated lenses of different and multiple intelligences[6]. Table 1 summarizes our rationale. In the following, we will elaborate on the three evolution stages.

## The Past - Empathy with the human

In the early phase of the SUGAR network, the responsible faculty of the participating university was highly focused on the program's core. This focus meant developing and implementing the necessary infrastructure—like processes—in the organization and curriculum. From a pedagogical perspective, the aim was to focus on the design mindset and build our students' emotional intelligence at that time. In the context of a Design Thinking program, we define emotional intelligence (EI) in a similar way as Salovey and Mayer: *"the ability to monitor one's own and others' feelings and emotions"* (Salovey & Mayer, 1990). The development of the individual student was the center of our efforts.

*Emotional Intelligence (EI)*

[6] Klein discusses and elaborates on some of Gardner's multiple intelligence theory shortcomings' (Klein, 1997). We are aware of this discourse in science, nevertheless interpreting the "multiple intelligences" as a lens to help us structure the development of the SUGAR movement.

The observation of students guided the thinking and rationale of the faculty. For example, often new students were not aware of their surroundings, such as team members and users, or they were poorly equipped with learned techniques to be mindful of their own biases. This led to the development of a first generation curriculum that targeted the students' EI.

With Needfinding techniques, including an Empathy Map or Persona, we helped students become aware of users, team members, and other stakeholders' emotions. Through early prototyping and fast testing techniques, students learned the benefits of an iterative Design Thinking process as to quickly uncover their own biases and incorrect assumptions. The Design Thinking process's fast-paced iterations led to accelerated learning within the teams and the individual. Students who had no prior knowledge in the challenge domain became instant experts[7]. Regular reflection sessions helped both the faculty and the students talk about (personal) emotions and increase EI.

Furthermore, regular ideation sessions with team members, faculty and corporate partners, and sometimes externals increase critical and creative thinking abilities and improve inter-personal skills that require sensing other's feelings and motives. A large number of teaching and coaching faculty members paired with smaller-sized classes (usually between 8-20 students per class), provides intensive learning opportunity and motivation to students to learn, participate and perform. By looking at the top 10 skills of 2025 according to the World Economic Forum (Whiting, 2020), the SUGAR program of 2008-2012 already addressed six of ten skills through its educational program.

The first turning point and revolution phase of the network started in 2012-2013. Because of the network's intense global growth (from 10 to around 30 projects) and evolving framework, including internationalization, the program realized a need for change. Besides this, the core faculty got smarter throughout the first phase too. One of the colleagues said, *"We got better to play coaches:"* What sounds amusing today was a reality at that time. The faculty and their designated teaching teams emancipated themselves from traditional teaching hierarchies and moved towards a coaching approach. They started to practice what they preached by displaying greater emotional intelligence in their modality. This meant the need for greater soft skills to optimize the hard skills being taught. The difference between teaching and coaching does not sound like much, but it is. As a coach, the faculty accompanied and developed the students as learners to achieve their personal and team goals. A disintegration of hierarchy between faculty and students started to happen. The entire group learned that everyone is in the same boat. Consequently, the faculty and students felt emotional to be in the same team, with the same goals. The faculty became a partner to the students and corporate partners.

## The Present - Empathy to collaboration

The present stands in the light of collaboration - collaboration between people, collaboration within the design team and collaboration across cultures. The need for emphasizing collaboration as part of the curriculum arose from the insight to better support the increased diversity featured in SUGAR to solve complex and wicked problems. We split them into three intelligence types again to address the different forms of collaborations, namely, collaborative intelligence, team intelligence and cross-cultural intelligence.

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[7] We are aware of an enlarging and critical discussion about the "rise of the instant expert" (*The Dangerous and Inexorable Rise of the Instant Expert*, n.d.). In this context, the "instant expert" is framed differently so that experts are still consulted as part of the project, but team members are still gaining a certain level of know-how that is novel and relevant to the project.

These three forms of intelligence types complement emotional intelligence. While emotional intelligence is primarily focusing on the individual and one's capability to empathize with others and itself, the intelligence types mentioned above focus on the collaboration of the individual with other people and groups.

*Collaborative Intelligence (CI)*

We defined collaborative intelligence *"as the ability to think with others on behalf of what matters to us all"* (Markova & McArthur, 2015). It expresses the need that today's problems are generally not solvable by individuals anymore, but rather by groups and teams. Being innovative demands different interpretations, views and opinions about topics to understand challenges in-depth and find comprehensive solutions.

Therefore, the SUGAR network intensified coaching students to think about collectives of people working together, not just others as individuals. It meant that the faculty had to prepare the students for understanding and incorporate different views on a given problem. "Understanding" in this context refers to the capability to listen first and judge someone's comments later on. It usually comes with a culture of acceptance, openness and tolerance: in recent years the expression of mindfulness was coined.. As Martini et al. write, it is "a state of being present in the moment and leaving behind a tendency to judge" (Martini et al., 2020). A study at the MIT Center for Collective Intelligence showed that specific training in being mindful increased the CI by almost 13% (Martini et al., 2020).

The ability to "incorporate" different views in one’s thinking requires the ability to be open-minded and willing to change a personal standpoint—if necessary. Further, it requires communicating one’s own perspective clearly and neutrally to others, with attention to fact. Especially if the student's counterpart is starting to change their opinion, students need to create enough "mental freedom" to let this change happen with respect. Being a “know-it-all” is not helpful in these situations.

Lastly, CI demands abilities to analyze and solve complex problems together. The togetherness requires the transparency, openness and willingness to exchange personal information with your teammates. Egoistic mechanisms of knowledge accumulation hinder the progress and performance of such groups. Effective collaboration can only happen if the students share their knowledge proactively. Regular team coaching sessions help students reflect on their own and group behavior.

| Time | Intelligence type | Definition | Student skills and targeted capabilities by the SUGAR Network |
|---|---|---|---|
| Past | Emotional Intelligence (EI) | *"We define emotional intelligence as the subset of social intelligence that involves the ability to monitor one's own and others' feelings and emotions, to discriminate among them and to use this information to guide one's thinking and actions."* (Salovey & Mayer, 1990) | • Ability to engage with others<br>• Ability to monitor one's own and others' feelings and emotions (Salovey & Mayer, 1990) / being self-reflected / showing empathy<br>• Aware of own biases (Liedtka et al., 2021)<br>• Curious and creative thinking (Liedtka et al., 2021; Salovey & Mayer, 1990)<br>• Motivated to learn (Salovey & Mayer, 1990) and seeking knowledge<br>• Critical thinking and willingness to challenge |
| Present | Collaborative Intelligence (CI) | *"Collaborative intelligence addresses problems where individual expertise, potentially conflicting priorities of stakeholders, and different interpretations of diverse experts are critical for problem-solving."* (Wikipedia contributors, 2021) in this context it is defined according to Markova and McArthur as *"[The] ability to think with others on behalf of what matters to us all."* (Markova & McArthur, 2015) | • Ability to think with others on behalf of what matters to the group (Markova & McArthur, 2015)<br>• Ability to understand and incorporate different views on a problem<br>• Ability to deal with complexity and ambiguity in problem-solving situations<br>• Paying attention to someone else's opinion and integrating team members' diversity (Martini et al., 2020)<br>• Analyzing and solving complex problems as a group |
| | Cross-cultural Intelligence (CCI) | We define cross-cultural intelligence as the cognitive, motivational and behavioral capacity to understand and effectively respond to the beliefs, values, attitudes and behaviors of individuals from other cultures. (adopted from (Ang et al., 2013)) | Based on (Ang et al., 2013) work:<br>• Ability to acquire and understand cultural knowledge sometimes through "experimentation"<br>• Knowledge about cultures and cultural differences<br>• Ability to direct and sustain efforts toward functioning in inter-cultural situations<br>• Empathy in cross-cultural interactions |
| | Team Intelligence (TI) | Team intelligence is defined in accordance to (Akgün et al., 2008) as *"...a team's capability to use information processes through project-related activities that achieve a desired end or perform a particular function or value activity during the project."* | Based on the work of (Akgün et al., 2008):<br>• Information acquisition capability of the team to conduct primary and secondary research with relevant stakeholders<br>• Information dissemination ability as the team's capacity to diffuse and transmit information among relevant members of the team<br>• Information utilization ability to use information directly and indirectly as part of the project<br>• Ability to create and share information within a team |

**Table 2:** Intelligence types and capabilities of students

| Time | Intelligence type | Definition | Student skills and targeted capabilities by the SUGAR Network |
|---|---|---|---|
| Future | Environmental Intelligence (EvI) | In our context we define environmental intelligence based on (*Environmental Intelligence*, n.d.) as the anticipation of human behavior causing environmental changes by integrating *"... environmental and sustainability research with data science, artificial intelligence and cutting-edge technologies to [create meaningful insights] to mitigate the effects of environmental change."* | ● Ability to acquire and interpret knowledge about the environment and environmental change<br>● Knowledge about the impact of today's decisions on the future of the environment<br>● Ability to steer design decisions towards the improvement of the environment in the future |
| | Global Intelligence (GI) | *"The ability to understand, respond to and work toward what is in the best interest of and will benefit all human beings and all other life on our planet" (Spariosu, 2004)* | ● Ability to understand the interrelationship between humankind, and nature<br>● Capability to abstract from local thinking to global thinking<br>● Ability to act in the best interest of society |
| | Digital Intelligence (DI) | *"Digital intelligence is the sum of social, emotional, and cognitive abilities that enable individuals to face the challenges and adapt to the demands of life in the digital world."* (Wikipedia contributors, 2020; Yildiz, 2019) | ● Ability to apply multiple intelligences in digital languages<br>● Algorithmic and Artificial intelligence thinking (Zeng, 2013) capabilities<br>● Ability "...to convert or represent the physical world in digital format." (Yildiz, 2019) |

**Table 2:** Intelligence types and capabilities of students

*Team Intelligence (TI)*

As part of the development of the SUGAR network, we further intensified the focus on the team and its intelligence structures. While collaborative intelligence focuses on the individual's ability to incorporate different views of group members, team intelligence targets the ability to effectively and efficiently act as a homogenous group. Certainly, the team has always been there as part of the SUGAR network, but we started to learn as faculty that further teaching and coaching are required to improve team intelligence within the students' minds. In this context, we define team intelligence (TI) as *"... a team's capability to use information processes through project-related activities that achieved a desired end or performed a particular function or value activity during the project." (Akgün et al., 2008)*

The faculty intensified sessions on team dynamics and proper project planning. In focus are students' abilities to disseminate information adequately to team members and project stakeholders. Teaching about project plans, Jour-Fixe meetings, project progress reports, inclusive language and clear communications practices are just a few things incorporated. Activities such as sharing hopes and fears, and personal motivations are used to assist functioning team dynamics. Further, the faculty focused on utilizing available information within the team. Young and newly formed teams can struggle to digest the sheer amount of data they have gained from their field research activities. To improve the knowledge utilization, we focused specifically on the synthesis sessions as part of the Design Thinking process. Students learn how to collect, analyze and interpret all gathered data together. Before the Covid19 crisis, these activities happened physically on the whiteboard with post-its and digitally on platforms like Miro. Since Covid19, the use of physical whiteboards has disappeared and the digital space has fully absorbed these group techniques.

Furthermore, TI's essential aspect is the ability *"to learn in teams."* While most students are trained in learning individually, we focused our efforts on enabling them to learn together as a group. As a group, with diverse characters and diverging views on the problem and solution space of the design challenge, we often observe the phenomenon of "accelerated learning" on the project when teams work effectively. To enforce this behavior, we usually assign group tasks to each team they have to accomplish together.

*Cross-Cultural Intelligence (CCI)*

Cross-Cultural Intelligence (CCI) increased its importance for the SUGAR network as we grew across countries and continents. Student teams started to work more frequently together across cultural spheres like Germany (Europe) - China (Asia), Australia (Australia) - Japan (Asia) or Poland (Europe) - Columbia (Latin America). Adopted from Ang et al., we define Cross-Cultural Intelligence (CCI) as the cognitive, motivational, and behavioral capacity to understand and effectively respond to individuals' beliefs, values, attitudes, and behaviors from other cultures (Ang et al., 2013).

To strengthen the CCI muscle within our students, we, as SUGAR network, introduced as part of our global kick-off week several workshops, speeches and reflection sessions to raise the awareness and importance of these differences across cultures. These sessions usually cover the basics like meeting culture, cultural heritage, organizational culture, preferences with conflict, and communication barriers because of language. For example, even for countries within Europe, it turns out to be

essential to raise the awareness of cultural differences as early as possible. This awareness creates the possibility for the individual to compensate and adjust to the new circumstances.

Part of CCI is the ability to be flexible in cross-cultural interactions—when you don't know what you don't know. Students need to find consensus and common ground between the different cultures. Even more, they need to be able to realize and understand differences to turn them into advantages! Potential team conflicts arise because of a lack of understanding of the opposite culture. Students can only mitigate negative team conflicts if the participants on all ends show willingness, openness, empathy and respect to negotiate these cross-cultural interactions.

## The Future - Empathy to the world

What will be the future development steps of the SUGAR network? The next revolution phase is becoming visible on the horizon and might have started already. Our world continues to change with various techno-cultural, socio-political drivers, shaping our direction. Climate change, a massive acceleration of digital technologies' progress, and ongoing globalization, to name a few, will push us and the next generation of students to adapt again. Schemel et al. (Schemel et al., 2019) provideclear insight into how future scenarios might look based on the behaviors and decisions we take today. Moreover, the recent pandemic has increased the speed of introducing digital technology in almost all parts of our lives.

In particular, the United Nations have envisioned the change needed for our environment and its global inhabitants as part of their 17 sustainability goals (*THE 17 GOALS*, n.d.). The SUGAR movement should anticipate this change early enough to prepare future students and participants.

Robust foresight techniques guide our thinking. Indeed, no one will be able to foresee the future precisely. However, with intelligent methods, we can still make predictions of specific life scenarios in the future, to provoke discourse and action to guide desired futures. To guide our thinking about the future, we base our assumptions on the UN sustainability goals and the foresight of the report by Schemel et al. from 2019 (Schemel et al., 2019; *THE 17 GOALS*, n.d.). We hope to achieve a positive future, like the "Post Anthropocene" described in detail by Schemel et al. (Schemel et al., 2019), who postulate *"... a shared consciousness and an understanding of Earth's limited resources."* Part of this future scenario sees the economy shifting into a fully circular model supported by smart computer technologies like Artificial Intelligence to optimize our ecological footprint permanently. Citizens are globally well-educated, and most people have sufficient access to educational resources.

Educating people on eco-design has been going on already for decades. Victor Papanek wrote his seminal book on *Design for the Real World: Human Ecology and Social Change* in the 1970s (Papanek & Fuller, 1972). McDonough and Braungart followed Papanek with their groundbreaking book *Cradle to Cradle* in the early 2000s (Braungart & McDonough, 2010) and many more followed on similar topics, including *Circular Economy* (Kirchherr et al., 2017; Korhonen et al., 2018).

Looking backwards in time it feels that so far ecology has been a topic that has been "in and out of fashion" in society. But by looking into the future, scientific studies about the environment and climate change show us clearly, that with the new drivers coming into place environmentally responsible behavior can no longer take a backseat. Accelerating population growth, increasing inequality, the recent pandemic and more factors call for change. As an international community, we

have to take responsibility and enfold action for the design outcomes we imagine and realize to protect our planet earth.

From our perspective, and by incorporating the insights about desirable futures into our thinking, we propose the SUGAR network integrate environmental intelligence, global intelligence and digital intelligence into design thinking pedagogy as a next step. As with the previously discussed intelligence types, these three future intelligences are additional to the existing set of intelligence types and combine to form a new "version" of the Design Thinking mindset. All seven intelligence types together will shape Design Thinking of the future.

*Environmental intelligence (EvI)*

While there are many definitions out there already, we define environmental intelligence as the anticipation of human behavior causing environmental changes by integrating *"... environmental and sustainability research with data science, artificial intelligence and other cutting-edge technologies to mitigate the effects of environmental change."* We want to sharpen our students' skills and capabilities to acquire and interpret accessible knowledge about upcoming environmental changes and challenges. Having soft skills such as the ability to conduct proper primary and secondary research is one part. The other part is enabling the students to utilize modern or cutting-edge technologies to analyze large data sets of our environment.

Additionally, we want to strengthen our education in forward-thinking techniques to empower all SUGAR members to think about desirable futures. Exploring desirable futures will help students be ready to shape today's solutions in a direction that is responsible for nvironmental sustainability. Design leadership and taking the right design decision can only unfold its potential with a robust understanding of systems and futures thinking.

*Global intelligence (GI)*

Global intelligence is seeking to improve students' capabilities in grasping and understanding global phenomena. We believe that people need to make decisions that incorporate every human's well-being in tomorrow's world. This decision making behavior requires a broad understanding of humanity, considering constructs across Social, Technological, Economic, Environmental, Political and Ethical (STEEPLE) domains Empathy is required to anticipate the needs, wishes, desires, challenges, and problems of different cultures and societies. Our students must learn how to abstract from a local thinking style into a global thinking style. The health of our planet is a highly complex challenge and will more than ever need capable, responsible and diverse expertise to collaborate and innovate in response. GI implies a broad set of capabilities to enable us to empathize and be open-minded toward complex systems. Students have to seek patterns and understanding by navigating perhaps seemingly different opinions and learn integrative thinking styles to develop appropriate solutions that address our society's challenges..

*Digital intelligence (DI)*

As our future will become much more computerized, we firmly believe that digital intelligence is necessary for our students. We define it as *"... the ability to adapt to the demands of life in the digital world."* Recent examples show that people need to learn to address to the digital world fundamental questions of life. For example, ethical and moral questions are just two examples of free speech,

democracy and privacy in the digital space that need to be thought about. The digital space will require new sets of capabilities in the future: that people become better designers and better design thinkers in the future. Students in this program must learn to interpret better existing and newly created data, leverage AI and develop digital business models. Furthermore, students must be able to effectively use digital mediums and language to enhance collaboration.

# Conclusion

The Design Thinking mindset space has grown over the last 13 years of development within the SUGAR network. It started with a narrow view of a design mindset as a key element and extended to emotional intelligence. In recent years the emphasis has shifted and increased towards collaboration - collaboration between people, within a team and across cultures. For the future, we foresee at least three additional intelligence types as relevant for extending the Design Thinking mindset: the focus on the environment, the extended view on global citizenship and the anticipation of the fast-growing digital world. As shown in figure 2, the future Design Thinking mindset is, for us, the convergence of the Design mindset and the seven types of intelligence.

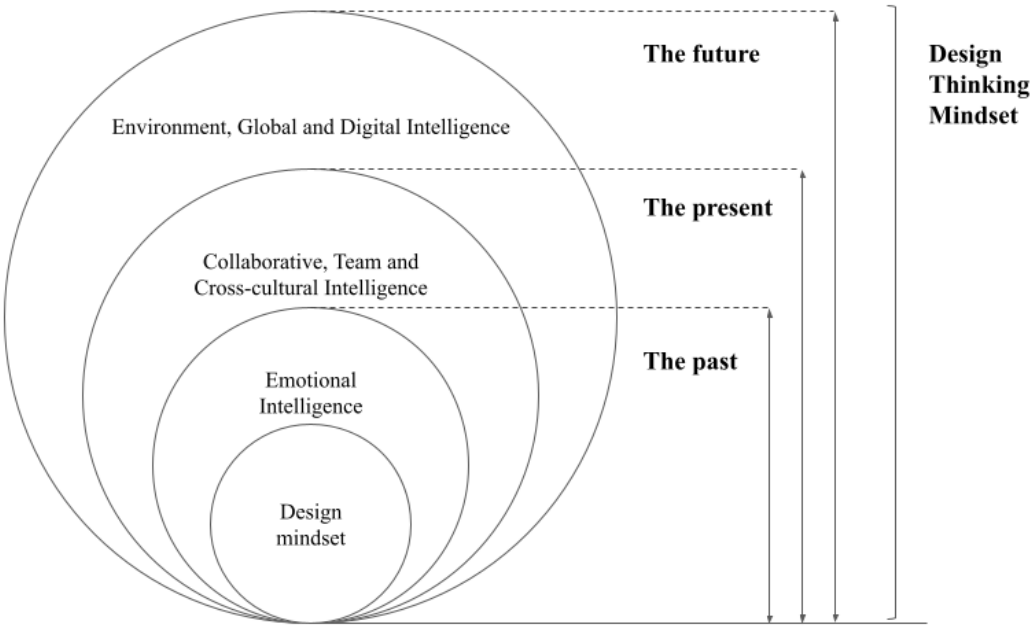


**Figure 2:** The composition of the Design Thinking mindset (of the future)

To conclude, today and tomorrow's challenges require an even stronger focus on planetary health and the living beings who inhabit earth. Design Thinking, in our view, offers an approach to tackle these areas of life efficiently and effectively.

# Disclaimer

This article includes a fact-based report describing the SUGAR network and proposes strategic visions about this incredible movement's future. As authors, we know that our vision has to be shared

and developed with all SUGAR movement members, which is still in progress. Therefore, this report reflects the authors' opinions and beliefs and does not represent everyone's SUGAR views.


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