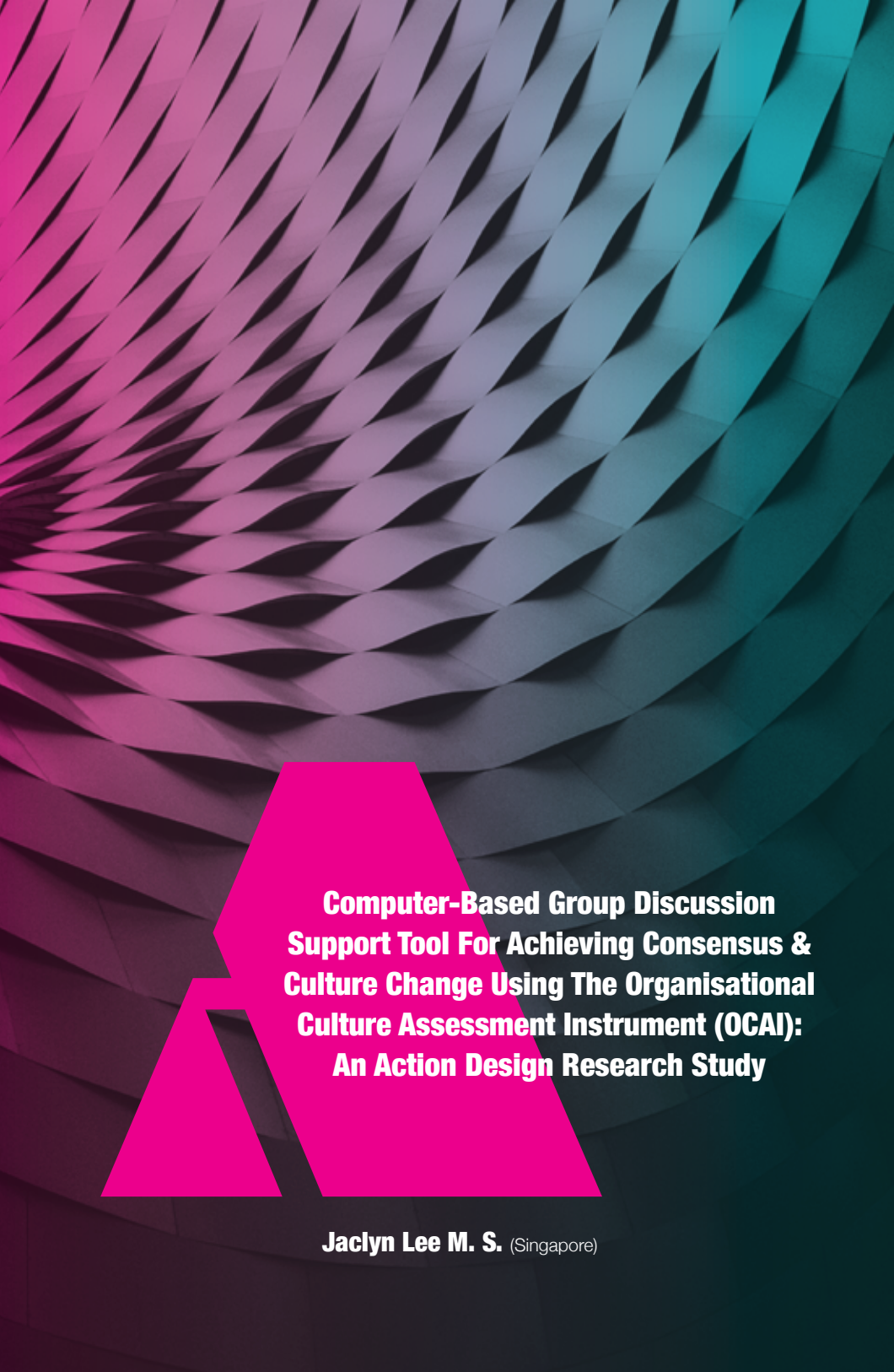


Computer-Based Group Discussion Support Tool For Achieving Consensus & Culture Change Using The Organisational Culture Assessment Instrument (OCAI): An Action Design Research Study

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A COMPUTER-BASED GROUP DISCUSSION SUPPORT TOOL FOR ACHIEVING CONSENSUS AND CULTURE CHANGE USING THE ORGANISATIONAL CULTURE ASSESSMENT INSTRUMENT (OCAI): AN ACTION DESIGN RESEARCH STUDY

DISSERTATION

To obtain
the degree of doctor at the University of Twente,
on the authority of the rector magnificus,
Prof. dr. H. Brinksma,
on account of the decision of the graduation committee,
to be publicly defended
on day the 1st of December, 2015 at 16.45 hours

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CHAPTER 1: INTRODUCTION

1.1 Problem Context and Background of Study

The Singapore University of Technology and Design (SUTD) is a Singapore public university set up by the government of Singapore. SUTD was created in 2009 with the mission of advancing knowledge and nurturing technically grounded leaders who will serve vital societal needs by designing solutions to meet human needs and problems. In a statement on the purpose of SUTD, Prime Minister Mr Lee Hsieng Loong, reiterating this vision, stated the following:

> The Singapore University of Technology and Design will provide something different from the existing institutions--a very high quality education, not just an academic education, but one which is going to stimulate students to go beyond the book knowledge, to apply it to solving problems. It will teach students to be creative, not just in the technology and the design part, but also to be creative in bringing ideas out of the academic environment into the real world, into the business arena and into the real economy.
> (http://www.youtube.com/watch?v=8tEfk8_E9Dk)

On May 2015, at the recent grand opening of the university, the prime minister again reiterated the important role that SUTD is intended to play in Singapore's economy when he emphasized that "many projects in the future, such as building greener homes and the planned high-speed rail link between Singapore and Malaysia, will require expertise and skills in engineering, technology and design. As such, there will be no lack of jobs or challenges for SUTD graduates" (Lee, 2015). Armed with a focus on big "D" (Design) and technology, SUTD was originally designed with four multi-disciplinary "Pillars":

1. Engineering Product Development,
2. Engineering Systems Design,
3. Information Systems and Design, and
4. Architecture and Sustainable Design.

A fifth division; Humanities and Social Sciences, have recently been created. The key objective of this new division is to support the Engineering and

Architecture pillars. Through this division, students will learn about the groundbreaking ideas, great historical moments, and dominant social paradigms that shape and have shaped the societies in which we live. This knowledge is intended to help them look beyond themselves, to develop empathy in social situations, and to foster a sense of fearlessness in their creativity.

It is in this respect that the various humanities, arts, and social sciences disciplines--grouped at SUTD under the acronym, HASS--envision their role at the centre of the creative process and also provide a firm foundation for students' work in technology and design. The HASS disciplines include psychology, sociology, history, anthropology, economics, literature, film, and urban studies. Management subjects are taught through collaboration with the Singapore Management University (SMU).

Since its inception in 2009, SUTD has recruited a full administrative team as well as a president, provost, four associate provosts, four heads of pillars, directors for its research centres, and a total of 150 high calibre faculty members. The recruited faculty members include members from different countries and from various disciplines spanning engineering, humanities and social sciences, general sciences, industrial design, computer sciences, and architecture. They are organised to collaborate in research with a multi-disciplinary focus that cuts across traditional disciplinary boundaries.

The university recruited its first batch of undergraduate students in 2012 and to date has 1200 undergraduate students and 150 graduate students enrolled in its various engineering and architecture programs (mainly doctoral and a handful of master's degree candidates).

SUTD is designed to be different from typical universities. It is designed in a fluid structure such that it has no boundaries. No traditional schools, faculties, or departments exist in this structure. Instead, the concept of pillars of specialisation dominate the key educational foundation of the university. These pillars interact through the key themes of research and design. There is multi-disciplinary collaboration across specialisations.

The pillars are managed by a "pillar head" instead of a "dean". The purpose of this management structure is to prevent territorial delineation. Administrators, faculty,

students, and researchers work together to achieve the mission and vision of SUTD. Even the seating spaces of faculty are defined by research themes rather than by pillars or schools. This is done to ensure multi-disciplinary collaboration. Table 1 below compares a traditional university to the design and vision of SUTD.

Table 1. The Vision and Design of SUTD Contrasted with Those of Traditional Universities.

	Traditional University	**Vision for SUTD**
Organisational Structure	Hierarchical and territorial	Flat and Agile with no schools, but instead pillars of specialisation form the main core of the university
Operating Model	Decentralisation	Shared Services
Student Interaction	Big Lecture Series to achieve economies of scale	Small Cohort size classrooms-—to achieve intimacy of interaction.
Student Learning	Theoretical	A strong theoretical foundation coupled with a hands on interactive experience that is interlaced with internships and practice
Research	Narrowly Focused	Multi-disciplinary, focus on innovation and creativity (development and improvement of artifacts) rather than only description or explanation.
Faculty Recruitment	Decentralised with a narrow focus	Decentralisation at the first level of screening, but centralisation when it comes to decision to hire. The President chairs the final selection committee together with a multi-disciplinary team to ensure that each faculty hired has the potential to collaborate across the different specialisations
Faculty Governance	Dominant in faculty self-governance	Mixed faculty governance with specifically chartered work teams on key projects that may also include administrative staff

The table explicitly shows how the SUTD vision is quite different from that of a typical traditional university.

However, through its traditional selection and recruitment process, SUTD is populated by key stakeholders, (students, academic and administrative management, faculty and staff) who may have been brought up and have been successful in a traditional university environment. They carry with them the assumptions and values, that is, the culture that helped them survive and succeed in a traditional university environment. Under work and promotion pressure it would be easy for them to revert back to a traditional university culture.

In creating a university with such a unique vision and mission, and with a fragile culture that is always in the danger of reverting back to the traditional university culture, the development and integration of a strong organisational culture that is consistent with SUTD's vision, becomes important.

In the case of SUTD, the development of a strong unifying culture is even more important, because SUTD's students, faculty and staff come from different disciplinary, national, cultural, and institutional origins and from diverse academic backgrounds. In Clayton Christenson's book, The Innovative University, the author noticed that in the spirit of honoring tradition, universities hang on to past practices to the point of imperiling their futures. They do not reinvent their curriculum to better prepare students for the increasing demands of the world of work. (Christensen and Eyring, 2011, pg xxii) SUTD's culture journey is in another sense, synonymous with the journies that today's universities must undertake to transform themselves and their traditional culture in order to meet the expectations of the changing world.

1.2 Definition of Culture and its importance

Cameron & Quinn (2011) defined organisational culture as, "the taken-for-granted values, underlying assumptions, expectations, and definitions that characterize organisations and their members. It is an enduring slow-to-change core characteristic of organisations" (Cameron & Quinn, 2011). Fralinger & Olson, (2011) state that at the university level, culture can be defined as the values and beliefs of university stakeholders, based on tradition, and communicated either

verbally or nonverbally. The beliefs and practices of the university community, including trustees, senior administrators, faculty and students, combined to fundamentally shape the effectiveness of the university. A strong and well defined culture helps to pave the way for stakeholders to align their actions towards achieving the organisation's vision and objectives.

It is therefore important to have a common understanding of shared beliefs, and through this understanding, obtain cultural alignment to achieve the mission and vision of the organisation. This common understanding is reinforced by Van den Berg & Wilderom's (2004) notion of culture as "shared" perceptions of organisational work practices within organisational units. Given that these are shared perceptions; it is important that members of the organisation participate in the process of agreeing upon their perceptions of the current culture; define their desirable cultures, and share these perceptions.

These cultures may differ across organisational units. Therefore, it is important that we identify the perceptions of the key stakeholders in various units (academic and administrative management, faculty, staff, and students) about SUTD's current and desired cultures. If the current culture is found to be different from the organisational culture underlying the desired vision for SUTD, we need to undertake an organisation culture change exercise. As there are a relatively large number of academic and administrative management, faculty members, staff, and students, we need an organisational culture change process and an organisational culture assessment tool that can be scaled up to measure, assess and change the culture of large groups of stakeholders.

However, culture change projects are complex and subject to process losses that can occur in large deliberation sessions that prohibit problem solving. Process losses as identified in more detail in Chapter 2, Section 2.3, are aspects of group interactions that might inhibit problem solving. It is typically exemplified in factors such as failure to remember, conformance pressure, concentration blocking, dominion, slower feedback, ambiguity and evaluation apprehension, to name a few. (Nunamaker, et al 1991)

Culture change in this digital age will also be subjected to the advent of new tools and the use of digital technology. These technologies and their abilities to speed up the process of culture change and reduce process losses will be important elements in change projects. This trend is addressed in a recent article

by Ewenstein, Smith, and Sologar (2015). The authors commented that change management as it is traditionally applied is outdated, and organisations have not utilised the use of digital tools to make change more meaningful and durable. Wearable technology, adaptive interfaces, and integration into social platforms are examples of digital tools that can be applied with great effectiveness to change management techniques. Digital tools could possibly address the problem of scalability and allow for users to connect through social platforms for more effective communciation and discussion.

The purpose of this thesis is thus to develop a scalable digital organisational culture measurement instrument and a tool and methodology for cultural change that is both scalable and at the same time, ameliorates process losses.

The key stakeholders in this change process in SUTD include: (1) SUTD's academic and administrative senior management (2) SUTD's faculty and staff, and (3) SUTD's students. These various stakeholders may have different motivations, needs, agendas, and backgrounds. Consequently, these stakeholders may also have different perceptions of the current state of culture in the organisation, and their desired organisational culture. Other things, such as, attitudes that "reinforce traditional professional hierarchies and stereotypes" (Wilson, 2000), issues of unequal workload (Ovretveit, 1997), conflicts between team and individual professional goals (R. Brown, 2000a; Onyett, Pillinger, & Muijen, 1997), role ambiguity (Jenkins, Fallowfield, & Saul, 2001), and mismatched expectations (Bosch-Sijtsema, 2007) may also affect how stakeholders perceive the current and desired cultures differently.

Therefore, it is important to:

a. Measure and make explicit the perceived current and desired cultures of each stakeholder group. Each group may need intra-group (within the group) discussions to make sure that members of the group agree upon the group's perceptions of the current and desired cultures

b. Discuss these explicitly represented, and agreed upon perceived current and desired cultures across groups (top-management, faculty, administrative staff, and students), to come to an inter-group (across groups) agreement or a common understanding.

c. Based upon this inter-group common understanding and possible agreement, to identify the differences or gaps between the current and desired cultures for each group.

d. To collectively discuss and come to an agreement about the possible means of reducing these gaps between current and desired cultures

e. To collectively assess the progress towards the reduction of these gaps

Participatory Discussion Process: Smith (2003) reported that only 10-32% of companies may attain the desired cultural shift. Baker (2002) observed that cultural change "is not easy to achieve; it is a difficult, complicated, demanding effort that can take several years to accomplish." Due to these difficulties, it is important that members of the stakeholder groups fully participate in group discussions to align their values and perceptions collectively to a common vision in order to achieve consensus towards a shared culture[1].

Genuine participation should increase the likelihood of stakeholders subscribing to the same culture. However, it may be likely that with effective discussion people may achieve a common understanding but not consensus. Common understanding might lead to opinion polarisation. It is thus important that these group discussions are skillfully guided to reduce such polarisation and to ensure more effective outcomes. (Bostrom, Anson & Clawson, 1993).

Requirements for a discussion tool to support this participatory process: Clear participation is thus needed to ensure that groups or individuals within a group fully subscribe to an understanding of the current culture and commit to the desired culture and the means to attain it. It is thus important to develop and use a discussion tool that allows various members of the stakeholder groups, and the groups themselves, to participate in and collectively influence this process of discussion. In the use of this tool, all stakeholder groups should be able to provide their input, and groups and members of the group should feel that they are being heard.

1 While it would be preferable to have a consensus among the various stakeholders, it may not always be possible to have one. The use of a Group Decision Support System (GDSS), by making the deliberations open and transparent to all, makes it possible to come to a common understanding of the current culture profiles and the vision for the future. This common understanding is only an initial step towards consensus. With common understanding, while the hope is to achieve consensus, a consensus may or may not emerge. Moreover, by making the differences of opinions explicit, it could lead to opinion polorization. Therefore, with the use of GDSS, the best we can claim is common understanding; not consensus.

Currently, while there are many culture-related tools available in the market, most of these tools only measure culture, and do not have the ability to allow for effective and efficient group discussions. These discussions are necessary to reach a common understanding and participatory group decision making that is necessary for alignment and potential consensus building.

We also see a lack of such an integrated tool in research. Many culture change projects still need a great deal of manual intervention after the culture survey is conducted. Marcella Bremer, in her book on "Organisational Culture Change", details the steps she takes in facilitating change conversations. Each change workshop takes 2 days and can only be facilitated in groups of 10. (Bremer, 2012) This process will take a great deal of time to cover large groups. If we are able to develop a tool and a methodology that can be used to not only measure current and desired cultures, but at the same time replace the manual sessions with an on-line discussion platform that can reach large groups of people to enable decision-making, it would speed up the process of culture change. We see the value and novelty in this approach as we integrate the culture tool and digital group discussion platform to effect culture change. Our objective is to develop a group discussion tool and a methodology that, (1) measures and identifies the perceived current and desired cultural profiles of each group, (2) represents these current and desired cultural profiles explicitly, and presents the representations to all members in the group, for all persons to review and understand them, (3) provides a means for openly discussing these profiles as a group, to arrive at a common group understanding of these profiles (4) is scalable (i.e. lets a large number of people participate in the group discussion process), and (5) ameliorates the possibility of process losses. For the above five objectives to be achieved, it is important that the process is accompanied by expert facilitation. This is further discussed in Chapter 2.

Organisational Culture Framework and Participatory Discussions: To facilitate the group discussion process, we first need to establish a culture framework that is able to assist us to measure the current and desired culture. In this research, we use the Cameron and Quinn's Competing Values Framework (CVF) as the underlying theoretical framework for our research. The selection of this culutural tool is explained in Chapter 2, Section 2.1.1. Cameron and Quinn used the CVF framework to develop the organisational culture assessment instrument (OCAI). Consequently this framework is used as a basis for selecting

the Organisational Culture Measurement Instrument (OCAI), which is our instrument of choice for measuring organisational culture.

OCAI profiles will possess face validity in our culture assessment and change exercise. The OCAI-CVF measures and represents an organisation's cultural profile as scores along four quadrants: adhocracy; clan; hierarchy; and market. The first two quadrants, adhocracy (innovative) and clan (collaborate), emphasize flexibility,discretion and dynamism, while the other quadrant, "hierarchy" (control) and "market" (compete) emphasize stability, order and control. The continuum ranges from organisational versatility and pliability on one end to organisational steadiness and durability on the other end. (Cameron & Quinn, page 38, 2011) The two quadrants for measuring adhocracy (innovation and creativity), and clan (teamwork and collaboration), are aligned with the vision of SUTD which emphasizes innovation and creativity achieved through teamwork and collaboration. Robert H Waterman, Jr, confirms the nature of adhocracy as, "a form of organization that cuts across bureaucratic lines to capture opportunities, solve problems and get results" (Waterman Jr., 1992). In order to promote SUTD's vision, we will need to move SUTD's culture to higher scores on the adhocracy and clan quadrants, while continuing to reduce the hierarchy, control and market orientation cultures. We will elaborate further in Chapter 2 within the literature review for culture, how OCAI as compared to many other instruments, is the only tool with the ability to measure ascription to values leading to adhocracy and clan cultures.

Coming back to participatory discussions, due to the "enduring and "slow-to-change" nature of culture, we noted that it is important that the members of each group feel that there is a genuine opportunity to participate in the culture measurement and culture change exercise. Even a hint of less than genuine intentions for participation can make the participants mistrust the process, and thus affect the process adversely. Most discussions of organisation culture (Cameron & Ettington, 1988; O'Reilly & Chatman, 1986; Schein, 2010) agree that culture is a socially constructed attribute of organisations that serves as the social glue binding an organisation together. Therefore group discussion is important to arrive at a common understanding and potential consensus of current and desired cultures.

To realize the vision of SUTD, culture change is necessary to align key stakeholders such as senior management, faculty members, staff and students to the desired

culture of innovation and collegiality, (adhocracy and clan culture types in Cameron and Quinn's competing values framework. (Cameron and Quinn, 2011)

Levin & Gottlieb (2009) state that any "successful organisational cultural realignment efforts must begin with reaching agreement among senior leaders and key stakeholder groups about the preferred help achieve business goals and implement planned changes." In addition, broad based meaningful engagement and participation across business units, functions and levels is a key mechanism for mobilizing and building ownership and commitment. The research of Coch and French Jr., (1948) shows that people more readily commit to change with enthusiasm and are willing to help enact it when they have had the opportunity to understand its rationale, have their voice heard, and are provided concrete ways to contribute to its design and implementation (Axelrod & Cohen, 2000; Kotter, 1996). Cultural realignment efforts, should not just be imposed from the top, they need to tap into the wisdom and talents of all organisational members.

Cameron and Quinn (2011, p. 102) also further reinforce that organisational culture change is a "group process," requiring buy-in from the members of the organisation"–both regarding their perception of the organisations current cultural profile; and its desired cultural profile. The difference between the common understanding of the current and preferred profiles in turn influences the steps the organisation needs to take to move from the current to the desired cultures.

Therefore, our objective is to develop a group discussion instrument that helps the top-management and key stakeholder groups explicate and discuss their respective perceptions of SUTD's current culture, their visions for the desired culture. This should hopefully help them to come to a common understanding of the agreed-upon profiles of their perceptions of the current SUTD culture, and eventually reaching a potential consensus on the agreed-upon desired culture. As reiterated in the previous paragraph on group discussions, currently we do not see such a tool (integration of culture assessment with group decision support system) available either in the market or being explored in research. In a recent article by Roger Connors and Tom Smith on "Transforming culture at the speed of light" the authors share that the key to culture transformation lies in the ability to accelerate change and speed it up and to engage the masses. In addition, millenials now prefer to collaborate with each other online as opposed to in person or via phone. The key to success lies in embedding collaborative technologies and digital tools to facilitate change efforts (https://trainingmag.

com/transforming-culture-speed-light-go-digital). This research will focus on the use of GDSS technology coupled with OCAI to facilitate on-line culture discussions and facilitate decision making for change projects. An tool like this will be a novel concept that will fit the changing times and expectations of the new workforce. In developing our instrument for culture assessment and subsequent discussion, we will ensure that all group members feel that they have a genuine opportunity to participate in the exercise, and potential process losses during participation are minimized. Achieving scalability and ameliorating process losses are very important requirements for our group meeting support tool.

At the beginning of this project, however our understanding of the perceptions of different stakeholder groups of their current and desired culture at SUTD was mainly intuitive and anecdotal. We therefore need empirical data to establish the current and desired organisational culture profiles of various stakeholder groups, and determine if these profiles are congruent or dissimilar. In order to reach the desired culture, SUTD would need to reach common understanding and possible consensus within and between the following stakeholder groups:

a. Academic and Administrative Management[1]
b. Faculty at all levels with at least one year of service[2]
c. Staff at all levels with at least one year of service[2]
d. Students – sophomore and senior year

The process steps for culture change with the above stakeholder groups involve the following :

Steps for Culture Change (as adpated from Cameron and Quinn 2011, pg 101)

1. A measurement/assessment of "current culture" of the organisation for each of the three stakeholder groups:

1 The academic and administrative management of the university are included as a separate group, as they provide leadership to the organisation and therefore strongly influence the desired culture and the organisation change measures used to achieve it.

2 The reason for choosing staff and faculty with at least one year of service or experience is to ensure that they have sufficient time to understand the current organisational culture, and become integrated in the SUTD culture.

2. An assessment of "desired culture" by different stakeholders in the organisation;

3. A method for representing the current and desired culture profiles for various stakeholder groups, so they can review, examine, and discuss each other's cultural perceptions;

4. A process for group-discussion and coming to a group-common understanding and potential consensus about the current culture;

5. A process for discussion and coming to a common agreement about desired culture; and

6. A process for discussion and agreeing upon the change measures that are needed to move from the current to desired culture.

For the above Steps, we use the organisational culture measurement instrument (OCAI) that was developed and tested by Cameron and Quinn (2011). Our choice of OCAI for these steps is discussed below in Chapter 1 as well as in Chapter 2.

1.3 Organisational Culture Assessment Instrument (OCAI)

What is OCAI? OCAI as explained in the earlier section is the culture instrument derived from the Competing Values Framework. It is an organisational culture survey instrument designed by Professors/Researchers Cameron and Quinn (at the University of Michigan). OCAI is used for measuring and graphing (visualizing) organisational culture profiles for members of a specified organisation. OCAI has been used and tested in various studies involving measurement or change of organisational culture.

This instrument has been extensively tested by Cameron and Freeman (1991) in a study that covered four year colleges and universities (n=334) in the US and included 3,406 participants. In Kwan and Walker (2004), the authors conducted a study to validate the CVF as a representation of organisational culture through institutional comparisons. The OCAI has also been used in studies of 1000 companies (Cameron and Quinn, 2011, p. 176) involving different types of corporations in the fortune 500 list. Finally, Zammuto and Krakower (1991),

in their study of college cultures, produced evidence of validity of OCAI by discovering that clan culture was associated with decentralization, trust, a sense of equity among members, high morale and satisfaction with the leader.

In this instrument, individual profiles measured by the OCAI are aggregated to produce the cultural profiles for the organisational-unit. At present, the aggregate group profile is a simple average where the OCAI scores for all persons in the organisational unit are added together, and then divided by the numbers of responding persons in the unit. Other aggregations could be weighted averages where unit members with high levels of influence in the unit may be awarded a higher weight. For this thesis, however, we will continue to use the simple averaging method proposed by Cameron and Quinn (2011) to compute the group profiles. These profiles include both "perceived current profiles" of the organisation, as well as "desired organisational culture profiles".

How is OCAI used? Cameron and Quinn and various users of the OCAI instrument (Bremmer, 2012) use OCAI as a tool for profiling the current and desired (preferred) organisational culture profiles; creating a group discussion using these profiles to come to a common group understanding and potential group consensus; discussing and implementing organisational culture change measures for moving from current to desired profiles (Cameron and Quinn, page 102, 2011) and measuring progress in their assessment of organisation culture change and measuring the culture change (from the perceived current profile to preferred or desired profile) process. OCAI can be used as an instrument for progressively tracking the changes in the organisation's culture profiles at different times during the culture change processes. The differences between profiles at different times provide an indication of the progress towards culture change. Moreover, it is possible that the participants may change their "desired culture" as the culture measurement, explication, and group discussion processes progress. Measurements of current and desired profiles using OCAI can also track such changes as and when they occur.

1.4 Initial Problem Identification

In February-March 2013, we conducted the process steps (1) through (6) with 13 members of the SUTD senior academic and administrative management to start the process of cultural assessment, change, and alignment.

The process took about one-half day for steps (1) through (6) for a group of 13 people. The results of the OCAI process for these steps are summarized in the next section.

1.4.1 Problems Observed in the initial Exploratory Study

a. This process for 13 people took about a week to complete. Firstly, we had to use the manual version of the OCAI tool for each member to complete. In order to ensure participation, we had to personally go to each person to explain and work through each step. While this process was possible for a small group size, it would be rather inefficient and time consuming if the same manual process was employed for the large number of staff, faculty, and students at SUTD.

b. Secondly, we had to spend a great amount of time to organise an off-site meeting for these 13 persons to achieve consensus. While there was general agreement on the type of desired culture that we want in SUTD, the perception of the current culture was quite varied for the 13 persons. The views differed in terms of the way they perceived the hierarchical make up of the organisation, innovation, market competition as well as management of employees. It took half a day of brainstorming to align and agree on the types of initiatives the team can undertake to drive towards a clan and adhocracy culture

We next attempted to scale up this process, and try it with sub-groups of the full complement of SUTD faculty and administrative staff. As we conducted this broader exercise we observed the following:

(a) First, members of the faculty and staff stakeholder groups were not fully responsive to the request to participate in our survey and subsequent group discussions. Reasons could be that face-to-face sessions are lengthy and time consuming, and members may not have the time

to participate in such sessions. In addition, due to potential problems of scalability and process losses of which the members may already be aware of, they may not consider the results of the group process credible and therefore may choose not to participate in the initial survey. This lack of participation and trust may render the effects of these computer-unassisted sessions less credible and less valid.

(b) Second, given the large numbers of potential participants in the university community, the process of collecting OCAI data from these large groups, tabulating this data and arriving at an agreed consensus, can be extremely time and effort intensive, and therefore not scalable.

(c) Third, face-to-face sessions may be subject to process losses where many participants in the group may remain quiet, and only the loudest or the most influential members may be heard in a group discussion. This is a conjecture based on findings by Nunamaker, et.al. (See Chapter II for a list of potential process losses (Nunamaker, Dennis, Valacich, Vogel, & George, 1991).

(d) Fourth, it may be difficult for a human scribe to capture the comments and suggestions by most participants

(e) Fifth, in a manual process, it may be difficult for people to arrive at a common understanding regarding their perceptions of the current organisational culture, agreement about the desired cultures, and the means (projects) designed to move from the current to the desired state. This again is a conjecture based on Nunamaker, et al understanding of process losses that hinder group decision making. (Nunamaker, Dennis, Valacich, Vogel, & George, 1991).

(f) Sixth, as culture change is a gradual process and requires ongoing measures at frequent intervals, frequent iterations of process steps (1) to (6) may be required. Each of these iterations can be time consuming and obtrusive; for the reasons of the problems stated in the above five points, iterations may not be possible.

1.4.2 Conjecture as to the Source of These Problems

As observed above, while there are computer programs for eliciting (surveying) individual's current and preferred culture (OCAI) profiles, aggregating them, and presenting them as visual graphs, the current discussion processes for OCAI continue to be a face-to-face manual meeting using paper and with manual graphic devices such as flip-charts. The above problems of scaling (problems (b), (d), and (f) above) and problems of process losses (problems (a), (c), and (e) above) can arise because of the manual nature of these sessions.

As observed in our initial one-half day exercise with senior management, our conjectures were that these problems were even apparent for a small group consisting of 10-15 relatively homogeneous people. For larger groups of over 100 relatively diverse people the problems of scaling and process losses are likely to become even more acute.

1.5 Research Objectives

The objective of this research was to design, develop, and test a computer-based process support system (a group support system). This GDSS or EMS (Electonic Meeting Support System) was used for:

(1) Collecting, Grouping, Summarizing, Graphing, and Reporting OCAI data from multiple participants;

(2) Supporting group discussion and decision-making at both intra and inter group levels for arriving at consensus[1], and agreeing upon culture-change measures; and

(3) Regularly and iteratively measuring progress towards the culture change project.

1 "Common Understanding" may not always lead to consensus, it may lead to polarixation. The use of GDSS, and therefore genuine participation, may lead to "common understanding" but not always consensus. In the use of GDSS we did not see any evidence of polarization, so we are assuming that a common understanding lead to agreement or consensus.

It should be noted that the focus of this thesis is the development and testing of a scalable tool for assessing group organisational culture and the subsequent group discussion. While the measurement and discussion process is useful for bringing about an organisational culture change, the culture change process at SUTD is a much larger and continuing project and is not the objective of this thesis.

However, the effectiveness of this tool however can only be assessed and iteratively developed by observing the "tool-in-use." Therefore while our research objective was the development of a computer-assisted measurement, representation, and group discussion support tool, it was important to evaluate the usefulness of this tool, and gradually improve it in real life "use conditions". Hence in the configuration of this tool and its integration with OCAI, we followed a prototyping process where the tool was evaluated and iteratively improved by employing it in a real-life "use" conditions.

In the absence of computer-support, manual interactive group techniques are the only option. Research has repeatedly demonstrated however, that GDSS technology has tremendous potential for improving group performance (Valacich, Dennis, & Connelly, 1994). Our assertion is that the GDSS technology can be used for culture change and consensus building to support the OCAI tool to increase its scalability, ameliorate its current shortcomings of process losses, and improve the cycle time for long and tedious manual sessions needed to reach consensus.

Moreover, numerous U.S. studies have found that groups using GDSS technology experience more process gains (e.g., satisfaction, synergy, more information, more learning, stimulation) and fewer process losses (e.g., production blocking, domination, apprehension, conformance pressure, coordination problems) than groups using non-GDSS technology or manual technology (Dennis, Nunamaker, & Vogel, 1990; DeSanctis & Gallupe, 1987; Morales, Moreira, & Vogel, 1995; Nunamaker, Briggs, Mittleman, Vogel, & Balthazard, 1996; Steeb & Johnston, 1981; Zigurs & Buckland, 1998). We, therefore, expect that the development and deployment of the GDSS-OCAI tool will result in more credible and effective culture change process.

1.6 Research Methodologies

This research proposes to solve the measurement and group discussion issues of diagnosing and changing culture in SUTD. It does so by developing, using, and testing a computer-based artifact and its "use-methodology".

We used an action design research (ADR) Methodology for developing the proposed in use-methodology. The ADR method is appropriate for this research because of the nature of the study which involves the researcher providing intervention in an organisational problem through the use of an IT artifact. This artifact is constantly refined to perfect the tool. The ADR Methodology in this instance includes the development of an artifact (design research), and the use of this artifact (the software and the use-methodology) for organizational action (Action Research). It deals with two seemingly disparate challenges. (1) addressing a problem situation encountered in a specific organizational setting by intervening and evaluating; and (2) constructing and evaluating an IT artifact (the use-methodology and software) that addresses the class of problems typified by the encountered situation (Sein, Henfridsson, Sandeep, Rossi, & Lindgren, 2011, p. 40)

The generic ADR methodology is described in Chapter II (Lit. Review) and the detailed (and adapted) ADR methodology used in this thesis is described in Chapter 3 "Research Methodology."

1.7 Research Outcomes

The research produced two key outcomes.

1. First, we produced a computer-based (software) artifact that supports the process steps (1) to (6) previously outlined above.

2. Second, it has resulted in Design Principles and Design knowledge about using OCAI and organisational culture change in large organisational group of stake-holders. These design principles and design knowledge are incorporated in the "use-methodology" associated with this software artifact.

1.7.1 Contributions of Research to Practice and Academia

This research contributes to practice as currently there are no tools in the market that can help speed up culture change. Most of the culture change currently being executed in organisations is long and tedious and takes years to complete. The advent of a culture change tool that can reduce process losses, and speed up change will capture the interest of many organisations who will find this an invaluable resource to help align employees to achieve change in a rapidly globalised world.

In academia, the design principles and ideas picked up from designing the artifact can be used as learning points to develop future tools for cultural change and organisational intervention. The ideas can also be used in research pertaining to human resource development and organisation development involving large groups of people.

1.8 Description of the Contents of this Research

Chapter 1 is about the problem context and background of the study. It covers the main scope of the research, its objectives, methodologies as well as expected outcomes.

Chapter 2 is a literature review on organisational culture and the competing values framework and organisational culture change mangement. It also covers barriers to change, group decision support systems, action research, design research, action design research and prototyping. The literature review is key to developing the functional specifications needed for the development of the artifact.

Chapter 3 covers the research methodology used in this dissertation and the functional specifications needed to design the computer artifact for culture change. Key design principles are articulated in this chapter

Chapter 4 deals with data collection after deployment of the computer artifact to the surveyed population. The data expounded the effectiveness of the tool for culture survey and culture discussions. Key statistics and data are explained.

Chapter 5 deals with the discussion of the results for (a) effectiveness of tool in use, (b) the ADR process in the OCAI-Spilter project, and (c) culture results

Chapter 6 is an overall summary and conclusion of the research as it contributes to practice and academia. It also deals with limitations and future research imperatives.

Chapter 2: Literature Review

Research Objectives: The objectives of this research were to design, develop, and evaluate (using the action design research methodology (ADR) a computer-based process support system (a group support system) for:

(1) Collecting, summarizing, and reporting OCAI data from multiple participants;

(2) Supporting group discussion and decision-making at both intra and inter group levels for arriving at consensus about OCAI (organisational culture (current and desired) profiles, and for agreeing upon and managing culture-change measures; and

(3) Regularly measuring progress towards the **orgnisational culture change**.

We designed the support using existing tool components (Spilter) and (OCAI) and also improved the GDSS-OCAI tool by deploying, observing, and improving it in a real-life use situations by following a prototyping process. This literature review will therefore include a review of the process of developing computer-based systems through prototyping and component based software development.

To meet these objectives we examined the extant state of knowledge (literature) about the following five key topics, and analysed how this extant knowledge can be used to design, develop, evaluate and use the organisational culture measurement and group discussion tools to effect an organisation culture change.

Therefore, our Literature Review focuses on the following key topics:

1. Organization Culture and OCAI
2. Change Management
3. Group Decision Support Systems (GDSS) – to avoid process losses, improve group dynamics and participation, enhance decision making ability and creativity
4. Action Research, Design Research, and Action Design Research
5. Prototyping As a Systems/Software Development Process (GDSS and DSS) are typically developed using a prototying process together with component based software development. Moreover, the requirements for the GDSS, and the GDSS itself, is continually and iteratively improved using this process. Therefore it is important to review and learn from the extant state of knowledge about prototyping systems development processes and component based software development.

2.1 Organisational Culture and OCAI

Cameron and Quinn (2011) define organisational culture as, "the taken-for-granted values, underlying assumptions, expectations, and definitions that characterize organisations and their members. It is an enduring slow-to-change core characteristic of organisations" (Cameron and Quinn, 2011). As an organisation's culture is an enduring, slow-to-change characteristic; in this research we are only focusing on the development and testing of a computer-based artifact; the process of culture change is beyond the scope of this PhD Research.

For the credibility and effectiveness of this process, it becomes especially important that members of the organisation fully participate in the process of measurement and discussions about the current and desired organisational cultures and the means of changing the current to desired culture. Van den Berg and Wilderom (2004) in their paper on defining, measuring, and comparing organisational cultures, define culture as "shared" perceptions of organisational work practices within organisational units. Given that these are shared perceptions; it is important that members of the organisation participate in the process of agreeing upon their perceptions of the current culture; and their desirable cultures, and share their perceptions. These cultures may differ from one to another organisational unit. At SUTD, we aggregate OCAI results between different organisational units and at different organisational levels (see chapter 1).

Schein on the other hand, calls organisational culture as "the pattern of basic assumptions that a given group has invented, discovered, or developed in learning to cope with its problems of external adaptation and internal integration, and that have worked well enough to be considered valid, and, therefore, to be taught to new members as the correct way to perceive, think and feel in relation to those problems." (Schein 2004) The invention and discovery process comes about through joint discussion and construction of the perceptions of culture. Thus, in our culture change process, we will be devising ways for working with stakeholders to align the group-patterns of basic assumptions to that of the desired organisational culture.

In building an institution such as SUTD with a radically new and unique vision, culture plays an important role in unifying staff and faculty from diverse backgrounds, training, nationalities, races and religions. It is challenging to align everyone to this new vision, as well as to the underlying core values and traits required for the university to succeed with this vision. "Changing the way things are done appears, on the functional level of systems re-design, relatively easy. Attempting to understand why things are done in their distinctive ways, the factors underlying resistance to change attempts, and the extent to which new practices are sustained is far more challenging" (Scott, Mannion, Davies, & Marshall, 2003).

To begin the process of culture change, it is important to understand the collective thought processes of the organisation by measuring the current culture of an organisation and comparing it to the desired organisational culture. From there, we assess the culture gap, and work through change programs to close the gap between current and desired culture. This requires the use of an organisational assessment cultural tool. We begin the next section by assessing the types of organisational culture measurement tools available.

2.1.1 Measuring Organisational Culture

Next, we review the current management literature for the types of tools used for measuring culture. In Table 2 below, we have included a total of eight popular instruments (Scott et al., 2003) with a short write up and description of the tool. They are subsequently reviewed with the following criteria to identify the most suitable one for our research: The criterias are:

- The instrument should have good face validity
- It should help us to look at both current and desired cultures
- It should examine most facets of organisation
- Must be easily administered, allows for automation, and cost effective
- Relevance to the education industry and to the goals of SUTD at hand in promoting a culture of innovation and collaboration

Table 2. Comparison of culture survey instruments:

Name and Key Reference	**Culture Dimensions**	**Nature of Scale**	**Strengths, Usability, Relevance**	**Limitations/ Reliability and Validity**
Competing Values Framework (K. Cameron & Freeman, 1991; M. B. Gerowitz, 1998; M. L. Gerowitz, Lemieux-Charles, Heginbothan, & Johnson, 1996)	Key Dimensions are staff climate, leadership style, bonding systems, prioritization of goals. Assessment results in four culture types, described as: **clan, adhocracy, market and hierarchical culture types**	Brief scenarios describe dominant characteristics of each type. Respondents divide 100 points between these scenarios depending on how similar each scenario is to own organisation	**Simple and quick to complete, high face validity, strong theoretical basis, assess both congruence and strength of culture and developed mainly for use in educational settings. Measures both current and desired culture**	Narrow definition. Tested on 10,000 executives in 1000 business. Tests by Quinn & Spreitzer, (1991) showed coeffi-cients at .74 for clan culture, .79 for adhocracy culture, .73 for hierarchy culture and .71 for market culture
Organisational Culture Inventory (Cooke & Lafferty, 2012; Ingersoll, Kirsch, Merk, & Lightfoot, 2000; Seago, 1997; Thomas, Ward, Chorba, & Kumiega, 1990)	Shared norms and expectations that guide thinking and behaviour of group members, resulting in 12 thinking styles of individuals within a group; humanistic, helpful, affiliate, approval, conventional, dependent, avoidance, oppositional, power competitive, perfectionistic, achievement, self-actualization. Analysis of these 12 styles result in three factors-people/security culture, satisfaction culture and task/security culture	5 point Likert scale	**Good face validity, addresses both existing and preferred culture**	Analysis result in limited number of aspects of culture. Long and complex to complete, under copyright and may be expensive to use. Tested on 6,444 members from 1090 organisational units

Harrison's Organisational Ideology Questionnaire (Camburn et al., 2013; Harrison, 1972; Litwinenko & Cooper, 1994)	Assess ideology of organisationin terms of orientation to power, roles, tasks and individuals	Respondents rank four statements in each item in terms of how representative they are of (a) the organisation and (b) the respondents own attitudes and beliefs	**Good face validity, addresses both existing and preferred culture**	Limited number of culture types
Mackenzie's culture Questionnaire (MacKenzie, 1995)	Employee commitment, attitudes to and belief about innovation, attitudes of change, style of conflict resolution, management style, confidence in leadership openness and trust, teamwork and cooperation, action orientation, human resource orientation, consumer orientation, organisational direction	Respondents state each statement which they feel is broadly true of their organisation	**Simple to complete**	Designed to assess only specific business units within an organisation
Survey of organisational culture (Tucker, McCoy, & Evans, 1990)	Describes culture in terms of 13 dimensions, orientation to customers, orientation to employees, congruence amongst stakeholders, impact of mission, managerial depth/ maturity, decision making/ autonomy, communication/ openness, human scale, incentive/motivation cooperation versus competition, organisational congruence, performance under pressure, theory S/theory T	5 point scale	Detailed qualitative work conducted as part of development, **has been used in public and private sector**	Used in range of health and non-health organisation
Corporate culture Questionnaire (Walker, Symon, & Davies, 1996)	Four principal domains: performance, human resources, decision making, and relationships	5-point Likert scale	instruments, comprehensive	Long and difficult to complete

Hofstede's Organisational Culture Questionnaire (Hofstede, Neuijen, Ohayv, & Sanders, 1990)	Based on three values, need for security, importance of work and need for authority, Within these, there are 6 factors relating to practice issues; process vs. outcome, employee vs. task, parochial vs. professional, open vs. closed system, loose vs tight control, normative vs. pragmatic	5 point Likert scale	Good theoretical basis and face validity of values and practical issues	Not widely used in English speaking countries
Organisational Culture Survey (Glaser, Zamanou, & Hacker, 1987)	Addresses six empirical factors: **teamwork** and conflict, climate and morale, information flow, involvement, supervision, meetings.	5 point Likert scale	**Easy to use, comprehensive process of development**	Address only superficial issues.

Adapted from "The Quantitative Measurement of Organizational Culture in Health Care: A review of the available Instruments: (Scott, et al 2003)

The above table summarises many of the key culture instruments and their characteristics. A quick review of the table points to OCAI as our most appropriate choice of instrument as it meets all the five criteria that are listed above. The OCAI has strong face validity, is easy to use and administer, measures both the current and desired culture, and is relevant to the education industry. In addition, the adhocracy and the clan quadrants of the culture instrument reflect and integrate well with the innovation and multi-disciplinary culture that SUTD is trying to promote.

Kim S. Cameron and Quinn, (2011) also showed that the OCAI has a strong theoretical basis, and as explained, accessesboth congruence and strength of culture. This has been proven by the extensive testing done by Cameron and Freeman (1991) in a study that encompassed four year colleges and universities (n=334) in the US that covers 3,406 participants. In addition to this, the adhocracy and the clan quadrants of the culture instrument reflect and integrat well with the innovation and multi-disciplinary culture that SUTD is trying to promote.

2.1.2 The Competing Values Framework (CVF)

After evaluating the above table, we chose the Competing Values Framework, and its associated culture measurement tool OCAI suitable for our purpose of bringing about an innovation and collaboration-oriented culture change at SUTD. The CVF/OCAI classifies organisations into four quadrants: clan, hierarchy, market, and adhocracy. It does so, based upon allocating 100 points among these four quadrants for six-dimensions or six facets of the organisation (Cameron and Quinn, 2011).

In this study, therefore, we used the theoretical model—of culture, the CVF and its associated culture assessment instrument Organizational Culture Assessment Instrument (OCAI). The CVF framework is based on a statistical analysis of the key indicators of organisational effectiveness proposed by Campbell, Personnel Decisions, Navy Personnel Research and Development Center, & United States National Technical Information Services (1974). It is formulated on the basis of fundamental assumptions about how organisations work and how they are managed. CVF and its associated OCAI describe and assess organisational culture at micro (individual) and meta (organizational) levels.

CVF is based upon the work by Quinn and Rohrbaugh (1983) on organisational effectiveness indicators. Quinn & Rohrbaugh (1983) analysed these organisational effectiveness indicators and organised them into four main clusters along two major dimensions. One dimension differentiates effectiveness criteria that emphasize organisational flexibility, discretion and dynamism verses criteria that emphasize stability, order and control. Thus, the first continuum ranges from organisational versatility and pliability (Flexibility and Discretion) on one end to organisational steadiness and durability (Stability and Control) on the other.

The second continuum ranges from organisational cohesion and consonance on the one end (Internal Focus and Integration) to organisational separation or differentiation and independence on the other (External Focus and Differentiation).

Cameron and Quinn (2011) name the four quadrants produced by the intersection of these two dimensions: clan, hierarchy, market and adhocracy (see Figure 2). It is important to recognize that Cameron & Quinn state that all organisations have some characteristics of each of these four archetypes. However different organisations can be differentiated by dominance of one or more of these archetypes.

The clan archetype is like an extended family where members work with each other based on internal focus, agility, and flexibility. In William Ouchi's work on markets, bureaucracies and clans (Ouchi, 1980), likened a clan culture as displaying a high degree of goal congruence, typically through relatively complete socialization brought about by high inclusion. Clan organisations also produces a strong sense of community.

A **hierarchy** on the other hand, is characterized by a formalized and structured place to work and is attuned towards stability with an internal focus. The **market** form is based on transaction costs as foundation of organisational effectiveness and it promotes an external stability-oriented focus. **Adhocracy** refers to a temporary, specialized dynamic unit, focused externally and on agility and flexibility. Adhocracy is based on the assumption that innovation and creativity leads to success. Cameron and Quinn (2011) explained that adhocracies do not have centralized power or authority relationships. Power flows from individual to individual or from task team to task team, depending on what problems are being addressed. Emphasis on individuality, risk taking, and anticipating the future is high as everyone in this type of culture becomes involved in production, testing, research and other matters. This experimentation allows for the generation of new ideas and innovation occurs.

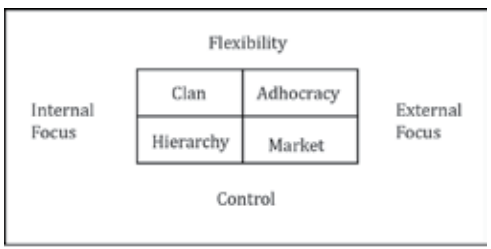


Figure 1. Competing Values Network (CVF)

As mentioned above, one of the CVF's quadrant is adhocracy or "innovation" Another quadrant is clan (which is characterized by "collaboration"). The vision of SUTD is to promote innovation through collaboration. Therefore, the structure of CVF, and its two quadrants, "adhocracy" and "clan" are consistent with SUTD's vision and objectives (also see chapter 1). Moreover, Singapore is a hierarchical, control oriented society–therefore this quadrant also fits in with the underlying Singaporean culture. Finally the fourth quadrant "market" is compatible with SUTDs desire to be the most effective organisation of its kind. Thus the Competing

Values Framework has face-validity for our exercise, and is suitable for measuring the current and desired cultures at SUTD.

2.1.3 The Organisational Culture Assessment Instrument

The Organisational Culture Assessment Instrument (OCAI), designed and validated by Cameron & Quinn (Cameron & Quinn, 2011) is based upon the above Competing Values Framework. It measures the strength of the above four organisational culture types along six content dimensions or six facets of the organisation. These six dimensions or facets, as shown in Table 2 below, are: (1) Dominant Characteristics; (2) Organisational Leadership; (3) Management of Employees; (4) Organisational Glue; (5) Strategic Emphasis; and (6) Criteria for Success.

Each of the six dimensions can be measured along each of the four organisational characteristics (quadrants) thereby creating 24 questions (6 x 4 = 24) in the OCAI instrument. Thus, OCAI includes 24 (4 x 6) items (questions) on which respondent data is collected. An organisation may have scores on each of the four cultural types, just more or less of each. The total scores of each of the six dimensions adds up to 100 points; the 100 points being allocated between four items (A to D) corresponding to each of the four organisational archetypes. Please see a sample of the questionnaire and the scoring in Appendix B.

The sum total of responses to all items marked “A” is calculated as clan culture and plotted on the diagonals in the clan quadrant, as shown in Figure 2. Similarly, we plot scores for all other three quadrants, namely hierarchy, market, and adhocracy. Joining the dots (representing total scores) on each diagonal results in a quadrilateral. This quadrilateral represents the cultural profile of an individual within the organization.

Individual profiles can be aggregated and averaged to get an organisation’s culture profile. An example of an organisation’s culture profile is shown in Figure 2. More of the area of the cultural profile in a particular quadrant corresponds to more the dominance of that cultural archetype. The largest score in a quadrant (i.e. the largest score) indicates the dominant culture in the organisation. These cultural profiles can be plotted separately for each of the six dimensions (see Table 3 below) on the OCAI scale and can be analysed for different demographic variables.

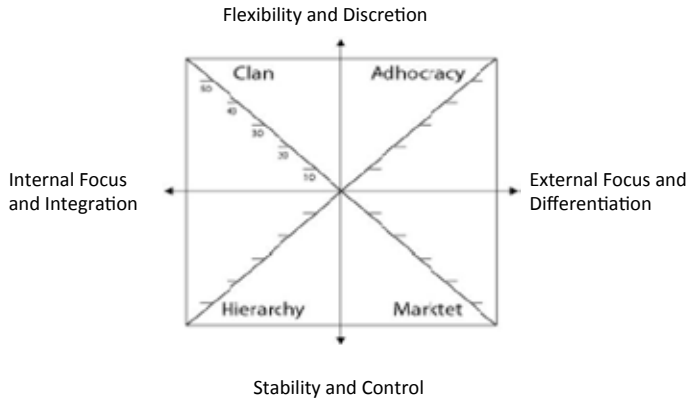


Figure 2. The Four CVF Quadrants.

Table 3. Six Dimensions of culture

1. Dominant Characteristics		**Now**	**Preferred**
A	The organisation is a very personal place. It is like an extended family. People seem to share a lot of themselves.		
B	The organisation is a very dynamic entrepreneurial place. People are willing to stick their necks out and take risks.		
C	The organisation is very results oriented. A major concern is with getting the job done. People are very competitive and achievement oriented.		
D	The organisation is a very controlled and structured place. Formal procedures generally govern what people do.		
	Total		
2. Organisational Leadership		**Now**	**Preferred**
A	The leadership in the organisation is generally considered to exemplify mentoring, facilitating, or nurturing.		
B	The leadership in the organisation is generally considered to exemplify entrepreneurship, innovating, or risk taking.		
C	The leadership in the organisation is generally considered to exemplify a no-nonsense, aggressive, results-oriented focus.		
D	The leadership in the organisation is generally considered to exemplify coordinating, organizing, or smooth-running efficiency.		
	Total		

3. Management of Employees		Now	Preferred
A	The management style in the organisation is characterized by teamwork, consensus, and participation.		
B	The management style in the organisation is characterized by individual risk-taking, innovation, freedom, and uniqueness.		
C	The management style in the organisation is characterized by hard-driving competitiveness, high demands, and achievement.		
D	The management style in the organisation is characterized by security of employment, conformity, predictability, and stability in relationships.		
	Total		
4. Organization Glue		**Now**	**Preferred**
A	The glue that holds the organisation together is loyalty and mutual trust. Commitment to this organization runs high.		
B	The glue that holds the organisation together is commitment to innovation and development. There is an emphasis on being on the cutting edge.		
C	The glue that holds the organisation together is the emphasis on achievement and goal accomplishment. Aggressiveness and winning are common themes.		
D	The glue that holds the organisation together is formal rules and policies. Maintaining a smooth-running organization is important.		
	Total		
5. Strategic Emphasis		**Now**	**Preferred**
A	The organisation emphasizes human development. High trust, openness, and participation persist.		
B	The organisation emphasizes acquiring new resources and creating new challenges. Trying new things and prospecting for opportunities are valued.		
C	The organisation emphasizes competitive actions and achievement. Hitting stretch targets and winning in the marketplace are dominant.		
D	The organisation emphasizes permanence and stability. Efficiency, control and smooth operations are important.		
	Total		

6. Criteria of Success		Now	Preferred
A	The organisation defines success on the basis of the development of human resources, teamwork, employee commitment, and concern for people.		
B	The organisation defines success on the basis of having the most unique or newest products. It is a product leader and innovator.		
C	The organisation defines success on the basis of winning in the marketplace and outpacing the competition. Competitive market leadership is key.		
D	The organisation defines success on the basis of efficiency. Dependable delivery, smooth scheduling and low-cost production are critical.		
	Total		

Adapted from "Diagnosing and changing organisational culture by Cameron and Quinn, 2011

Deriving Group Culture Profile from Individual Culture Profiles: At present, according to Cameron and Quinn (2011), group aggregation of profiles is a simple averaging process where the OCAI scores are added together for all persons in the organisational unit, and then divided by the numbers of responding persons in the unit. Such group profiles are created for each of the above six dimensions (Table 2). Other possible group aggregations could be weighted averages where unit members with high levels of influence in the unit may be awarded a higher weight. For this thesis, except for some very obvious persons, it is not easy to determine the levels of influence of each person in a group; hence, we continued to use the simple averaging method proposed by Cameron and Quinn (2011). This is a limitation of this study.

How is OCAI used? Cameron and Quinn (2011) and various users of the OCAI instrument use OCAI as an instrument for profiling the current and desired (preferred) organisational culture profiles; coming to a group consensus about the group profiles; discussing and implementing organisational culture change measures for moving from current to desired profiles; and measuring progress in their assessment of organisation culture change and measuring culture change itself (from the perceived current profile to preferred or desired profile). OCAI can be used as an instrument for progressively tracking the changes in the organisation's culture profiles at different times during the culture change processes. The differences between profiles at different times along the culture change process provide an indication of the progress towards culture change.

In our research, the OCAI instrument will be used to assess the "gap" between the current culture versus the desired culture amongst each of the stakeholder groups: senior management, staff, faculty and students. Results from the survey will assist us in assessing the results of the culture change process, and devising methods for bringing about a culture change.

We will apply the learning from the above literature on organisational culture to this dissertation. Culture is very complex and not easy to crystalize. However, it is a critical part of the organisational glue that binds people together towards a common vision and goal. In a young institution like SUTD with such a unique vision, developing and ingraining the right culture in its DNA becomes important from the beginning. It is therefore important for us to use the right tool that can reinforce the innovative, creative, and collaborative culture that we want. This tool should be scalable and able to ameliorate process losses, thereby increasing the level of genuine participation in the measurement and consensus generation.

2.2 Organisational Change Management and Culture Change

How do you ensure that everyone in the organisation subscribes to the new culture that you are setting and aligns with it? Marcella Bremer, in her book, "Unleashing your Organisation's Potential in Circles of 10" (Bremer, 2012), states that the most successful way to change is by engaging co-workers and employees so that they are motivated to share interesting information, insights and ideas to improve culture, leadership, engagement, strategy, diversity innovation, and performance. Many other authors have described the necessary steps for organisational culture change (Buch & Wetzel, 2001; K. Cameron, 2008; Hooijberg & Petrock, 1993; Kotter, 1995). As outlined in Cameron (2008), the following key themes on culture change have emerged:



Figure 3: Steps to culture change

First, a period of assessment is required, to identify which aspects of the organisation will need modification. An initial step toward cultural transformation is to define "what it means" and "what it doesn't mean" for the organisation's culture to change (Cameron and Quinn 2011). Hooijberg & Petrock (1993) used surveys based on the Competing Values Framework (Quinn, 1988) to identify the current values and desired cultures. Other authors recommended directly observing the material cultural objects and espoused values within the workplace, and inferring how these objects and espoused values reflect the basic underlying values and culture of the company (Buch & Wetzel, 2001). This was an important first step for this project on culture change in SUTD. We needed to understand the core mission that defines what SUTD should be and from there derive the desired culture. This could be achieved by engaging with key stakeholders on what they think should the desired culture should be versus the current culture. Table 1 in Chapter 1 provides a description of the core mission of SUTD as envisaged by its founder the Singapore government.

The second step is to identify some (at least one or two) positive stories (anecdotes) that reflect the desired culture. These stories, for instance, may highlight a recent example of excellent customer service in a company that desires to become more "customer-centric." Such stories may be motivating and clarify what is to be accomplished by the change. LaGuardia (2011) suggests that the best way to identify stories is through a process of "inquiry, engagement, and review," incorporating surveys, interviews, debates, and posting results in

a common forum. This point of culture change would involve the SUTD senior leadership team engaging with staff and faculty to discuss and agree on the desired culture that is needed to drive strategy. As a part of this engagement, stories about the current and desired cultures would emerge and be recorded and shared with SUTD's stakeholder groups. In the initial days of culture discussion, stories of exemplary students at MIT who embody the SUTD culture were shared. In essence, SUTD is the embodiment of MIT in Asia and she aims to build in Singapore a locale similar to that of MIT. The vision of SUTD comes from Professor Thomas Magnanti who is the Founding President as well as former Dean of Engineering from MIT.

Thirdly, the organisation must then determine strategic initiatives, outlining which activities will be initiated, terminated, or modified. As a group, the stakeholders identify these strategies through brainstorming, reviewing the current processes and policies for improvement, and ultimately discussing and agreeing on the action plan before moving on to step 4. Moreover, the groups regularly monitor progress towards these initiatives in a continuous iterative manner.

Fourth, the organisation should identify "small wins," describing quick and easy, but successful, changes. This strategy will create momentum, reduce resistance (as small, incremental changes are unlikely to generate much opposition), recruit additional supporters, and create "a sense of progress and advancement" that "helps build support for the larger and more fundamental changes" (Cameron 2004). This is akin to the "tune-ups" described by Buch & Wetzel (2001). Tune-ups are shallow changes, often to "artifacts" or visual symbols of culture. Such changes may be as simple as hanging a new highly-visible sign. "The immediacy of the changes produced by "tune-ups" can build trust and commitment to the change process" (Buch & Wetzel, 2001). After the gaps are identified, the key stakeholders in the SUTD project would be engaged in active dialogue to discuss on possible projects or ideas that can be undertaken for culture change. The action plan could include identifying projects which SUTD members could work on to obtain immediate wins. These wins would thus be subsets of the action plan in step 3.

Fifth step entails crafting metrics, measures, and milestones. The organisation must determine the key indicators of success, what to measure, how to measure it, and when certain levels of progress will be noted as a crucial part of the change

process. Change requires the identification of indicators of success in culture change as well as interim progress indicators. A data gathering system needs to be designed as does a time frame for assessing the results. What gets measured gets attention, so the key initiatives and outcomes must have associated with them metrics and measuring processes. Of course, overloading systems with multiple measures is a sure way to kill change initiatives, so the key to good metrics, measures, and milestones is to identify few enough to be helpful, attach them to decisions and resource allocations, attach them to the key levers and indicators of change, and ensure that they are understood by those involved in the culture change process. This should form part of the change document where we capture key outcomes to be achieved and track the milestones of the identified culture change projects.

Sixth, "communicating the culture change process….is a critical tool in helping to overcome resistance and generate commitment. Explaining why the culture change is necessary and beneficial is probably the most vital step in generating commitment" (K. Cameron, 2008). This will be achieved through using clear communication channels and group decision support systems.

Seventh, communications would be shared with as much information as possible; would be disseminated broadly on a regular basis; and would highlight the positive aspects of the environment; and describe the parts of the past that will not be carried forward while avoiding their criticism. Visual symbols of change, e.g. new logos or structures, can be helpful in this regard. This should also constitute the broader project of change through regular management forums, key management meetings, and employee communication sessions. Communication would be achieved through using social media and group support systems to work with team members to ensure commitment and to overcome resistance.

Eighth, Kotter (1995) underscored the importance of creating a sense of urgency. Although rather risky, in some cases, this could mean that organisational leaders sometimes "stage" or identify a crisis. Public reports of customer dissatisfaction and financial losses are often effective catalysts for change, even when purposefully manufactured by company leadership. SUTD is operating in a very competitive landscape where there are more established universities competing for top students and top faculty. This sense of urgency is needed to propel

members to create a unique culture and vision at SUTD that is very different from the other local universities. The leadership will need to bring this important message to faculty, staff and students through regular town halls, forums, as well as through reiteration of its vision, mission and key goals.

Ninth, form a "powerful guiding coalition" (Bremer, 2012; Kotter, 1995). "Building coalitions of supporters among key opinion leaders, involving individuals most affected by the changes, and empowering individuals to implement aspects of the change process are also ways to help reduce resistance" according to (K. Cameron, 2008). Leaders of the organisation must champion the culture change, and future leadership should be cultivated with training in the competencies necessary in the new environment. SUTD President and senior management team are heavily involved in this culture project, and sponsoring it. This will include rallying key members of staff and faculty to champion projects.

Application to learning: The above culture change process from literature helps to guide us in SUTD's culture change process. Many parts of this change process can be used as a blueprint to develop a computer based artifact that can support, automate, and speed up the change process. From looking at the change literature, we understand firstly that the computer artifact should assist us in looking at the current culture gap through the easy to use survey tool that can be built by the OCAI-Spilter program. A computer based survey will be much easier than a paper based survey that is currently available in the OCAI instrument. Subsequently, the computer artifact should also be able to help facilitate the process of change through a facility where different stakeholder groups can participate and a have a voice in the change process. The computer-support will be a Group Decision Systems Support that can be integrated with the survey tool. The meetings can be done online, anytime and anywhere so that maximum participation is possible. The system would also be able to capture all the ideas contributed by team members so that greater buy-in can happen when change projects are carried initiated.

Barriers to change: Many of the the barriers to culture change have been addressed in Chapter 1. We understand from literature that it is a long and tedious process taking years to complete (Baker 2002). In fields such as education, it may be deemed more appropriate to structure change as a gradual, ongoing "process" rather than an abrupt alteration of current systems and structures (Hill

& McNulty, 1998). Basic assumptions, inherent in an entrenched culture cannot be overthrown at once, as this creates cognitive dissonance and resistance (Kuwada, 1991).

"If an organisation has had a long history of success based on certain assumptions about itself and the environment, it is unlikely to want to challenge or reexamine those assumptions" (Schein, 2004). These assumptions often serve as a source of pride and identity and thus are seldom examined or challenged.

A company turnaround or transformation may sometimes require outright coercion (Schein, 2004). Schein further states that "Once a culture exists, once an organisation has had some period of success and stability, the culture cannot be changed directly, unless one dismantles the group itself." Moreover, as most members of SUTD come from successful backgrounds, they may continue to adhere to a culture that made them successful in the first place.

Hence, most processes designed to change organisational culture take a decade or longer (Buch & Wetzel, 2001). Fortunately for SUTD, it is a new organisation with little history or baggage, making culture change and transformation relatively easier. The only history that it has comes from the history of its stakeholders, thus there is no necessity to dismantle any group. It might be easier to change the individual stakeholders' cultures than the whole organisational culture. Furthermore, most of the stakeholders who join this new institution would have some sort of alignment with the mission and vision of what SUTD aspires to become. In this sense, the likelihood of success in the SUTD culture change project is higher.

As Smith (2003) notes, the longer a change takes, the more opportunities there are for things to go awry – which further perpetuates the slowness of the process. Consequently, this research focuses on creating a scalable tool for measuring culture; not the culture change project itself. The latter could be a rather long and drawn out process. On the other hand, if we have an easily used tool to assess culture and changes in culture, we can continuously and regularly assess if the culture change process is moving in the desired direction.

Some culture changes occur naturally over time as the company evolves, while others are planned. The process of initiating change may also differ based upon the stage of the organisation (Schein, 2004). As a group is formed, the decisions made by company leadership also establishes workplace culture, such

as hiring practices and resource allocation. At this stage, culture is likely to be strongly adhered to, as "(1) the primary culture creators are still present, (2) the culture helps the organisation define itself and make its way into a potentially hostile environment, and (3) many elements of the culture have been learned as defences against anxiety as the organisation struggles to build and maintain itself" (Schein 2004).

Once the organisation is established and successful, however, its culture is difficult to change. It often takes a catastrophic event to spur change, such as a major loss or product failure. "To embed new assumptions in a mature organisation is much more difficult than in a young and growing organization because all of the organization structures and processes have to be rethought and, perhaps, rebuilt" (Schein 2004).

Several barriers to rapid cultural change have been identified and they include:

The development of subcultures. "No real-world company works as one uniform whole" (Vilet, 2013). Schein (2004) characterized three types of subcultures: operations (drivers of daily activities), engineering (focused on technology), and executive (often focused on financial matters). Cultural change may occur via systematic promotion of members of a selected subculture, however this is a particularly slow process and the basic underlying culture of the organization may overshadow any attempts at change (Schein, 2004). Furthermore, a worker who is transferred between subcultures requires "time to adjust and get acclimated as if she/he were a brand new employee." As SUTD is a new entity, we do not foresee many sub-cultures that exist as compared to an older institution. Sub-cultures that may prevail, however, would be those that are carried with individuals who come from established institutions with ingrained practices. This will also include differences between different job functions and roles, e.g, administration versus faculty, students versus faculty, senior academic leadership versus administration and faculty and so forth.

Effects of broader social culture. Corporate culture may be more complex than anticipated, as the organisational culture typically descends from, or is influenced by its broader social culture (Weeks, 2004). This is an important point as SUTD has over 27 nationalities working within its premises. The point of contention is also the fact that Singapore is a country that emphasizes hierarchy and control, and thus staff might be operating within those constraints. Thus,

in keeping with the culture of Singapore, our culture change process will be respectful of the Singaporean Hierarchy and Control culture, and would aspire to maintain the essential aspects of that culture.

Effects of the existing culture. The existing culture of the organisation may be one of resistance to change, or the desired culture may clash with the existing one (Smith, 2003). In a case study of the company "Eurel" (a pseudonym), it was stated that "the company culture of tolerance and its aspiration in being an employer for life, perhaps create[d] an amount of stagnation in terms of being slow to change" (Ryan, 2005). Other cultures that experience difficulty with change include those that are inward-looking, bureaucratic, and autocratic (Kotter & Heskett, 1992). As SUTD is a new institution, we do not see effects of existing culture as prevalent. Individual notions of culture brought in by people from other established and successful institutions and practices may on the other hand, influence the existing culture of SUTD. Thus, any change process will have to take into account successful existing cultures and the need to build consensus despite such differences.

Too many interrelated, complex pieces of the puzzle. It is difficult to change culture because "an organisation's culture comprises an interlocking set of goals, roles, processes, values, communications practices, attitudes and assumptions. The elements fit together as an [sic] mutually reinforcing system and combine to prevent any attempt to change it. That's why single-fix changes, such as the introduction of teams, or Lean, or Agile, or Scrum, or knowledge management, or some new process, may appear to make progress for a while, but eventually the interlocking elements of the organisational culture take over and the change is inexorably drawn back into the existing organisational culture" (Denning, 2011). This is a very valid point for SUTD as faculty and administration view their interrelated roles and job functions very differently. The administrators need to impose rules and regulations as a result of compliance, while the faculty see them as obstructions to their research and teaching.

Ineffective or slowly transitioning leadership. New leadership does not necessarily mean a shift in culture. Grooming new leaders takes time. When a leader selects and trains a successor, it is often someone from within the company, usually in the leader's own image. Less resistance to new management may be expected if the leader is "one of us." Particularly when leadership is passed down

through a founding family, this person is likely to adhere to the present culture and is trained in the likeness of past leaders. If a successor appears to stray too far from established values, the previous leader may intervene (Schein, 2004).

Cultural shifts may occur if new outside leadership is established and workers who do not adhere to new standards resign or become forced to leave. As with the promotion of internal employees, however, new outside leadership does not necessarily translate to a change in culture. When James Wolfensohn was brought in to lead World Bank from 1995-2005, he "launched a massive reorganisation that preoccupied managers and staff for several years, though as in earlier reorganisations, the culture re-emerged largely unscathed from the experience, despite the changes in personnel and structures." In later years, under new outside leadership from Paul Wolfowitz, "the organisation, which has no tradition….of bringing in new managers from outside, responded like an immune system reacting to invading pathogens." If new leadership is not accepted, new systems fail to result in improvements, the new leader is not given credit for success, or the new systems are too threatening to core believes, the new management may then be discredited or forced to resign (Schein, 2004).

Culture change may also be stimulated by bringing new employees from outside of the company into jobs below the top management level and allowing them gradually to educate and reshape the thinking of company leadership. This is most likely to happen when the new employees serve as managers of subgroups, reshape the cultures of those subgroups, become highly successful, and hence, create a new model of organisational function (Kuwada, 1991; Schein, 2004). This process takes time. Perhaps the turnaround of World Bank under the guidance of Robert McNamara in the late 1960's to early 1970's was relatively rapid, with a new philosophy accepted within four years, because of a new leader with a clear vision, but one who did not waste time at the beginning with reorganisation or hiring a new workforce (Denning, 2011).

These points are applicable for SUTD. SUTD is in a "building up phase", and still recruiting senior academic leadership to lead key teams. This means the current SUTD leadership is in a formative stage and is not already ossified into existing patterns of behaviour and culture. Both leadership and the organisation culture are changing symbiotically; with new recruits both shaping the organisational vision; and being shaped by the expectations of the organisational vision. As

new people are introduced into the institution from time to time, there will be re-assimilation into the cultural norms.

Moreover, these new individuals will, through an open discussion process facilitated by our proposed computer-assisted OCAI-GDSS/EMS integration tool, have an opportunity to shape the desired culture at SUTD. On the other hand if they stray too far from the cultural vision (desired culture) they are likely to feel uncomfortable with the cultural evolution at SUTD and may leave.

Excessive turnover. In the attempt to transform the culture of long term care facilities, it was noted that the effective administrators were "frequently removed temporarily from their facility to "fight fires" and deal with crisis situations in other facilities or they were promoted into regional supervisory positions. In both situations, these actions effectively serve to delay and short-circuit the development and/or implementation of culture change in the primary facility" (Scalzi, Evans, Barstow, & Hostvedt, 2006). As part of this culture project, the SUTD HR strategies of retention becomes important. The HR team would have to work closely with senior management to implement strategic HR intervention programs to retain core talent within the teams. Moreover, as SUTD being a local, relatively new institution, there would be lesser likelihood of key personnel being removed temporarily from their facility, or being promoted out of their responsibilities.

A lack of psychological safety. A worker may feel anxious when learning new information or methods (Schein, 2004) or when his/her role or value within an organisation is unclear (Abdul, 2014; Hill & McNulty, 1998). To create psychological safety requires a significant investment of time and effort into training. Furthermore, staff members "are not going to change their way of seeing their job and their own role overnight" (Hill & McNulty, 1998). Group Decision Support Systems allow for a platform where staff can voice their concerns anonymously and provide the platform for change. The tool allows for staff interaction and participation in the change process, thus reducing the anxiety associated with change and learning of new methods.

The need for confirming data. It takes some negative experiences to spur change; it will take some positive, confirming data to stabilize and internalize a new cultural viewpoint. If these positive data are not presented, further change may be catalyzed (Schein, 2004). Depending upon the outcome measures, it

may take time to see the effects of a cultural shift. The question of how online platforms such as the one we are developing, can assist in data collection and dissemination of results, will be explored in this Ph.D. project.

Unclear or ineffective processes for attaining goals. A new goal may be established, but senior management may not be clear about how to attain that goal, leaving the employee to adopt a "trial and error" approach. While perhaps time-consuming, this approach of employee involvement often leads to greater internalization of a new value system (Schein, 2004). Moreover, as our culture change process has the stakeholders participating in defining the desired culture, and the means to achieve it, there is less chance that the stakeholders and senior management will not be clear about how to attain the goal. In this project, we explored the use of the computer artifact to faciliate communication regarding the methods for goal attainment.

In other cases, a new goal may be established, but processes are not changed to reflect new values. Hence, change is slow or nonexistent. As in the case of World Bank under the leadership of Wolfensohn, the "goal was for the first time clearly focused on fighting poverty. However as all of the management systems and processes remained focused on getting out the lending program, the [new] mission statement has still had little operational impact" (Denning, 2011). Again, as the stakeholder groups are participating in identifying measures for culture change, there is less likelihood that process change will not accompany the change of goals.

Issues related to resources and controls. A lack of working capital or other resources, or poor resource allocation, may inhibit change (Abdul, 2014). In the case of the nurse education merger described by (Hill & McNulty, 1998), the organisation ran into roadblocks due in part to the "contract manager's need to keep tight central controls on the budget in at least the first year of the contract." placed in his full support behind this project and provided the needed resources.

Changes are not carried forward. Successful strategies may not be passed down to new leaders, or memories may become blurred regarding why strategies were successful (Kotter & Heskett, 1992; Smith, 2003). It is possible that on-line platforms and word-of-mouth could help to transmit strategies and success stories to the next generation of leaders. As we are able to use the GDSS system for group discussion and feedback, this would allow regular iterative

measure of progress towards culture change. Regular monitoring means that we would get an early warning if the change is not carried forward, or if (or when), with experience, the goals themselves change.

Perhaps most importantly, the need for clear communication. In the case of the nursing education merger (Hill & McNulty, 1998), "One of the first tasks was to involve the senior team in a range of activities that would encourage their commitment to the new contract management. This involved setting up meetings, sharing information and involving them in a range of project teams to address particular issues." Face-to-face meetings take time, and may be particularly difficult if there are a large number of people involved and employees are spread across multiple campuses. As Hill & McNulty (1998) noted, "it is very difficult to get everyone together regularly and involve them in departmental matters, although shared meetings such as teaching workshops, academic liaison meetings and research forums are available to all staff." The importance of communication was echoed by Smith (2003), Abdul (2014), and Spicer (2011). In 1991, Kuwada suggested that "face to face communication is the most powerful way of exchanging and processing rich information." Again, with the use of the GDSS platform provides a venue for people to gather together to share and exchange ideas. Other activities to perpetuate the culture change will be performed through regular forums and meetings, and use of other social media platforms such as facebook or the university intranet. We do however need to note that this research only has a limited objective–that is to develop and test a computer-based tool for supporting the longer term project of culture change running in the background. These caveats and solutions are useful for the larger background project and may be applied to the presesnt research only insofar as they affect the real-in-use prototyping process.

The above literature on the management of change outlined the challenges faced during the culture change, including the issues of scalability and procesess losses.

Group Decision Support Systems/EMS may help to address these barriers. These loses adapted from Nunamaker et al. (1991) include the following

Table 4. Group Process Losses

Name	Description
a) Attention Blocking	New comments are not generated because members must constantly listen to others speak and cannot pause to think. This can result in an organization not getting consensus in the change process
b) Failure to remember	Members lack focus on communication, missing or forgetting the contributions of others. Key ideas might be lost in the change process
c) Conformance to pressure	Members are reluctant to criticise, missing or forgetting the contributions of others. This might result in lesser buy-in to the change process
d) Evaluation apprehension	Fear of negative evaluation causes members to withhold ideas and comments. This will result in lesser buy-in to the process of challenge
e) Free Riding	Members rely on others to accomplish goals, due to cognitive loafing, the need to compete for air time, or because they perceive their input to be unneeded. This will result in passivity to the change process
f) Air time Fragmentation	The group must partition available speaking time among members. Key ideas are thus lost in the process
g) Attenuation Blocking	This occurs when members who are prevented from contributing comments as they occur, forget or suppress them later in the meeting because they seem less original, relevant or important. This could result in resentment toward others and resistance to the change process
h) Concentration blocking	Fewer comments are made because members concentrate on remembering comments until they contribute them. Again, in this, lesser ideas are generated
I) Information overload	Information is presented faster than it can be processed. Members in this case are not able to grasp all the information needed and participate in the change process

Adapted from.Nunamaker et al. (1991)

In this dissertation, I developed and tested a computer artifact using an Action Design Research approach by integrating the use of the OCAI tool with Spilter (a configurable Group Decision Support Systems or EMS tool). The computer-based OCAI tool was designed to speed up the process of culture change, reduce the scalability problem, and reduce process losses during the change project.

The literature review below suggests the benefits of GDSS technology as well as strategies that can potentially help to improve the use of such technology for process change.

2.3 Group Decision Support Systems/Electronic Meeting Systems

Huber (1984) was one of the first few authors who expounded the need for the use of GDSS systems. He noticed in the early days that, “the need for such Group Decision Support Systems, whether designed by the user or by a vendor, is a consequence of the clash of two important forces—the environmentally-imposed demand for more information sharing in organisations and the resistance to still more meetings.

Later, Nunamaker et al. (1991), observed that Electronic Meeting Systems in the early days, were used to directly impact and change the behaviour of groups to improve group effectiveness, efficiency, and satisfaction. This technology resulted in fewer process losses, sped up group decision making and reduced biases. In this section we explore the literature on what is Group Systems (or EMS) and how its use help to reduce process losses and improve effectiveness in group decision making.

A Group Decision Support System (GDSS) is an interactive, computer-based system that helps a group of actors or decision-makers solve problems and make choices. A GDSS is targeted to supporting groups, working together as a group, in analyzing problem situations and in performing group decision-making tasks (DeSanctis & Gallupe, 1987; Huber, 1984).

A Decision Room is a type of GDSS discussed extensively in GDSS/EMS literature. A Decision Room refers to the physical arrangement for using a Group DSS. In a single room, workstations are made available to meeting participants for a same-place, same-time meeting. The objective in using a Decision Room is to enhance and improve the group’s decision-making process. Technology has advanced substantially since the early papers on this topic and there now exists web technology that can make the decision room virtual without having the entire team doing this in one venue. It is the intention of this research to create a anytime, anyplace group discussion, however, this discussion would be limited to a certain pre-specified duration.

Characteristics of a Decision Room include:

1) Each participant has a computer workstation;

2) A leader (facilitator) coordinates the meeting;

3) The room has a display screen that all participants can view;

4) Computers are networked and client/server architecture is used; and

5) Specialized software is available to all participants

GDSS-Decision Room allows participants to sit together anonymously and have equal air time through using GDSS software. By having equal air time, individual can participate actively in the group's strategic meetings and contribute ideas productively. GDSS reduces process losses through task structure, task support, process structure and process support (Nunamaker et al., 1991). **Task Structure** assists the group to better understand and analyse task information. This is achieved through problem modelling, multicriteria decision making and other methods. Individual and group OCAI, current and desired profiles and the gaps between them, provides us with easily understood problem models. The ensuing group discussion helps the participants consider multiple aspects of the culture change problem and thus helps in multi-criteria decision making. **Task Support** reduces process losses arising due to incomplete use of information and incomplete task analysis by providing information from previous meetings. As the EMS information is available to all participants, the problems of incomplete information, use and incomplete task analysis are reduced. **Process structure built into the GDSS/EMS** allows for a proper flow of the meeting and thus reduces process losses due to co-ordination problems. Lastly, **process support** allows for parallel communication, group memory and anonymity. This allows everyone to communicate simultaneously.

Nunamaker et al. (1991) argue that EMS, a channel of communication, in the GDSS, strengthens process support through group memory, anonymity, parallel communication and media effects. Effective communication is achieved through support, task structure and process structure to reduce process losses. An EMS/GDSS, by making the group discussion available to a large number of people, improves meeting scalability and reduces process losses as follows:

- Parallel communication, as compared to sequential communication, reduces the time required for people to express their opinions, promotes broader input into the meeting process, and reduces the chance that a few people dominate the meeting.

- Anonymity mitigates evaluation apprehension and conformance pressure, so that issues are discussed more candidly.

- Group digital memory (reproduced on the computer screen) enables members to pause and reflect on information and opinions of others during the meeting and serves as a permanent record of what occurred.

- Process structure helps focus the group on key issues and discourages irrelevant digressions and unproductive behaviors, while task support and structure provides information and approaches to analyse it.

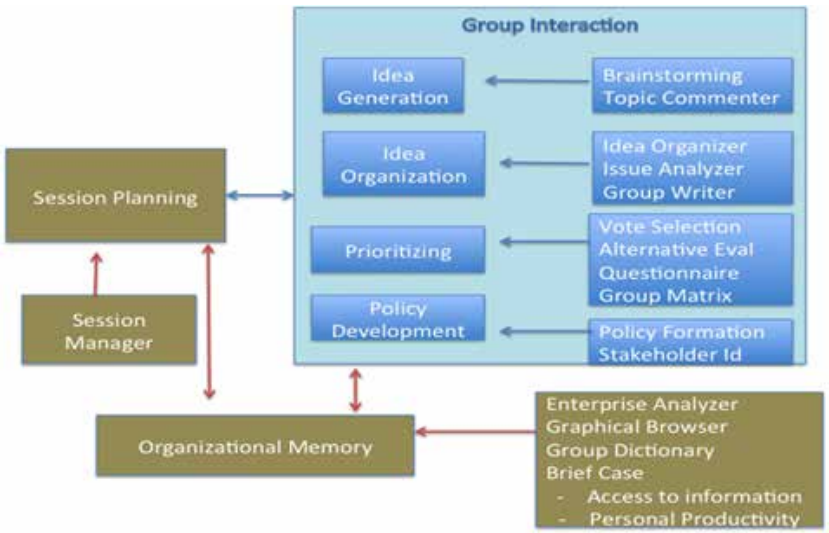


Figure 4: Typical Flow of a GSS Meeting.
(Source: Nunamaker et al. (1991)

In another paper chronicling a dozen years of experience on GDSS research, the authors Nunamaker et al. (1996) explain that the groupware inside GDSS caters to three work group levels: A) an individual level which is uncoordinated

individual effort toward a goal, B) a coordination level which is co-ordinated but independent effort, and C) a group dynamics level which is concerted effort toward a goal. This allows for participation at all levels of the workgroup. For example, in a culture change scenario, individuals and groups can input their individual ideas, as well as pull their ideas together for reaching group consensus.

Table 5. Productivity Process Benefits at Different Levels of Participation from Group Support Systems.

	Communication	**Thought**	**Information Access**
Group Dynamics Level	Anonymity Parallel Contribution	Structured and Focused Processes	Session Transcripts, Automatic Concept Classification
Coordination Level	Asynchronous Communication	Schedule Matching Automated Workflow Project Management	Shared Data Stores
Individual Level	Preparing Communication Stimuli	Modelling Simulation	Info Filtering Local Data Stores

Each cell contains examples of the kind of support available for a particular process at a particular level of work. Source: Nunamaker et al. (1996).

Based upon a dozen years of research and experience with GDSS (Nunamaker et al., 1996), other observations include the ability of GDSS/EMS to do the following:

a. Increase buy-in from key stakeholders
b. Increase the speed of goal achievement
c. Enhances the effectiveness of a well led team (but does not replace leadership)
d. Reduce labour costs by more than 50 percent
e. Enable role clarification: help to identify those having a stake in a project and to reveal underlying assumptions
f. Allow more participation
g. Increase the number of ideas contributed as a result of anonymity
h. Improve cross-cultural collaboration

A study of group systems used in IBM Corporation in 1986 to solve problems on the production-line quality show a 50 percent savings in cost and labour for teams using technology. A descriptive evaluation of 54 case and field studies from 79 published papers spanning two decades of GDSS research by Fjermestad (2000) reported the following key benefits of GDSS.

a. Leads to improved effectiveness and efficiency of the group (Adelman 1984)
b. Allows much larger number of personnel to be actively involved in the planning process resulting in higher quality product (Adkins, Shearer, Nunamaker Jr., Romero, & Simcox, 1998) (Adkins, Sheare, Nunamaker, Romero & Simcox, 1998).
c. GDSS leads to the generation of more high quality ideas, in a shorter time period (Alavi, 1993).
d. Reduced the amount of time and the number of times that teams were in conflict (storming) (Caouette & O'Connor, 1998).
e. Provides structure and flexiblity as well efficiency and effectiveness for large groups. (Dennis, Heminger, Nunamaker, & Vogel, 1990).
f. Outweighs the obstacles encountered in a manual session. In addition, the users report high levels of satisfaction with the outcomes and rate the GSS as an important tool for idea generation (Nanamker, Applegate, & Konsynski, 1987).
g. Helps to achieve global objectives in a system design project by supporting efficient data collection and model construction activities (de Vreede & Dickson, 2000).

Chidambaram, et al. (1990) conducted a longitudinal study of the impact of GDSS on Group Development. They conducted this study by comparing the behavior of GDSS groups versus manual groups over four sessions, in a controlled lab setting. In general, they found that groups with computer support and those without computer support exhibited different patterns of development over time. The ability to manage conflict and the degree of cohesiveness were both higher for manual groups during the first session. However, this was not true for the entire duration of the study. As the experiment progressed, GDSS groups became more cohesive and managed conflict better than manual groups.

These findings were important for our OCAI-Spilter integration project. They suggested that the first-time behavior or performance of groups does not tell the entire story. In order to have a more complete understanding of the impact of GDSS on group behavior, we needed to observe and measure the culture change efforts longitudinally over repeated sessions.

2.3.1 GDSS and User Interface

On the topic of GDSS and user interface, Huber (1984) highlights two important points for developing software for GDSS:

1. The GDSS should be built as independent special-purpose modules and it is important that subtle differences in user interface be made as this can lead to big differences in group dynamics.

2. and provide easy import and export capabilities both between modules and with external tools.

One important feature of GDSS is a **polling and ranking feature**. Just as the purpose of decision support systems is to increase the effectiveness of individual decision makers by facilitating the interactive exchange and use of information between the individual and the computer, the purpose of group decision support systems is to increase the effectiveness of groups by facilitating the interactive sharing and use of information among group members and between the group and the computer. The polling and ranking feature allows for members to put a poll to the ideas that they like and to rank them in the order of what they think are important. This feature allows for maximum participation and response from participants as it is interactive and allows for freedom of expression and contribution of ideas.

Effective utilization of the GDSS system will also depend upon the following three factors:

1. User skills (eg, facilitator skills, chauffeur skills and participant skills) decline if they are not utilized. There may be a critical frequency of GDSS use that must be attained in order for the system to survive in any given organisational environment.

2. Since the frequency of a GDSS use is partly a function of the number of group tasks it supports, there may be a critical number or set of group tasks that the GDSS must support in order for it to survive in a particular organisational environment.

3. Finally, since the number of group tasks that a GDSS supports is partly a function of the number and nature of the GDSS capabilities, there may be a critical number or set of capabilities that the GDSS must possess in order for it to survive in a particular organisational environment (Huber, 1984).

4. Fortunately the GDSS/EMS component of our artifact is an item of software that has been used and tested in several use situations. We are also using and evaluating it in a “use” situation. These two criteria and the four requirements for GDSS outlined by Huber (1984) are included in our artifact. Moreover, as we are iteratively improving the artifact by observing it in use, we would be able to observe and report on the iterative requirements for the gathering and development processes for our artifact.

2.3.2 Facilitators and Group Systems Support

Bostrom, Anson, and Clawson (1993) argued that the use of GDSS by itself, although having many benefits, would not yield its maximum effectiveness without the input of a good facilitator. The authors stated that a facilitator plays a key role in the success of GDSS systems. Integration of good computer tools with effective human facilitation can lead to more effective meetings. (Table 6)

Table 6. Key Finding from Group Process

Interventions that improve group processes and outcomes
1. Apply structured Procedures a. Providing instructions to group memers (J. Hall & Watson, 1970) b. Extending problem formulation (Volkema, 1983) c. Separating idea generation from evaluation (van de Ven & Delbecq, 1974
2. Encouraging Effective Task Behaviours a. Discussing task procedures (Hackman & Kaplan, 1974) b. Applying explicit criteria (Hirokawa & Pace, 1983) c. Using factual information (Hirokawa & Pace) d. Maintaining focus on task goals (Dalkey & Halmer, 1963)
3. Encouraging Effective Relational Behaviours a. Encouraging broad participation and influences (Hoffman &Maler, 1959) b. Managing conflict constructively (Putman, 1986) c. Emphasizing consensus acceptance over majority votes (J Hall & Watson, 1970) d. Applying active listening techniques (Bostrom, 1989(e. Discussing interpersonal processes (Hackman & Kaplan, 1974)
4. Training a. Training group members and /or leaders (J. Hall & Williams, 1970) b. Training external facilitators (Anson, 1990; Bostrum, 1989; Hirokawa & Gouran, 1989, N. Maler & Maler: 1957: miner, 1979; White et al., 1980)

Source: Bostrom et al. (1993).

At SUTD, we continue to use a facilitator. However, we need to modify the protocols for facilitator use, from a face-to-face same-place, same-time situation, to one of distributed facilitation, in an any-place any-time use situation.

2.3.3 Future of GDSS

We conclude from this brief history that DSSs research and practice have evolved together with information technology. As (Orlikowski, 1992) points out, technology plays a dual role in both enabling and constraining human activity. Humans can only do what is feasible with technological resources. Thus, the concept of DSSs to support concentrated human problem solving was not really feasible until we could interact with computers. IT could not support groups until networking infrastructure was readily available. Knowledge-based DSSs were not feasible until AI and expert systems concepts were developed. As information technology seems to be expanding exponentially and becoming ubiquitous and new technology-enabled organization forms regularly continue to regularly emerge, opportunities for DSSs will become ever more extensive. Ultimately, for research to continue to produce meaningful ideas for organisations, researchers of the future must strive to integrate technology evolution into the concept of organisational decision support while understanding that technology, decision-making processes, and organisational support are different focus of the research

The second trend for the future is the use of social media for group decision support. Social networking plausibly extends group support systems, but currently rather than brainstorming organisational requirements, users brainstorm more socially-oriented ideas such as movie or restaurant popularity. This is often done through the voting process such the process of “liking a page” in Facebook or placing a publicly posted comment. Negotiations between differing rankings may take place in, or be supported by, social media. Social networking applications are beginning to be seen in critical group decision-making as well. For example, social networking has been discussed as a tool to support pilot decision-making (Scott & Carrington 2011) or decision-making in healthcare (Griffin & De Leastar, 2009).

Since the time of Group Decision Support Systems of the 1980s and 1990s, the group systems in Arizona have evolved into that of web based system named “Think Tank”. The system now has the capability of anytime; anywhere function where collaborations can be done for virtually any type of project or planning situation. As a result of new technologies, the use of Decision Rooms may no longer be applicable.

In a recent paper on GDSS adoption (van Hillegersberg & Koenen, 2014), the authors explained that although the use of such technology aids in effective decision-making, the adoption is poor due to improperly designed GDSS sessions, technology breakdowns and unskilled participants or facilitators. They ran a study to validate this proposition through interviews with frequent users, less frequent users, former users and non-users. Conclusions from the study found that low adoption was due to several factors such as resistance to new tools, long preparation time needed to set up GDSS, and fear of losing face-to-face contact. GDSS is also seen as having no proven effect on results and having a high investment cost. These results support the claim that a skilled facilitator is crucial to the success of GDSS adoption. In addition, picking the right meetings and user groups for early adoption is also crucial. Based on these recent studies, the findings are important considerations for the design of the artifact in SUTD.

2.3.4 Current Group Decision Support Systems Technologies

Technology has advanced in the 21st century and many of the GDSS technologies in the present day have moved from the traditional decision rooms to modern day on-line interactive systems that can be accessed anytime and anywhere in the world on a 24 X 7 basis. The many GDSS tools include commercial systems like Think-Tank and Spilter, which are business collaboration tools that allows for professionally facilitated workshops. Others such as Meeting Sphere and Monsoon are more integrated tool kits for everyday online meetings and workshops. In this dissertation, we will be using the Spilter tool. Although it has less functionality than Think-Tank, it is simpler for users, is less complex to manage, and has functionality that is sufficient for SUTD use. In addition, it is available for use free of charge, and the Spilter developers are very open to collaborate with research institutions and to work jointly on adaptations of the tool.

Our artifact will integrate the state of art internet and web-technology (Spilter) for GDSS/EMS with an organisational culture assessment tool (OCAI).. As technology further evolve, (i.e. by the use of cloud-computing) we expect our instrument to be modified to employ new technology. Another possible technology-based improvement in our artifact would be the use of data-mining techniques to analyse the large amount of data collected in the culture assessment and change process. However, this functionality does not currently exist, and is part of future improvements to our designed artifact.

2.4 Action Research and Design Research

2.4.1 Herbert Simon – Sciences of the Artificial

The concept of Design Research, and its successor Action Design Research can be traced back to the seminal, but often ignored work by Herbert Simon. In Herbert Simon's book, "The Sciences of the Artificial" (1996) he reiterated that thinking and problem solving behaviour is artificial–learned, and subject to improvement through the invention of improved designs and their storage in memory.

Simon emphasized that "man" the designer must learn more about the theory and process of design. This relates to the formal logic of design, search methods, the theory of structure and design, and the representation of design problems. Design is also the core of SUTD's vision. Therefore Simon's concept of an artifact, and the artifact design methodology espoused in his book "Sciences of the Artificial" are appropriate points for us to start the discussion of our research methodology.

In the Science of Design: Creating the Artificial," Simon (1988) noted that engineering, architecture, and business schools whose central task was that of design, revolted some years ago against a "cook-book" approach to their subject, and started to gain technical mastery and increased respectability by turning over more and more of their courses to the basic sciences. Simon argued that an unfortunate side effect was that students in professional schools had very little teaching of how to bring together (integrate) the various techniques they had learned from basic sciences into the creative solution of design problems. Thus, in chapter 5, he stated the importance of setting up actual courses in design, and concluded by drawing up a curriculum in design - in the sciences of the artificial - to take its place by the side of natural science in the whole engineering curriculum. Simon lists the following topics as needed for "design":

a) The evaluation of designs – This would include theory of evaluation such as utility theory, statistical decision theory as well as computational methods (Simon, 1996, p. 134)

b) The formal logic of design – This would include imperative and declarative logics (Simon, 1996, p. 134)

c) The search for alternatives – This would include heuristic searches such as factorization and means-end analysis (Simon, 1996, p. 134)

d) The theory of structure and design organization--This would include hierarchic systems. (Simon, 1996, p. 134)

Simon defines the term "designer" broadly to refer to anyone "who devises courses of action aimed at changing existing situations into preferred ones" (Simon, 1996, p. 55). The design process has emerged since the 1970s and applies to engineering and other professional disciplines. Design theory, as expounded by Simon, is thus aimed at broadening the capabilities of computers to aid design, drawing upon the tools of artificial intelligence and operations research. Design is concerned with improvement or how "things ought to be", and with "devising artifacts to attain goals and about problem solving".

In his paper with D. Kulkarni "The process of scientific discovery: the strategy of experimentation" (Kulkarni & Simon, 1988), Simon simulated the reasoning of chemist Hans Krebs during the experiments, which lead him to discover the "ornithine's cycle.". The program simulated search procedures where hypotheses were generated and evaluated. After several iterations, a satisficing level of comparative-confidence characterized the discovered effect. Thus, to Simon, design, creativity and discovery were composed of the same repertoire of heuristics that we can find in usual problem solving within a bounded-rationality perspective.

Simon thus argued that whether we are looking at the evolution of animals, or the progress of human problem-solving or design, if useful solutions are to be achieved in reasonable times, then some sort of hierarchical organisation seems almost necessary. As a particular formal expression of such a hierarchical arrangement, he introduces the idea of a nearly decomposable system, in which we may distinguish subsystems within which there are strong interactions, but between them there are only weak interactions. He also discussed the problem of finding simple descriptions of complex systems, and contrasted the state description with the process description.

Herbert Simon's theory from The Sciences of the Artificial set a basic foundation for the present research topic and proposal. In this study, we used the principles of design as proposed by Simon to develop a computer-based artifact that can support and accelerate the current manual process of culture change.

The Sciences of the Artificial, as a contemporary research methodology, was developed through three streams: 1) Design Research (Designing computer-based artifacts to improve the human condition (Hevner et al. (2004). 2) Action research (especially participative action research, where the researcher works together with the stakeholders to design an organisation to address a human problem (McNiff, 2013) and 3) Action design research where the researcher works with the participating stakeholders to develop an action solution, that could also include a computer-based artifact (Sein et al., 2011).

This artifact will be developed through the Action Design Research Methodology (Sein et al., 2011). This methodology is grounded in Herbert Simon's ideas as expressed in his book, The Sciences of the Artificial. In the next few sub-sections, we will review the literature in action research, design research, action design research as well as prototyping, to understand the applications of the theories to the development of this computer based tool.

2.4.2 Action Research (AR), Design Research (DR), and Action Design Research (ADR)

In this sub-section we briefly examine the literature on action research (AR), design research (DR) and action design research (ADR).

Action research as explained by McNiff in her book, Action Research, is a process that involves the researcher not just being a passive observer, but as an active participant in the research process. "The Action Researcher (AR) thinks carefully about the circumstances they are in, how they go there, and why the situation is as it is" (McNiff, 2013). Action Research helps to generate knowledge that can lead to improved understanding and experience for social and environmental benefit. The following key principles of action research as expounded by McNiff includes the following (McNiff, 2013, p. 20):

1. Action researchers see knowledge as something they do, a living process in a constant state of development. Reality is a process of emergence, surprising and unpredictable.
2. The action researcher believes in improving lives and status quo

3. Action researchers use learning and experience as processes that enable individuals and groups to negotiate choices about who they are and how they are together.
4. Action researcher asks questions about the implications of knowledge on socio-political and environmental issues.
5. Action researchers use their knowledge for social and environmental well-being.

Action Research is grounded in a robust methodology when producing new knowledge. This involves gathering data, generating evidence, producing theory and making judgements about its quality and usefulness. The action Researcher will need to produce professional narratives, gather data and provide evidence to show that their work have influenced the quality of life for others.

Other researchers on action research point out that it is a change-oriented research methodology which seeks to introduce changes with positive social values, the key focus being on a problem and its solution (Elden and Chisholm, 1993). There is a vast amount of literature available on action research. The following is only a brief sampling of the relevant literature.

Baskerville and Wood-Harper (1996, p. 239) mentioned that 'the ideal domain of the action research method' is one where: "the researcher is actively involved, with expected benefit for both researcher and organisation; the knowledge obtained can be immediately applied…. research is a cyclical process linking theory and practice" (Baskerville & Wood-Harper, 1996). The researcher can intervene in the problem situation, before applying and subsequently evaluating the value and usefulness of the theory. This practice enables the researcher both to validate and improve upon existing theories and to introduce practical improvements in the problem situation investigated (Checkland, 1981).

The canonical Action Research (CAR) (Davidson 2004) based AR on five principles:

1. The principle of the researcher-client agreement – solving problems in a joint collaboration within a mutually acceptable ethical framework (Rapoport, 1970).
2. The principle of the cyclical process model – diagnosing, action planning, action taking, evaluating and specifying learning (Susman & Evered, 1978)

3. The principle of theory – need theory to guide action (Davidson et al (2004).
4. The principle of change through action –an improvement in the client's problematic situation should occur with the AR cycle.
5. The principle of learning through reflection – the researcher and client examine what they have learned in an explicit, systematic and critical manner (Davidson et al. 2004).

In the case of this research project, we designed the use of an IT artifact to facilitate and help effect organisational culture change. Consequently, these principles and practice of action research came into play. The action design framework was used in this research to develop the OCAI-Spilter tool for culture change.

As an action researcher, I worked within the organisation with internal clients at SUTD to develop the tool. As in Davidson's principle 1, we established a joint working relationship with the senior management team to build the SUTD culture through the use of the OCAI-Spilter tool. This involved principle 2. We used the cyclical process model to diagnose the intervention needed through the use of the OCAI culture tool. After understanding the culture gap, the action researcher through principle 3 worked with the team to devise programs to close the gap. Learnings were gleaned from this process. The use of ADR methdology guided the process of culture change using the IT artifact developed. This resulted in change through action and the learnings gathered helped the action researcher to continuously and iteratively improve the tool through continuous feedback as exemplified in principle 4.

We next delve into the literature on Design Science Research.

Used in conjunction with action research, design Science is aimed at devising or improving artifacts to attain goals and to create things that serve human purposes. Typically it is technology-oriented. The products of design science are assessed against criteria of value or utility. – "does it work, is it an improvement?" Design to improve value and utility is a key activity. Flyvbjerg (2006), however, suggested that, improvement, value and utility are commonly defined by the prevailing culture, accepted by the technician, and not investigated by the organizational or social scientist (Flyvbjerg, 2006).

Hevner et al. (2004) noted that the design science paradigm seeks to extend the boundaries of human and organisational capabilities by creating new and innovative artifacts, including constructs, models, methods, and instantiations. Cross in his paper on Designerly Ways of Knowing (Cross, 2010) stated that:

> "Design science comprises a collection (a system) of logically connected knowledge in the area of design, and contains concepts of technical information and of design methodology. Design science addresses the problem of determining and categorizing all regular phenomena of the systems to be designed, and of the design process. Design science also is concerned with deriving from the applied knowledge of the natural sciences appropriate information in a form suitable for the designer's use.

This definition of Design Science extends beyond "scientific design," in including systematic knowledge of design process and methodology, as well as the scientific/technological underpinnings of the design of artifacts (Cross, 2001). In a latest collection of articles in Design Science compiled by Panos Y. Papalambros (2015), Amaresh Chakrabarto describesd the following facets of design science:

- Designs are plans for intervention that may include artifacts. Not all designs include artifacts, and not all designs consist of artifacts only
- The concepts of undesirable and desirable situations are essential to the act of designing. Without an undesirable situation, there is no designing
- Designing involves identifying these situations as well as developing the plan with which to change the undesirable into the desirable
- A design is implemented with the hope that it will bring in the desired change, which may or may not happen; hence the need for design science

On the other hand, design science research is typically IS oriented, resulting in an IS or computer artifact. In a broader sense, design research can be about designing any technology-based artifact that may either be computer based or based upon other physical technologies. Iivari & Venable (2009) define DSR as a research activity that invents or builds new, innovative artifacts for solving problems or achieving improvements. In DSR, no client or joint collaboration is

involved, but instead the artifact is used to address a class of problems (Walls et al., 1992)

In his three cycle view of Design Science Research (Hevner, 2007) analyzed design research as an embodiment of three closely related cycles of activities: the relevance cycle, the rigor cycle and central design cycle *(see Figure 5 below).*

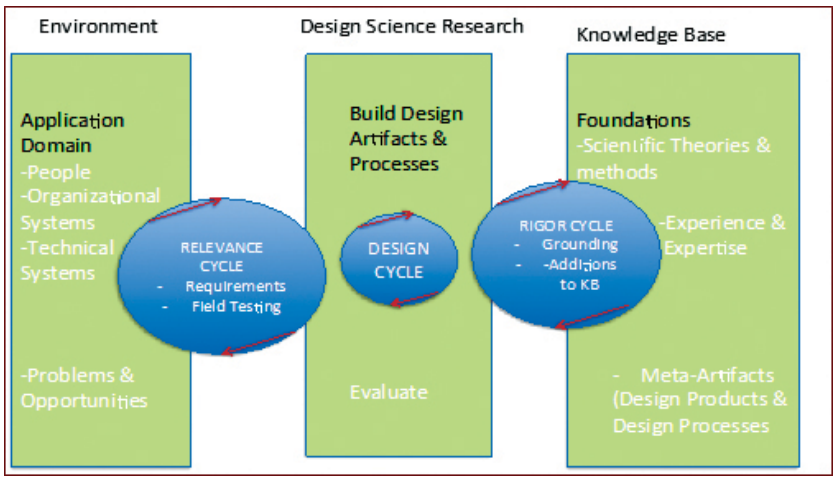


Figure 5. The Design Science Research Cycle.
Adapted from Hevner (2007)

In the relevance cycle, design science research is initiated with real-world problems, opportunities, and an application context that not only provides the requirements for the research as inputs but also defines acceptance criteria for the evaluation of the research.

In the rigor cycle, design science draws from a vast knowledge of scientific theories and engineering methods to provide foundations for rigorous research. It draws on the experience and expertise of state of the art application domains, as well as existing theories, artifacts and processes.

In the design cycle, the cycle of research activities iterates rapidly between the construction of an artifact, its evaluation and subsequent feedback to further refine the design. The design cycle may also include the concept of "creativity".

At present, researchers are only beginning to recognize the role of creativity in research

In an article by Alexandra Ossola from The Atlantic, she exclaims that Albert Einstein once said, "The greatest scientists are artists as well." Ossola referenced several great thinkers such as Rex Jung and Charles Limb, who all agree that whether in medicine or in other forms of research, just like artists who built upon the foundation of impressionism, scientists innovate based on the work conducted before their own (http://www.theatlantic.com/education/archive/2014/11/the-creative-scientist/382633)

In their seminal essay on the Anatomy of a Design Theory, Gregor and David Jones (2007) stressed the importance of design knowledge as theory to add rigour and legitimacy to the IS discipline. They argued that understanding the nature of IS design theories supports the cumulative building of knowledge, rather than the re-invention of design artifacts and methods under new labels.

After reviewing several schools of thoughts and theories on design research and theory, Jones and Gregor (2007) devised a proposed framework for IS Design Theory (ISDT). According to Gregor and Jones, design goals in this definition can be either "object-design" or "realization-design" (Van Aken, 2004, p.226). On the other hand, the range of artifacts that are the object of design theorizing covers a broad spectrum and includes customer centric websites, auction markets for supply chain organisations, and schema of inter-organisational workflows as well as organisational processes. Thus, a design theory instantiated would have a physical existence in the real world. The phenomenon for design research include:

1. Instantiations or material artifacts:- Artifacts having a physical existence in this world, such as hardware or software, or the series of physical actions that leadto the existence of a piece of hardware or software or an IS.
2. Theories or abstract artifacts.- These artifacts do not have a physical existence, except in that they must be communicated in words, pictures, diagrams, or some other means of representation.
3. Human understanding of the artifacts- Human beings conceptualize and describe artifacts in abstract, general terms.

Gregor and Jones further reiterated that an IS theory includes the principles prevalent in the process of designing an IS artifact with an end goal through using knowledge of IT processes and Human behaviour. This will include both the principles underlying the form of design as well as the act of implementing the design in the real world.

Tim Brown (2008) in his Havard Business Review article on design thinking, discussed the use of design principles in the daily processes that happen at work. He used the illustrative example of a hospital, named Kaiser, where nurses worked on a project to re-engineer shift changes. A project team was formed to identify the problems encountered in the way shift changes occurred. They compiled the information and explored potential solutions through brainstorming and rapid prototyping. Next, the team built a working prototype that included new procedures and some simple software which nurses could use to call up previous shift-change notes and add new ones. This resulted in a higher quality knowledge transfer and reduced prep time, vastly improving patient care. Brown commented that,

> "The myth of creative genius is resilient: We believe that great ideas pop fully formed out of brilliant minds, in feats of imagination well beyond the abilities of mere mortals."

What the Kaiser nursing team accomplished was neither a sudden breakthrough nor the lightning strike of genius; it was the result of hard work augmented by a creative human-centered discovery process and followed by iterative cycles of prototyping, testing, and refinement" (Brown, HBR, 2008). Brown states that these design projects must go through three stages mainly, "Inspiration, Ideation, Implementation." Inspiration," would trigger a problem, and/or opportunity, or both that motivate the search for solutions. "Ideation," is the process of generating, developing, and testing ideas that may lead to solutions. Finally, "implementation" is for the charting of a path to market. Projects will loop back through these stages—particularly the first two—more than once as ideas are refined and new directions taken. (Brown, HBR 2008).

Further taking Brown's design thinking process to the next level, Peffers, et al, came up with a model for producing and presenting information systems research. (Peffers, et. al 2006) The authors reiterated that in addition to applying theories to solve problems, IS research needs to deploy theoretical models to

expound the design science research process. Through synthesizing previous theories and papers, they came up with a design science research process detailing six steps: The steps are:

1. Problem identification and motivation – defining the research problem and justify the value of the solution
2. Objectives of the solution – inferring the objectives of a solution from the problem definition
3. Design and Development – Creating the artificial solution
4. Demonstration – demomstrating the efficacy of the artifact to solve the problem
5. Evaluation – Observe and measure how well the artifact supports a solution to the problem
6. Communication – Communicate the problem and its importance, the artifact, its utility and novelty, the rigor of its design and its effectiveness to relevant audiences. (Peffers, et. al 2006)

Returning back to ISDT theory, (Gregor and Jones 2007) proposed 8 components for a Design process. These eight components are shown in Table 7

Table 7. Components of a Design Theory for Managing Risk as Illustrated in Software Development.

Eight Components	**Description**
1. Purpose and Scope	"What the system is for, the set of meta-requirements or goals that specifies the type of artifact to which the theory applies and in conjunction also defines the scope, or boundaries, of the theory. Example: The aim is to develop an approach for understanding and managing the risk in software process improvement
2. Constructs	Representations of the entities of interest in the theory. They could be physical phenomena or abstract theoretical terms. Examples: Risk item, risky incident, resolution actions

3. Principle of form and function	The abstract "blueprint" or architecture that describes an IS artifact, either product or method/intervention Example: A risk framewortk is given to aid in the identification and categorization of risks and a process with four steps is given to show heuristics that can be used to relate identified risk areas to resolution strategies.
4. Artifact mutability	The changes in state of the artifact anticipated in the theory, that is, what degree of artifact change is encompassed by the theory Example: Suggestions for improving the approach are given for further work: one example is that parts of the approach could be packaged as a self-guiding computer-based system
5. Testable propositions	Truth statements about the design theory that is testable against all the stated objectives and requirements. Example: It is claimed that the approach is adaptable to other organisational settings, although it is seen as a general approach, rather than a procedure to be followed blindly
6. Justificatory knowledge	The underlying knowledge or theory from the natural, social or design sciences that gives a basis and explanation for the design. This knowledge links goals, shape, processes and materials together. Example: The approach proposed is derived from other risk management approaches
7. Principles of implementation	description of the processes for implementing the theory (either product or method) in specific contexts. It concerns the means by which the design is brought into being- process linking agents and actions. Example: It is stated that the approach requires facilitation by a facilitator experienced in risk management, SPI and running collaborative workshops
8. Expository instantiation	A physical implementation of the artifact that can assist in representating the theory both as an expository device and for purposes of testing Example Four examples of variants of the approach are given in descriptions of four iterations of an action research cycle

(Adapted from Gregor and Jones 2007 p. 322, 324))

2.4.3 Overlap of Action Research and Design Research

After conducting literature review of action research and design research in the previous sections, we applied both these research methodologies in our development of the OCAI-Spilter integration software artifact for accelerating culture change.

While AR and DR differs in their ontological and methodological approaches, there is considerable overlap between them (Iivari & Venable, 2009). This overlap occurs when the action researcher actually is also conducting DSR where he or she is inventing a new, innovative artifact or solution technology to better address the client's problem solving needs. The client's needs are conceptualized as a socio-technical problem. Research includes the development and evaluation of the solution technology as well as active involvement by the action researcher in organisational intervention. This includes: theory building, solution technology invention and naturalistic evaluation activities.

This leads us to the next section Action Design Research (ADR). ADR combines Action Research (AR) with Design Research (DR).

2.4.4 Action Design Research Methodology

In an earlier paper by Cole et al. (2005), the authors observed that IS as a discipline has been accused of having no relevance in the practical world. Research needs to make a dual contribution to academia and practice. Two research methods with this dual orientation are design research and action research. As shown by Ivari and Venable (2007), both of these methodologies though distinct, are closely related and offer unique strengths to the research community. By examining two distinct projects with overlapping AR and DR, they found that the two methods shared important assumptions regarding ontology, epistemology, and axiology. The authors proposed a model to integrate the two approaches together. Their integrated model involves four ADR steps:

A. **Problem Definition:** - Problem definition in DR and diagnosing the problem in AR

B. **Intervention:** - Similar to the build stage of DR and a combination of the action planning and action taking stage of AR

C. **Evaluation:-** Evaluation of the solution based on the usefulness to tthe practitioner

D. **Reflection and Learning:**- Abstract knowledge to make a practical and theoretical contribution to the field.

Fast forward to year 2011. In a MIS-Q article, Sein et al. (2011) developed and described a research methodology called action design research methodology (ADR). ADR is a methodology for generating prescriptive design knowledge through building and evaluating ensemble IT artifacts in an organisational setting. Prescriptive knowledge "concerns artifacts designed by humans to improve the natural world" (Gregor & Hevner, 2013). The four types of prescriptive knowledge include constructs, models, instantiations and design theory (March & Smith, 1995). ADR is in fact, an adaptation of AR and DR and borrows from many ideas from the Cole paper authored in 2005.

ADR deals with two seemingly disparate challenges:

1. Addressing a problem situation encountered in a specific organisational setting by intervening and evaluating. A problem situation in the case of this research protocol would be trying to align the organisational culture of an institution amidst the diversity of the members involved, so as to achieve a stated goal.

2. Constructing and evaluating an IT artifact that addresses the class of problems typified by the encountered situation. (Sein et al., 2011).

The class of problems associated with culture change are many and include:

a) low level of participation rate as a result of conflicting work demands and time taken to attend face to face meetings

b) Scalability

c) Process losses

d) Accuracy of information being captured

e) Getting consensus to agree on a desired culture

f) Long lead time

In our OCAI-Spilter Integration project, the problem situation is the issues of scalability, process losses and lack of participation encountered in culture change at SUTD. There are many types of process losses encountered in the current way that culture change is attempted as previously outlined. Another set of problems encountered is the lack of participation in the current manual approach to OCAI based organisational interventions. To address the problems associated with process losses and lack of participation, we propose the OCAI-Spilter project. The proposed artifact is a both computer program and a group improvement discussion methodology. The project is an integration of OCAI, a culture assessment instrument to devise organisational change management, with a GDSS/EMS system (Spilter). This research project is an example of action design research. Multiple classes of problems are addressed by the OCAI-Spilter integration software. They include:

a) Low participation rates of stakeholders in the culture change project

b) Process losses encountered during group meetings

c) Low speed of change

d) A lack of cultural alignment between various stakeholder groups

e) Problems with Information capture and display for the measurement and discussion processes

The OCAI-Spilter Integration project covers theory building, solution technology invention, and naturalistic evaluation. Sein et al. (2011) suggested four stages for the ADR method. Adapted from Page 40 -44 (The ADR Method)

1. **Problem Formulation** – identifies and conceptualizes the research opportunity

    a. Practice inspired research: This stage identifies and conceptualizes a research opportunity based on existing theories and technologies. It is practice-inspired research and not only provides for organisational intervention but generates new knowledge

    b. Theory ingrained artifact. This stage structures the problem, identify solution and guides design

2. **Building, Intervention and Evaluation (BIE)** – In this stage, we use the problem framing and theoretical premises adopted in Stage one to develop the initial design of the IT artifact. This artifact was subsequently shaped by organisational use and new design cycle. This phase interweaved the building of the IT artifact, and included intervention in the organisation, and evaluation. The outcome was the realized design of the artifact. There were two end points for the research design continuum in the BIE stage and they were:

    a. IT-Dominant BIE- At the Dominant BIE stage, designers work on the artifact through continuous improvements and user feedback.

    b. Oganization Dominant BIE involves. In the Organiaation Dominant BIE stage. the participants' existing ideas and assumptions about the artifact's specific use are challenged to create and improve the design.

3. **Reflection and Learning.** In this stage, we move from reflection and learning to building a solution for a particular instance to them applying that learning to a broader class of problems.

4. **Formalization of learning.** Researchers at this stage outline the accomplishments realized in the IT artifact and describe the organisational outcomes to formalize the learning.

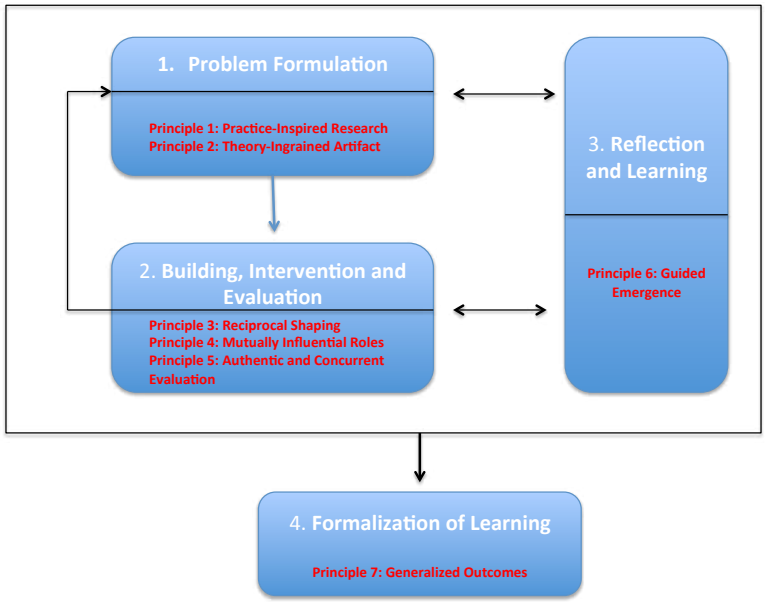


Figure 6. The ADR Method.
(Source: Sein et al. (2011)).

Table 8. Comparison of Key Components of Design Theory, Action Research, Design Research, & Action Design Research.

ITEM	Herbert Simon	Action Research	Design Research	Action Design Research
Description and Goal	Design theory is aimed at broadening the capabilities of computers to aid design by drawing upon the tools of artificial intelligence and operations research. It is concerned with how things ought to be and devising artifacts to attain goals and solve problems	Change-oriented research methodology which seeks to introduce changes with positive social values, the key focus being on a problem and its solution.	Design Science is aimed at devising or improving artifacts to attain goals and to create things that serve human purposes	Methodology for generating prescriptive design knowledge through building and evaluating ensemble IT artifacts in an organisational setting.

Is Client-Researcher Relationship Present?	Yes	No. Research is carried out in collaboration between action researcher and client system	Yes	Yes
Is Problem Solving Present?	Yes	Yes but does not involve building an artifact	Yes –Artifact developed to solve problems	Yes, artifact developed to solve problems in an organisational context
Is Action Planning Present?	No	Yes by considering alternative courses of action for solving a problem	Yes, but this takes the form of proposing	Yes, this takes the form of proposing and intervening
Is Action Taking Present?	No	Yes., the Action Researcher is involved in selecting a course of action	Yes, but this takes the form of design modelling, prototyping, constructing and demonstrating	Yes, this involves not just the design phase, but also the problem solving phase
Is there Evaluation?	No	Yes, by studying the consequences of an action	Yes, by evaluating the artifact usefulness	Yes, by evaluating artifact usefulness within the organisational context and soliciting user feedback
Is there Reflections and Learning?	No	Yes through identifying general findings to produce knowledge	Yes, by producing design knowledge	Yes, new Set of design principles

2.5 Prototyping using Component Based Software Development

The integration of OCAI with Spilter Integration is done by developing software to combine the OCAI culture measurement instrument with a internet-based GDSS/EMS tool(Spliter) and testing and improving it in “real-life” use situation. Both the culture change process using this integrated tool, and the artifact (tool) development process are iterative processes where the prototype artifact and the

culture change methodology evolve with feedback from "in-use" evaluation. They are then improved with each version of the research project. In addition to these, we use some elements of component based software development to integrate modules of the OCAI culture tool into the Spilter GDSS system.

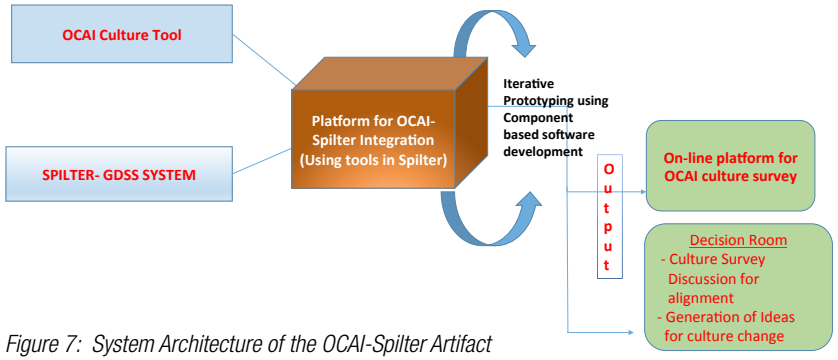


Figure 7: System Architecture of the OCAI-Spilter Artifact

In this literature review, we will examine both the concepts of prototyping and component based software engineering.. We start with prototyping. A prototype is a working model with basic specifications of the artifact or system. While it is used for preliminary demonstration purposes or as a part of the development process, it is only one type of software development- not a crucial part of systems development. In our case we also use the prototype as a continuous production tool for measuring the organisational cultures of various groups, using this measurement as a basis for culture change, and assessing the progress towards culture change.

By allowing the client to use the prototype, the client not only gets a feel for the real system but can also help himself/herself in getting a clearer picture of what exactly he/she wants as the end product. Prototyping, is an initial instantiation of a concept as part of software development process.

We defined the prototyping artifact development strategy as the set of decisions that dictate what actions will be taken to accomplish the development of the prototype. A well defined initial clear specification requirement needs to be articulated in order to determine the initial prototype. We developed these initial set of requirements for the initial prototype by reviewing the above literature and by using two already tested components, the successful culture measurement tool OCAI, and a successful GDSS/EMS system, Spilter.

Currently, the OCAI is administered using pencil and paper. After the initial culture survey is conducted, design and management of culture change is also facilitated through a manual process. This current method of change management for culture is archaic, takes a long time, and can result in process losses. In this research protocol, we developed a prototype that could speed up the process of culture change by automating the culture measurement, display and discussion of methodology and artifact, vastly improving the participation rate of surveys, and automating the actual process of culture change by using a GDSS technology. GDSS technology has been known to reduce process losses in group participation as well as improving the willingness of group members to share freely their ideas and thoughts without inhibition because of the technology that it employs.

In this research project, we looked at the development of the integrated GDSS-OCAI system as a prototyping process. The GDSS artifact used in this project was the Spilter software, and the culture instrument was the OCAI. Spilter is a GDSS/EMS tool that can allow participation from anywhere in the world and at virtually anytime convienient to the user. The OCAI instrument was integrated with the GDSS tool "Spilter" to facilitate culture change. In the development of the artifact, every version of the OCAI-Spilter tool was reviewed to see if it could further help to improve the participation rate of stakeholders in culture change as well as generate new ideas through its use. Peter Keen in his paper on GDSS development describes the prototyping process of GDSS. This thirteen step process can be used as a model for the GDSS development in this research study. The steps for the GDSS development specified by Meador, Guyote, & Keen (1984) include:

a) Planning – User needs assessment and problem diagnosis

b) Application Research – Identification of relevant fundamental approaches for addressing user needs and available resources

c) Analysis – Determination of best approach and specific resources required to implement it

d) Design – Detailed specifications of system components, structure and features

e) System construction – Technical implementation of the design

f) System testing – Collection of data on system performance to determine whether the system performs in accordance with design specifications

g) Evaluation – Determination of how well the implemented system satisfies users' needs and identification of technical and organisational loose ends

h) Demonstration – Demonstrating the system capabilities to the user community

i) Orientation – Instruction of top level managerial users in the capabilities of the system

j) Training – Training of direct users

k) Deployment – Operational deployment of the full system capability for all members of the user community

l) Maintenance – Ongoing support of the system and its user community

m) Adaptation – Planned periodic recycling through the above tasks to respond to changing user needs

Next we examine the literature of prototyping approaches and component based software engineering techniques used to build and fine-tune the OCAI-Spilter artifact.

Prototyping: Camburn et al., (2013) described these prototyping methods as strategies for conceptual phases of design framework and experimental assessment. By performing an extensive research and review of the best practices of prototype development, Camburn integrated their findings into a methodology for an enhanced prototyping process. Various independent design context variables like budget, time, and difficulty of meeting the design requirements derive this strategy.

Beaudouin-Lafon & Mackay (2003) stated that a prototype as a design artifact should include certain characteristics. A perfect prototype should (a) support creativity, (b) should encourage communication within and outside the development team and also (c) should ensure early evaluation of the product with proper user feedback. They explained this further by categorizing two major types of prototypes: **offline prototypes** and online prototypes. Offline prototypes do not use a computer. They are usually implemented using paper sketches, story boards, cardboard mock-ups or videos. These are generally created at the earlier stages of the development. Online prototypes depend on the use of a computer to implement. **Online prototypes** include animations, product presentations, application mock-ups created using scripting languages and other similar methods.

Sefelin, Tscheligi, and Giller (2003) in their study investigated the major differences between **paper based** and **computer based** low fidelity prototypes. Even though their study indicated that clients mostly preferred computer based prototypes to paper based prototypes, there were certain situations where clients prefered paper based prototypes.

In our research, we compared initial offline (paper-based) prototypes with online (computer-based) prototypes developed for this research. The inefficiencies inherent in the paper-based prototypes is our primary motivation for developing and testing the computer-based (online) prototype (see Chapter 1). We reviewed the inefficiencies and use them as a basis for developing the structure and flow of the computer artifact to facilitate change management at a greater and more efficient speed.

Coughlan, Suri, and Canales (2007) presented some powerful objectives enabled by a process of prototype design: Firstly, prototyping enables organisational thinking to develop concretely through action, thereby creating tangible expressions like learning faster by failing early and often, allowing low-impact failures to occur early and providing faster organisational learning; Secondly, the development of a prototype gives the developers permission to explore new behaviours thereby reliving individuals from the responsibility to consciously change what they do.

Different prototypes which differs in their life span lengths may be created, in order to suit their applications and scenarios in which they are used. Beaudouin-Lafon and Mackay (2003) in their book classified prototypes based on the length of their life span as follows:

- **Rapid prototypes** are created for some specific purposes and then thrown away. These are essentially useful in early stages of software development. For example, Guger et al. (2001) supplemented this idea of a rapid prototype by creating a new type of EEG-based brain-computer interface. This interface that uses rapid prototyping to enable a fast transition of estimation of various types of parameters and classification algorithms to real-time implementations and testing.

- **Iterative prototypes** work in iterations or steps in order to work out some details and increasing their precision. Here, each iteration should inform some aspect of the design.

- **Evolutionary prototypes** are a special case of iterative prototypes in which the prototype evolves into part or all of the final system. Evolutionary prototypes require more planning and practice than other approaches since these prototypes are representations of the final system and the final system itself, hence making it more difficult to explore alternative designs.

Component Based Software Development: In this research we developed, evaluated, and fine-tuned iterative, prototypes. The integrated OCAI-Spilter artifact was used in a real-life "use" situation, and the feedback was used to iteratively fine-tune and improve the artifact. This iterative prototyping process was employed through the use of a Component Based Software Development (CBSD) technique. This means that the prototype need not be developed from scratch, but as a sub-system within the GDSS system. As explained by Vitharana 2003, key advantages of CBSD includes reduced lead time and costs as business applications can be developed from an existing pool of components. This also leads to enhanced quality as components are retested, easily maintened and easily replaced. The life cycle of CBSD includes doing a requirements analysis, preparing the preliminary design which involves component specification, detailed design which consists of component search and identification, and finally implementation. In implementation, it is important to conduct unit testing, integration testing as well as system testing. Expertise in matching user requirements with components available in the repository before assembling them into applications will be a crucial aspect of CBSD. (Vitharana, 2003). As CBSD requires seamless communication between developers, assemblers and the customer, in the development of the OCAI-Spilter artifact, we have built a strong communication pipeline and co-operation between the Spilter developers, the programmers developing the OCAI component within Spilter, as well as the end customer and users of the artifact.

Moving on to component development, Crnkovic (Crnkovic 2001) explains that a component must be well specified, easy to understand, sufficiently general

and easy to replace. The interface should also be as simple as possible and strictly separated from its implementation. In component development specified by Crnkovic (Crnkovic 2001), the author lists the following steps:

a) Find components that may be used in the system

b) Select the components that meet the requirements of the system

c) Create a proprietary component to be used in the system

d) Adapt the selected components so that they suit the existing component model or requirement specification.

e) Compose and deploy the components using a framework for components.

f) Replace earlier with later versions of components.

The next steps may also require design and integration into the whole system. Component based systems development is the correct approach to develop the prototype for the OCAI-Spilter. Instead of developing the system from scratch which is costly and time consuming, the culture software component portion of the prototype was developed using tools from the Spilter system to build the survey. The OCAI survey is then automated through the Spilter system and data captured exported to another component within Spilter for statistical reporting. The second phase consisted of designing the decision room within Spilter for culture discussion, agreement, and gathering ideas for culture change.

Culture in software development: Borchers (2003) reported that culture can be a major factor in software product development teams. His obervations were collected in three different countries: India, Japan and America. This study used three socio-cultural indices: power distance (PDI), uncertainty avoidance (UI) and individualism (IDV) to explain the differences in behavior and preferences for software development practices of Indian, Japanese, and American teams. This term "power distance" has been inspired by the work of Mulder (1976). The country-level correlation of the preferred type of decision making in the superior worker with the perception of the behavior of both sthe uperior and colleagues reveals a fundamental fact about power distance in a hierarchy,

namely, that a society's way of dealing with power relationships is established through the values of superiors as well as those of subordinates. We saw that in systems in which superiors maintained a great power distance, subordinates tended to polarize toward dependence or counterdependence. On the other hand, where superiors maintain less power distance, subordinates tended to prefer the consultative decision style, which can be interpreted as a compromise solution, an interdependence of superior and subordinate. This was a factor in consideration when developing the OCAI-Spilter platform as this involves a multi-cultural software team from both the Netherlands and Singapore.

Uncertainty Avoidance (UAI) is the tolerance index for uncertainty about the future. UAI expresses the degree to which a person in society feels uncomfortable with a sense of uncertainty and ambiguity.[5] It reflects the extent to which members of a culture attempt to cope with anxiety by minimizing the sources of uncertainty.

Individualism (IDV) represents the index which measures the strength of the relationship between an individual and their societal group. individualism is the one side versus its opposite, collectivism, that is the degree to which individuals are integrated into groups. On the individualist extreme, we find societies in which the ties between individuals are loose: everyone is expected to look after him/herself and his/her immediate family. On the collectivist extreme, we find societies in which people from birth onwards are integrated into strong, cohesive in-groups, often extended families which continued to protect them in exchange for unquestioning loyalty (http://www.clearlycultural.com/geert-hofstede-cultural dimensions/individualism/).

**Borcher (2003) investigates the influences of these three indices, PDI, UAI, and IDV in software architecture development practices and configuration management. He inferred that the Indian team's cohesiveness was strengthened by high PDI and low IDV in India. Implications for Indian teams would mean that they would thrive on software projects that require teamwork. For the Japanese team who was slow in decision making, it was more appropriate for them to engage in development projects that required more deliberate software processes. The findings also showed that American teams, because of their weak uncertainty avoidance, were culturally suited for iterative development and prototyping. This resulted from the way they operated with no decisive hierarchy and an emphasis

5 http://en.wikipedia.org/wiki/Uncertainty_avoidance

on flexible rules. Problems were resolved by negotiating (Hofstede, 1983). Thus a societal culture may explain the preference for and prevalence of software development practices. We did take note of the above cultural impact when we formed the team to develop and work on the prototype

Our prototype of the OCAI-Spilter artifact was jointly developed by a team from Singapore, and a team from the Netherlands. The process of the prototype based development were as follows:

1. The prototype was first developed between Netherlands and Singapore by two teams, the Spilter team and the SUTD team, connected digitally. The original requirements for the prototype were developed based upon the ongoing discussion, by the author, and Professors Kuldeep Kumar and Jos van Hillegersberg. The prototype development team members included Professor Jos Hillegersberg from University of Twente, Mr Bryan Yap who (student from SUTD) and Mr. Jeroen Monteban (student from University of Twente).

2. The first pilot test for the prototype was conducted in Singapore with the Human Resources team to obtain feedback on user functionality and the interface between OCAI and Spilter. The OCAI questionnaire was built onto the Spilter platform so that feedback and features of the survey could be customised. After the pilot run, the survey and discussion methodology was fine-tuned such that it could be rolled out to both staff and faculty. This prototype also took into consideration the flow of the consensus building process involved in coming to an alignment on the desired culture. The functionlities of the system will be described in more detail in Chapter 3.

3. The next step was to use the OCAI-Spilter artifact as a discussion platform to facilitate culture change "in-use" at SUTD. The discussion session was modelled after the OCAI culture types to identify the gaps between the current and desired cultures. The first group to pilot test the artifact as a tool for culture change, was the senior management team of SUTD. The team used the GDSS technology of Spilter to contribute ideas that could help to bridge the culture gap between the perceived current culture and the desired culture, and promote the desired culture.

2.6 Conclusion

Literature search and review was conducted on five main topics, namely: culture, change management, group support systems, AR, DR, DS and ADR and prototyping using component based software development.

Starting with culture, we identified that out of the many instruments, the OCAI has the most applicability to a culture change project at SUTD because of the ease of use, but most importantly, the inclusion of the adhocracy (innovation) quadrant of culture, which is the core vision and mission of SUTD. We used the culture tool to assist us to determining the current culture versus the desired culture.

As described in the section on culture and culture change, there are many challenges to culture change, including barriers as well as resistance to change. In addition, people come from different background and training, which makes it harder for them to change in an aligned manner. These challenges can be overcomed by understanding the right methods to employ for change, and the barriers involved.

Culture change is facilitated by the use of group systems support tools to speed up the process of change, as well as to reduce process losses. In addition, currently the use of the OCAI tool is manual.

The integration of the OCAI into a GDSS system greatly assists to reduce the barriers to change by first:

1. automating the OCAI tool
2. using GDSS to facilitate group discussions
3. using GDSS to develop a task force for change projects
4. using GDSS as a social media platform for ideas and suggestions
5. employing the tools and resources available in the GDSS to assist in culture change

We employed an action design research approach in this research project. Action design desearch involves the building of an IT artifact to solve organisational problems. It combines both action research (and its user participation and feedback features) and design research (its “computer-based artifact development feature), In addition, there was an organizational intervention to work with key stakeholders to facilitate change. The constant evolving of the artifact was developed through prototyping using component based software development to improve the artifact through many iterations.

Chapter 3: Research Methodology

3.1 Introduction to the Research Problem

In chapter 1, we discussed the need to develop a desired culture that can drive the vision and mission of SUTD. In building such a culture, we need to ensure that through a process of culture change, all key stakeholders of SUTD reach a common understanding and agreement of this desired cultural profile. These various stakeholders (senior management, faculty, staff, and students) have different motivations, agendas, and backgrounds leading to different perceptions of the current state of culture in the organisation. As quoted by various authors, attitudes that "reinforce traditional professional hierarchies and stereotypes" (Wilson et al. 2000a), issues of unequal workload (Ovretveit, 1997), conflicts between team and individual professional goals (R. Brown, 2000b; Onyett et al., 1997), and role ambiguity and mismatched expectations (Bosch-Sijtsema, 2007), all affect how stakeholders may perceive the current and desired cultures differently.

Therefore, it is important to:

a. Measure and make explicit the perceived current and desired cultures of each stakeholder group. The group may need intra-group discussions to make sure that most members of the group have a common understanding of and agree upon the group's perceptions of the current and desired cultures.

b. For different groups, such as senior-management, faculty, administrative staff, and students, to discuss these explicitly represented, and agreed upon perceived current and desired cultures, to come to an inter-group agreement or common understanding.

c. Based upon this inter-group potential consensus, to identify the differences or gaps between the current and desired cultures.

d. To collectively discuss and come to an agreement about the possible means of reducing these gaps between current and desired cultures

e. To collectively assess the progress towards the reduction of these gaps

The objectives of the thesis were to design, develop, and test a computer-based process support system (a group support system) for:

(1) Collecting, summarizing, and Reporting OCAI data from multiple participants;

(2) Supporting group discussion and decision-making at both intra and inter-group levels for arriving at consensus, and agreeing upon culture-change measures; and

(3) Using the principles of Action Design Research to continuously refine the tool-in-use in a real live situation till no other iterations are needed.

(4) Regularly and iteratively measuring progress towards the culture change project.

The effectiveness of this tool was assessed and further developed by this group support "system-in-use". Therefore while our primary research objective was the development of a computer assisted measurement, representation, and group discussion support tool, it was equally important to evaluate the usefulness of this tool, and gradually improve it, by observing it in real live "use conditions", and eliciting feedback from its users. Therefore in the development of this tool we followed a prototyping process in which the tool was evaluated and iteratively improved by employing it in a real-life "in-use" conditions.

Since we are developing an "artifact-in-use" for organisational actors, we have adapted an action design research methodology (Sein et al., 2011). Following the suggestion of Sein et al (2011) the design of the artifact was informed by both functional and technical requirements for the artifact, derived from the existing literature; as well as

> "shaped by the interests, values, and assumptions of a wide variety of communities of developers, investors, users" (Orlikowski & Iacono, 2001, p. 131) without letting go of the essence of design research (DR): (1) innovation and (2) dealing with a class of problems and systems (Sein et al., 2011). In this research, we dealt with the problems of elicitation, data collection, representation, group discussion, scalability and potential process losses.

3.2 Action Design Research Methodology

We followed the four stage ADR methodology described in Sein et al. (2011). The stages of this methodology have been described in Chapter 2:

Framework of OCAI-Spilter using an ADR research methodology:

Table 9 outlines the proposed ADR research methodology for the building of the OCAI artifact that we adopted in this research project. In Chapter 2, we have already explained the use of OCAI as a cultural instrument. As for the GDSS system, we made use of Spilter, a commercially available GDSS system. Besides having features that we need, they are very open to collaborate with research institutions and to jointly work on adaptations of the tool. This makes the application of ADR very plausible in this study. The four cycles are embedded in the OCAI-Spilter development, testing and deployment.

Table 9. Summary of the ADR Process in the OCAI-Spilter Integration.

Stages and Principles	**ARTIFACT**	
Stage 1: Problem Formulation		
Principle 1: Practice Inspired Research	Research is driven by the need to develop and test a computer based group discussion tool for group discussions and deliberations about coming to a group consensus for culture change using the results of OCAI	Recognition: a. Shortcomings of the existing manual process used to reach consensus using the OCAI instrument b. Scalability of the tool
Principle 2: Theory Ingrained Artifact	Use of the OCAI instrument to reach the desired culture of SUTD through the use of GDSS	
Stage 2: BIE		
Principal 3: Reciprocal Sharing	Group process losses were expected to be an on-going problem as a result of manual intervention. Problems encountered will be used as design principles for the IT artifact	Alpha Version: The artifact conceived should address the issue of participation and group process losses

Principal 4: Mutually influencing roles	The ADR team will include HR personnel from SUTD, UT undergraduate student, and SUTD undergraduate student. Together with Professor Jos Van Hillegersberg who will guide them through on developing the prototype, they incorporate theoretical, technical and practical perspectives	Beta Version: Prototype developed to speed up the decision making process of desired culture will be called the OCAI-Spilter Artifact.
Principal 5: Authentic and concurrent evaluation	The OCAI-Spilter software will be tested out with focus groups to gauge the usability of the survey. The GDSS platform for culture change will be tested out with the senior management team for group decision making before it is rolled out to the wider group	
Stage 3: Reflection and Learning		
Principle 6: Guided Emergence	The OCAI-Spilter should be an emerging evolution as the programmers and users work together to improve its usability and collation of survey results, as well as for culture change	Emerging Version and Realization: The IT artifact should be continually refined through continuous feedback
Stage 4: Formalization of Learning		
Principle 7: Generalized outcomes	New set of design principles should be articulated for the OCAI-Spilter artifact, plus the GDSS platform for achieving culture change	Ensemble Version: An ensemble embodying the design principles for achieving the desired culture through OCAI-Spilter

ADR = action design research: GDSS = group decision support systems: HR= human resources: IT = information technology: OCAI= organisational culture assessment instrument: SUTD = Singapore University of Technology and Design UT = University of Twente

The proposed BIE form selected in this research is the **Organization Dominant BIE**. Organizational Dominant BIE, is used as the project deals with intervention of culture at the organisational level. The OCAI-Spilter artifact is deployed in the design iterations and tested with members of the university. Feedback obtained was incorporated into subsequent versions of the artifact till changes and improvements become stable and are only marginal. Throughout the process, we kept a record of observations of the artifact “in-use,” and the consequent iterative, continuous improvement to our artifact.

3.3 Functional Requirements and Design Principles

The Design Principles of the OCAI-Spilter artifact included:-

1. Automating the OCAI culture survey within the Spilter system to allow for easier access and participation by respondents
2. Graphing, collecting and consolidating culture survey data through the use of the Spilter system to establish the current and desired culture
3. Enabling the culture alignment process (section 1.2, page 9) by establishing common understanding of current and desired culture of SUTD through the use of group discussion within the Spilter system.
4. Using the Spilter system to brain-storm ideas for culture change from perceived current to desired organizational cultures.

We examined the process model of an organisation dominant BIE in the building of this OCAI-Spilter Artifact. This is illustrated in Figure 6:

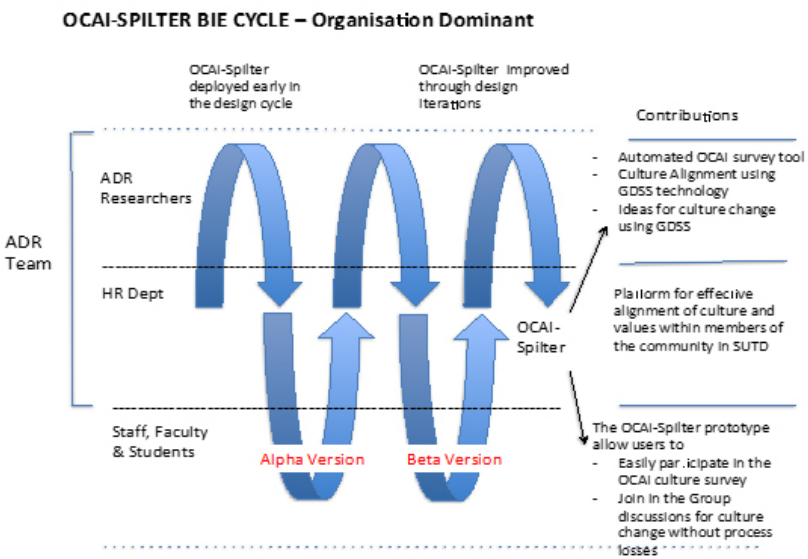


Figure 8. Organisation-Dominant BIE in the OCAI-Spilter Project at SUTD.

3.3.1 Design Iterations and Functional Requirements

The design process in the development of the OCAI-Spilter included the following steps.

1. Developing functional requirements
2. Building usable screens for the prototype
3. Building iterations with organisational intervention in the prototype
4. Finalising the prototype after the feedback and iterations
5. Reflection and abstraction of learning principles

The following design iterations were developed during the functional requirements of each stage of the prototype.

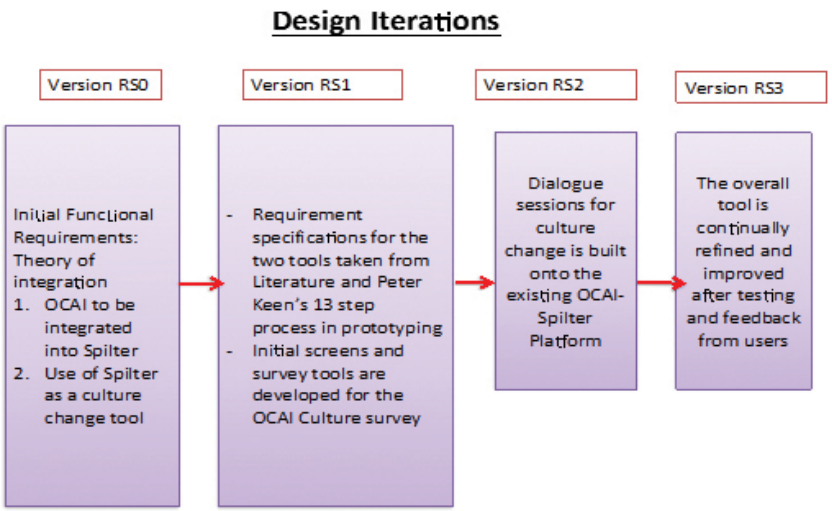


Figure 9. Design Iterations.

3.3.2 Functional Requirements

The list of functional requirements for the artifact was compiled from literature on OCAI, GDSS/EMS, and the exploratory research done with the senior management

team members in the pilot testing. This functional requirement is called "RS0" – or Requirement Specifications at time "0". Subsequent iterations of requirement specifications are called RS1, RS2 and so forth.

The requirements at times 0 are defined here as: "RS0"

ADR Process Stage 1: Problem Formulation and Theory Ingrained Artifact:

Cameron and Quin's Competing Values Framework (CVF) was the choice theoretical framework for this research to gauge culture gaps between the perceived current organisational culture, and the perceived desired culture. The Organisational Culture Measurement Instrument (OCAI) was the CVF-based measurement instrument used in our research.

Group Process Requirements for Using OCAI (Problem Discovery and Definition):

At present the use of OCAI-based measurement and the use of OCAI results to establish an organisation's culture profile in group discussion is mainly to come to a consensus about the current OCAI and preferred future OCAI; as well as presentation of the organisational profile to group members. At present the deliberations about the actions to be taken to change the organisational culture from the current to desired culture use only minimal computer-support.

The resulting group discussions are manual, using paper-based manual tools such as markers and flipcharts, whiteboards; powerpoint slides; and manual facilitators. Being a manual process, it takes a lot of time and can be subject to many "group-process losses". The discussion session for the first group of 13 top education and administrative managers at SUTD, for example took one-half day.

Moreover, as the organisational culture change process takes time, and requires repeated measures and interactions within the whole community, multiple iterations of the process can be expensive and prone to repeated losses. It is to remedy these shortcomings of the process that we are suggesting the development of a computer-based artifact that integrates OCAI with group meeting.

OCAI, except for its measurement, and culture profile representation aspects, itself does not provide a platform for a group of people (especially large groups of people) to (a) discuss the results of the OCAI measurements and come to a common understanding of the results; or (b) discuss and prioritize actions needed to move the organisation's culture in the desired direction. Therefore

OCAI measurements, the subsequent iterative group discussions to come to a common understanding of perceived profiles, and the development of means to intervene in the organisation to change the current perceived culture profile to the desired culture profile, can be time-consuming, and error-prone.

Measurements using OCAI: OCAI produces two profiles: (a) the respondent's perception of the current cultural profile of the organisation (the current perceived culture profile); and (b) the respondent's preferred or desired profile for the organisation (the desired culture profile). Individual respondent profiles can be combined to produce an organisational profile and the instrument can be administered within an organisation to either the whole organisation (i.e. all members of the organisation), or to smaller samples of the population. OCAI results (the two graphs – current and preferred) in themselves do not provide any guidelines for culture change in an organisation. The current and preferred OCAI graphs provide a visual measure of the extent of desired change in the organisation's culture. Thus, they provide a graphical and explicit basis for discussion of the organisation's current and perceived cultures within the members of the organisation. The measures to change the culture of the organisation are collectively designed by the organisation members through group discussion.

The organisation's current and desired profiles are presented to the organisation as a basis for discussion to (a) come to a common understanding of the organisation's current and desired cultures; and (b) developing and hopefully agreeing upon actions to be taken to change the culture.

Group Processes: However, it should be recognized that OCAI is only a culture measurement instrument. The organisation's members still need to:

- develop a common understanding and hopefully consensus about the current perceived and desired culture profiles,
- discuss and develop a common understanding, and hopefully consensus about change measures to change the current perceived profiles to desired profiles,
- implement the change measures, and
- continuously, at regular intervals, assess progress towards the goal.

Measuring organisational culture at one point and later discussing actions for change, can be time intensive. Iterative measures will multiply this time and cost manyfold. When the process is repeated iteratively for organisational culture change, the repeated process can quickly become onerous, and consequently organisations either do not measure progress, or try to take the easy way out by imposing progress from the top and hoping that progress will happen.

In addition, the process of discussion is subject to the shortcomings of typical face-to-face meetings. Process losses were listed in Chapter 2, Table 3. Moreover, up to this dissertation, the discussion process remained manual, and the meeting and deliberation process took a large amount of time. This could have further increased the process losses:

1. Typically, not all members of the group participate equally. The most vocal and assertive members of the group, or the most influential members of the group dominate the meeting and may get the most "floor-time" for expressing their views. Even if the most influential members remain silent, if their views are usually already known to the organisational unit's members. In face-to-face sessions, especially in hierarchical cultures, the views of top influential members may still influence the discussion disproportionately, and thus may distort the group common understanding and potential consensus.

   On the other hand the less assertive or shy members of the group, typically the majority of the members, remain quiet, and are unable to express their views. This does not mean that they do not have dissenting views, or that they do not care. It is just that they cannot express their views, and consequently give-up and may only pay lip service to the change. This would defeat the very purpose of the cultural change.

2. Furthermore scheduling a same-place same-time meeting between all members of the group can be a lengthy and time-consuming process. This problem is even more acute if the members of the group are need to travel frequently for their work-related duties. Those people who cannot attend the same-place same-time meeting may still have some valid and useful ideas to contribute. But because of structural impediments built into such meetings, their views may not be considered.

3. The meeting process is sequential – each person sequentially presents his/her views and this takes time. Moreover, often, as views may be expressed slowly and deliberately by some speakers, they are often overruled or overwritten by more vocal, assertive, and impatient members of the group. This not only wastes time, but can also lead to significant process losses.

OCAI Implementation Requirements at SUTD:

Community and Groupings:

The Singapore University of Technology and Design (SUTD) community includes four sub-groups: Senior Administration (about 22 persons) Faculty (about 150 persons); Staff (about 300 persons); and students (approximately 600 persons). For the data to be meaningful and based upon the opinions of people immersed in the SUTD culture, we only surveyed senior management, staff, students and faculty that have been with the university for at least one year.

Given the different stakeholder groups currently prevalent at SUTD, we partitioned and compared sub-groups in the SUTD community, as follows:

- Top management vis a vis faculty
- Top management vis a vis staff
- Top management vis a vis students
- Faculty vis a vis staff
- Faculty vis a vis students
- Asians vis a vis europeans
- Asians vis a vis north americans

However, given the potentially different worldviews of these groups, we also needed to create a plenary discussion and dialog among all groups. Thus different people in the groups could become aware of inter-group and intra-group differences, and could negotiate common meanings and solutions in a fair and effective dialog.

Plenary Sessions: It would be useful to administer the OCAI instrument to each group separately; come to some sort of common understanding within

the sub-group, and make group recommendations; and finally create a plenary discussion, common understanding, and agreement about the possible action items identified. If the sub-groups get the feeling that they have authentically participated in the relatively unbiased group processes they are more likely to agree with the group consensus, and be committed to the culture change projects.

Need for Computer Support: Given the relatively large sizes of each of these groups, manual inter and intra-group discussions and manual and verbal dialogues are likely to be chaotic, time-consuming, inefficient, and subject to process-losses. Thus, some sort of a computer-based group discussion and decision support is needed to assist this process.

The two tools developed and evaluated in this dissertation are:

1. The OCAI-Spilter survey that assess the current and desired organisational cultures

2. A platform and a methodology using the Spilter software to engage various stakeholder groups (i.e. administration, faculty, staff, and students) in discussing the requirements and actions for culture change. This platform is the Group Decision Support Syststem (GDSS) or the Electronic Meeting Support System (EMS) that uses the Spilter software

The next design iteration of the prototype is named RS1

RS1

We continued to refine the requirement specifications by examining at the initial requirements (RS0) and modifying them by adding additional requirements derived from our literature review (Chapter 2),to produce an enlarged set of Requirements Specifications, namely, RS1. This will involved STAGE II of the ADR methodology, including Deployment, Evaluation, and Iteration. During this stage, Principal 3: (Reciprocal Shaping), Principal 4: (Mutually Influencing Roles): Principal 5: (Authentic and Concurrent Evaluation), Prinicpal 6: (Guided Emergence), Principal 7: (Generalized Outcomes) of the ADR Methodology were used.

Part 1: OCAI culture survey (Reciprocal Shaping)

The OCAI tool was used in this research to assess current culture versus the desired culture. This is a necessary first step for culture change. However, currently, before this dissertation, the OCAI and the subsequent group discussion was administered manually. The manual process is time consuming and laborious, especially with a large workforce. In addition, there are many barriers to culture change such as process losses during group deliberations, as well as the long and tedious procedures required in the administration of change. By automating the survey using the Spilter platform, the questionaire is delivered electronically to participants, thus reducing cycle time and encouraging higher levels of participation.

Our OCAI-Spilter integration team embarked on Peter Keen's thirteen step process in the prototype development of the OCAI-GDSS system. (Meador & Keen, 1984)) These steps included:

a. Planning – User needs assessment and problem diagnosis

b. Application Research – Identification of relevant fundamental approaches for addressing user needs and available resources

c. Analysis – Determination of best approach and specific resources required to implement it

d. Design – Detailed specifications of system components, structure and features

e. System construction – Technical implementation of the design

f. System testing – Collection of data on system performance to determine whether the system performs in accordance with design specifications

g. Evaluation – Determination of how well the implemented system satisfies users' needs and identification of technical and organisational loose ends

h. Demonstration – Demonstrating the system capabilities to the user community

i. Orientation – Instruction of top level managerial users in the capabilities of the system

j. Training – Training of direct users

k. Deployment – Operational deployment of the full system capability for all members of the user community

l. Maintenance – Ongoing support of the system and its user community

m. Adaptation – Planned periodic recycling through the above tasks to respond to changing

Working through this thirteen step process, our team first examined the specification requirements at RS0 to review the requirements of the OCAI-Spilter tool. RS0 requirements covered steps a, b, c and d of Peter Keen's DSS development methodology. The ADR team comprised of Jaclyn Lee and Adeline Wang, both HR personnel from SUTD, an undergraduate student programmer from SUTD, an undergraduate programmer from University of Twente, Professor Jos Van Hillegersberg from University of Twente, and Professor Kuldeep Kumar from University of Twente University. The team also consulted and discussed the required improvements to the tool with the Spilter developers.

The team worked on two working prototypes for the system. They included:

A) OCAI Survey

We next used the Steps e and f of the thirteen process steps listed above. We utilised the features in the Spilter tool to automate the OCAI survey. The development process included the following steps:

1. Survey Building

Spilter allows the creation of interactive meetings and surveys. It incorporates various built-in tools to enable the process of survey creation. The tools provided by Spilter are classified by their functionality into the following types:

NAME	DESCRIPTION
TOPIC	Used to place a number of questions or analyses.
OPEN QUESTION	Used to ask open ended questions with inputs spanning a single to multiple lines.
CLOSED QUESTION	Used to ask closed ended and multiple choice questions.
ANALYSIS	Used to analyse answers from previous questions or to test a set of questions for the same answer options.

CATEGORY TOPIC	Used to cluster answers from previous questions into relevant categories.
TEXT	A page with text can be used to clarify the purpose or subject of the next question or questions.
CONCLUSION OR REMARK	Add a conclusion or remark to the report.
TEMPLATE	Import a previously saved part of a meeting structure.

Of the various tools that Spilter provides, the team used the following two tools because of their compatibility with the current OCAI survey question structure:

NAME OF TOOL	DESCRIPTION	TYPE
SELECTION MENU RADIO BUTTONS	Selection menu with radio buttons only allows the user to select one option out of a number of options available.	Closed question
DISTRIBUTION	With a distribution analysis, the participant distributes an exact number of points among a series of questions.	Analysis question

In our implementation of the OCAI survey, we used the selection menu radio buttons for the registration questions, and the distribution analysis questions tool for the OCAI questions.

2. Survey Registration

Spilter provides the ability to register users directly into the survey through the uploading of an Excel file. Through keying in the contact information into an Excel file and uploading the information into the server, we were able to speed up the registration time of users, thus reducing the need for manual registration.

3. Survey Dissemination

After the registration process, it was essential to be able to inform users about the survey, its purpose, and the procedures required to participate in the survey. In order to do this, we made use of the "email function" available within Spilter. This function allowed us to add all the registered users into an email list such that a customized invitation was generated for each user.

When users receive the email, all they needed to do was to click on a link which would direct them onto the first page of the survey. If users had any problems in using the login or the survey itself, or had any suggestions for improvement, they could contact the survey administrator through the email address provided within the email message.

This feature helped us explain the theoretical basis of the survey, the need for the survey as well as the procedures for participating in the OCAI-Spilter group discussion. Remember, in the manual process, this step took a lot of time and effort for individual explanations to each of the participants. By moving this task onto the computer, we would reduce this time and effort substantially, and could scale up the process to large groups of faculty, staff, and students.

4. Survey Monitoring

During the course of the survey, monitoring was done through both the helpdesk email at culture@sutd.edu.sg and the Spilter dashboard itself. Through the Spilter dashboard, the number of participants who answered the survey was constantly tracked. Occasionally, raw data from the survey would be downloaded and analysed through Excel to check for emerging trends.

5. Spilter Screens

The flow of the survey sequence was mapped to ensure that the process of culture alignment was taken into consideration. The following screen illustrates the flow of the OCAI Spilter cultural survey and alignment process:

Screen 1: OCAI Survey Flow:

The screenshot of the Spilter-OCAI screen below shows the process flow:



The subsequent screen shots of the OCAI-cultural alignment process are as follows.

Screen 2: Introduction Screen:

An introductory message from the SUTD President explained the purpose of the OCAI survey for organisational culture building. It also encouraged staff and faculty to partake in this exercise by filling in the OCAI survey to share what they perceive and thought of the current and desired organisational culture at SUTD. The message from the President also assured all participants of anonymity.



The Message from President Reads:

"Dear SUTD Colleagues,

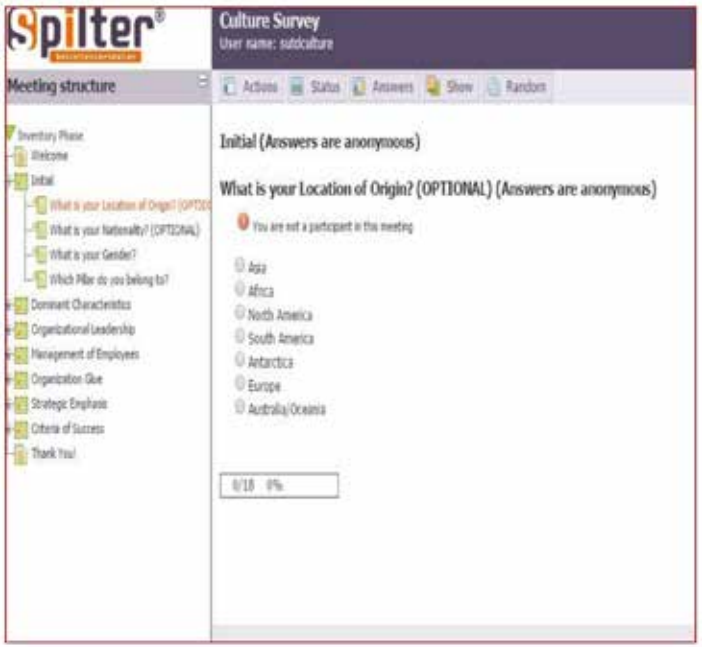
As SUTD continues to grow and develop toward our mission and vision, we all have an important role to play in creating a desired SUTD culture that aligns with our five core values of **Leadership, Integrity, Passion, Collaboration and Creativity.** To help us achieve this outcome, we need your participation in completing an Organisational Culture Assessment Instrument (OCAI) survey. All the results will be assembled, summarized and shared with all in due time. Please be assured that all responses will be kept anonymous.

The OCAI is probably the most frequently used instrument in the world today for assessing organisational culture. It is designed to help identify an organisation's current culture. It is also used to determine the desired culture that the organisation's members believe should be developed, to create the type of environment where they would like to work in and to contribute, to achieve organisational goals. Simply click on this link to start the survey: OCAI Survey_Test

If you have any question about the OCAI survey or about SUTD's use of this instrument, please contact us at culture@sutd.edu.sg. You play an important role in making SUTD a great University and I look forward to your participation.

Screen 3: Registration Screen:

In this screen, the users key in their location, gender and employee type.



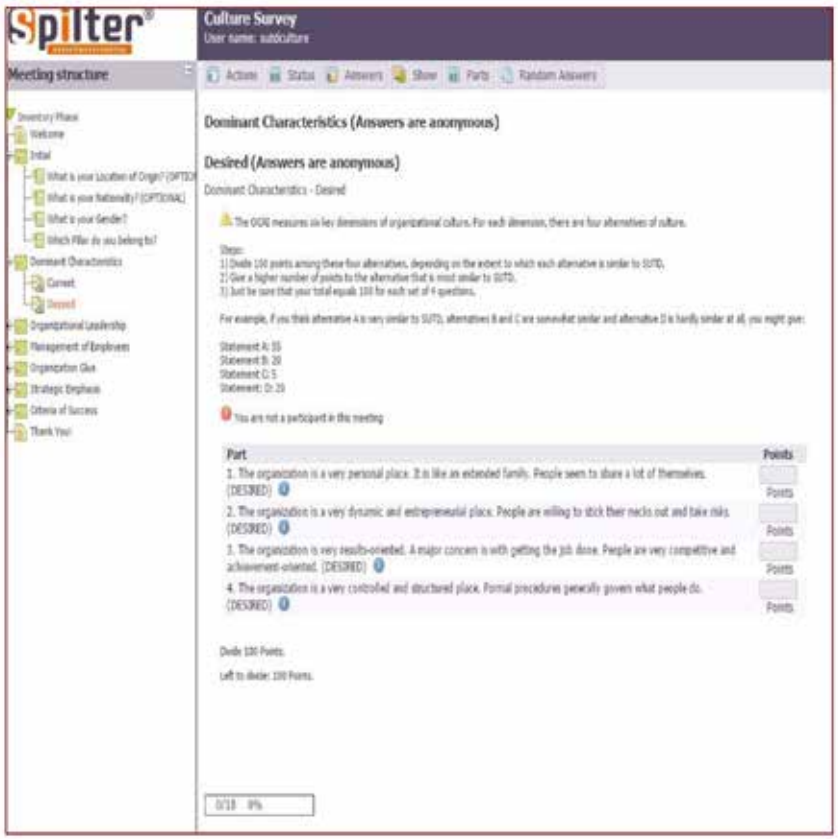
Screen 4: Dominant Characteristics Screen (Current):

The fourth screen takes the participants through what they think are the dominant characteristics of the current SUTD culture. The four questions in each dimension make up a total of 100 points, and participants rank each of the question from highest to lowest based on a distribution of 100 points.



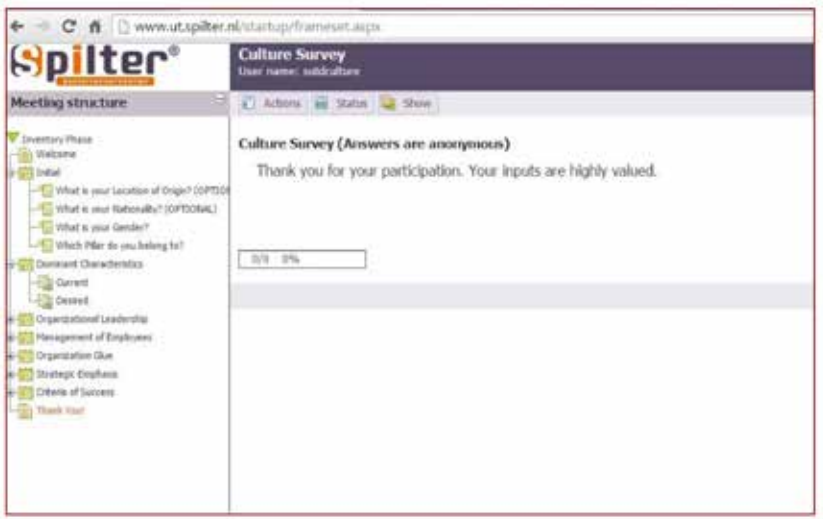
Screen 5: Dominant Characteristics Screen (Desired):

The fifth screen takes the user through what (s)he thinks are the dominant characteristics of the desired SUTD culture. Each of the four questions make up a total of 100 points, and participants rank each of the question from highest to lowest based on a distribution of 100 points.



Screen 6: Ending Screen:

The ending screen thanks all participants for their feedback.



6. Survey Analysis

MS-Excel was used to analyse the data collected by the survey. Steps for each round of analysis are detailed in this section.

Step	Description
1	Download raw data from Spilter
2	Paste the raw data into existing Excel template file
3	Change cell references as the format is not consistent with excel
4	Select relevant cells and create appropriate radar plots

Steps g and h of Peter Keen's model were employed when the first prototype was tested with a small group of users who would first review its functionalities and ease of usage. Observation of the prototype in use and the users' opinions/ suggestions for improvement of the artifact were noted. These learnings are detailed in Chapter 5, Section 5.1, Table 26. New learnings and knowledge about the OCAI process we encountered during these iterations were observed in order

to refine and improve the prototype to help in creating future versions of the artifact. These observations continued until the prototype converged and the need for no more changes was observed. The process was similar to the iterative prototypes explained by Beaudouin-Lafon and Mackay, 2003, as prototypes that "work iterations or steps in order to work out some details and increasing their precision. Each iteration should inform some aspect of design."

The final converged version was deployed to the entire SUTD community in phases, from staff to faculty and finally to the student community. This completed the 13 step process of Peter Keen's model.

Final results from this automated survey were collated to review the degree of cultural alignment between the different stakeholder groups. The gaps between the current and desired culture were also identified in this exercise.

Version RS2

Group Discussion for Culture Change using Spilter as an EMS tool.

After Version RS1 was developed, we proceeded with Version RS2 where the OCAI-Spilter GDSS was being used as a tool for culture change. This was done through group discussion and group decision-making. We took the following steps to incorporate the discussion screens.

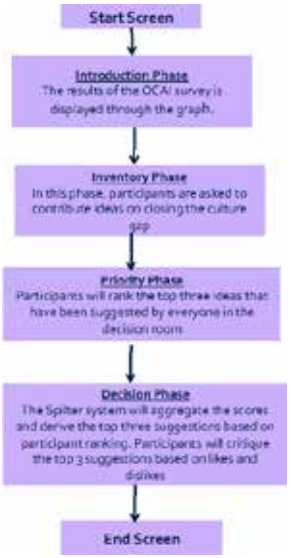
Stage 1

Version 1: Developed the prototype of the Spilter screen for group discussions to include the purpose of the meeting, as well as the desired culture types that have arised as a result of the OCAI survey.

The system was configured to allow for brainstorming and idea generation for culture change. Please see the process map below for enabling OCAI discussions using Spilter.

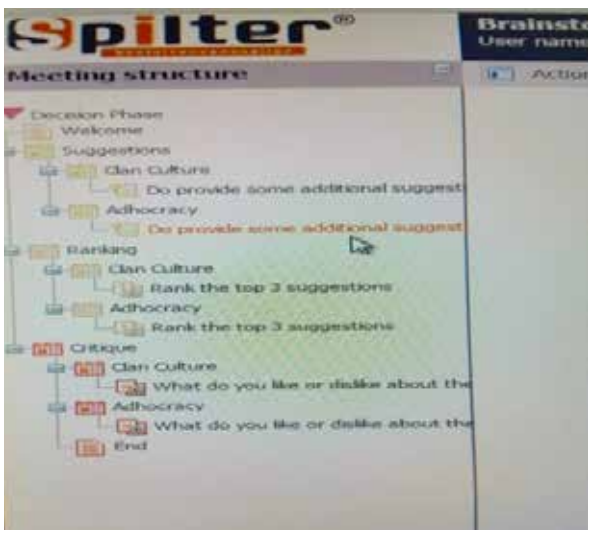
PROCESS FLOW for enabling group discussion on culture change using the Spilter system

Figure 10. Process Map.



Screen 1:

Screen shots of the flow of culture discussion is displayed in the Spilter system.



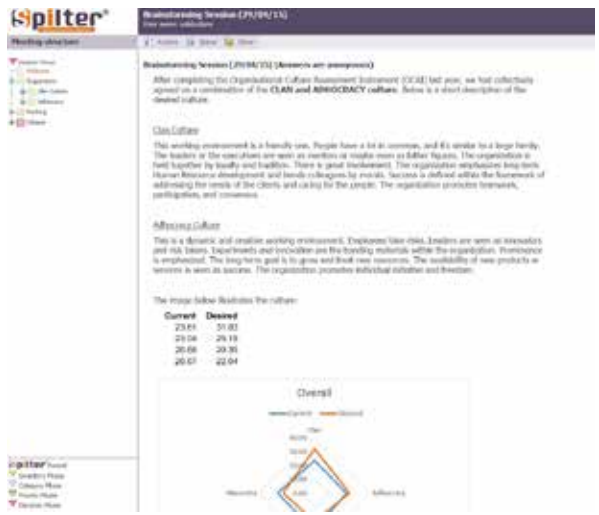
The team was taken through the following screen shots of the GDSS system for culture change discussion.

Screen 2: Start Screen



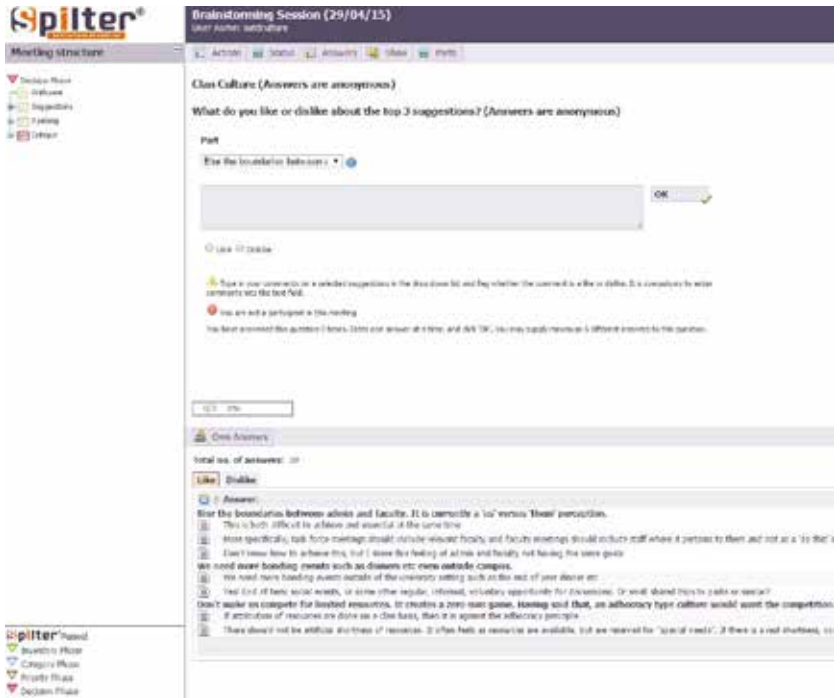
Screen 3: Welcome Screen

Participants were shown a screen outlining the results of the culture survey which demonstrated a dominant clan and adhocracy culture. It also explained the clan and adhocracy culture.



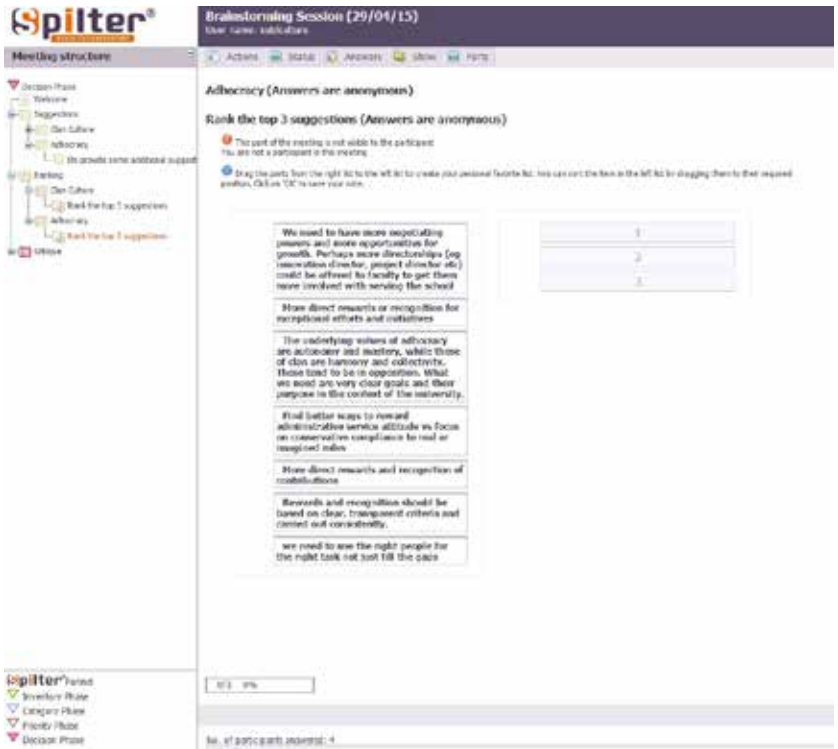
Screen 4: Suggestion Screen

Participants were then taken to the next screen where they were asked to give suggestions to help the institution move towards the desired clan culture. At this stage, all participants were able to see each other's ideas in real-time being populated on the screen. All answers were anonymous at this point. This is to encourage participants the room to freely suggest ideas without being pre-evaluated.



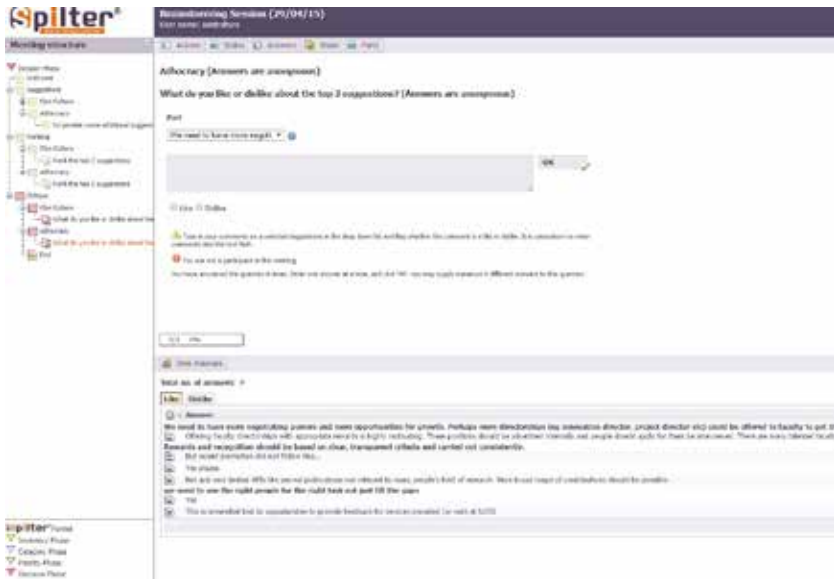
Screen 5: Ranking Screen

After successfully inputing all of their ideas, participants were able to see all of the ideas being populated and were able to rank the top three ideas that they liked.



Screen 6: Critique Screen

On this screen, they were asked to critique the ideas and express what they liked or did not like about these ideas for culture change.



Version RS3

Finally, the software was tested out with a pilot group for its functionality and features. Suggestions gathered were incorporated into the final prototype. The following sections review the software evaluation protocol and steps used.

Prototype Evaluation

One of the aims of this exercise was to evaluate the user friendliness and interface of the OCAI-Spilter software for culture change. The feedback was used to help improve the interface so that staff, students, administration, and faculty could find this a purposeful and easy platform on which to share on ideas for culture change at SUTD. The feedback from the previous session was used to improve the interface progressively so that there is a continuous iteration to improve the Spilter software tool according to action design research (ADR) methodology.

3.3.3 Artifact Evaluation Methods

It is important for us to evaluate the artifact to validate the usability, ease of learning as well satisfaction with the features of the software. This evaluation is according to the Technology Acceptance Model (Davis, 1989) that states that users come to accept a technology based on perceived usefulness and ease of use. We used accredited instruments and literature for developing the survey which were extracted from Table 10 below:

Table 10. Methodology for Software User Testing was Extracted and Adapted from the following sources.

Acronym	Instrument	Reference	Institution	Example
QUIS	Questionnaire for User Interface Satisfaction	Chin *et al*, 1988	Maryland	27 questions
PUEU	Perceived Usefulness and Ease of Use	Davis, 1989	IBM	12 questions
NAU	Nielsen's Attributes of Usability	Nielsen, 1993	Bellcore	5 attributes
NHE	Nielsen's Heuristic Evaluation	Nielsen, 1993	Bellcore	10 heuristics
CSUQ	Computer System Usability Questionnaire	Lewis, 1995	IBM	19 questions
ASQ	After Scenario Questionnaire	Lewis, 1995	IBM	3 questions
PHUE	Practical Heuristics for Usability Evaluation	Perlman, 1997	OSU	13 heuristics
PUTQ	Purdue Usability Testing Questionnaire	Lin *et al*, 1997	Purdue	100 questions
USE	USE Questionnaire	Lund, 2001	Sapient	30 questions

The evaluation of the Spilter-OCAI integration system was conducted using two methods:

1. An **online questionnaire survey** to gather feedback on the Spilter software regarding technology frustration.
    - Usefulness
    - Ease of use
    - Ease of learning
    - Satisfaction with the software.
2. A **structured focus group interview** to gather qualitative feedback on the OCAI-Spilter software on:
    - What respondents liked best about the software
    - What respondents liked least about the software and
    - What improvements they would suggest or recommend.

This interview was facilitated step-by-step according to each screen of the Spilter software to gather the feedback in a structured manner

3.4 Reflection and Learning

Principles for reflection included three key principles:

- Reflect on the design and redesign during the project
- Evaluate adherence to principles
- Analyse intervention results according to stated goals

The OCAI-Spilter integration should be subject to continuous improvement as the programmers and users work together to improve its usability as a survey tool and platform for culture change. The transition from version RS0 to version RS3 provided for a prototype that was used effectively to measure the culture gap between current and desired cultures and provided a platform for stakeholders to discuss and share ideas for closing the culture gap.

3.5 Data Analysis and Comparison

We used statistical methods to analyse the coefficients to test the reliablity of data. The validity of the data will be explained in chapter 4, section 4.3.1. In addition, we also employed mean averages of the responses to analyse the results of the OCAI survey across corporate and stakeholder groups. We also analysed the mean averages of each dimension of culture and the views of each stakeholder groups on these dimensions.

Part 1: OCAI Spilter Survey

We used two ways to review the results of the OCAI survey administered on the Spilter platform. Firstly the effectiveness of the digital survey vis-vis the manual platform was determined. We also analysed the participation rate for the same survey administered manually versus using the Spilter platform. Secondly, we collected feedback from focus groups on the ease-of-use of the Spilter platform, and with each iteration, how the tool could be refined and improved.

Part 2: Spilter survey on current vs desired culture.

Data were collected from staff, faculty and students. Results of the survey were used to compare perceptions of culture between four groups, namely: management, faculty, staff and students. Overall results of the culture survey were analysed using the following inter-group comparisons:

a. Top management vis a vis faculty
b. Top management vis a vis staff
c. Top management vis a vis students
d. Faculty vis a vis staff
e. Faculty vis a vis students
f. Asians vis a vis europeans
g. Asians vis a vis north americans

The averages of the six characteristics of culture, namely dominant characteristics, organisational glue, management of employees, organisational leadership, strategic emphasis and criteria for success were aggregated and presented for each of the categories of employees mentioned above.

Part 3: Collated data were used as a basis for group discussions using the Spilter platform.

There were two parts to this data collection:

1. Ideas were sought from each category of employees to propel culture change. The scalability of the tool was observed through the rate of participation rate. The speed by which the use of GDSS/EMS could accelerate change versus the manual change methods (as performed during the senior management retreat) was also assessed.

2. Feedback from each focus group was obtained regarding the ease-of-use of the Spilter platform, and the feedback was used to further fine-tune and improve the OCAI-Spilter artifact. The feedback obtained during the interaction sessions asked the questions about:

    a. Ease of use of the Spilter system

    b. Ideas and suggestions for improvement

    c. Observations on how people interact with the software

3.6 Conclusion regarding the effectiveness and usefulness of the Digital GDSS Platform and its Application

The conclusions from the surveys conducted on all of the different groups of faculty, staff and students gave us an idea about their current perceptions of the current SUTD culture and their preferences as to what it should be. This gave us a good understanding of how to works towards an alignment between these groups. In addition,

- A strong set of design principles were developed based on:
    - Reflection on the design and redesign during the project
    - Adherence to principles
    - Analysis of intervention results according to stated goals

These principles would be useful in the future design of such tools to achieve culture alignment, as well as in the implementation of successful culture change programs for SUTD. These discovered design principles will be explained in more detail in Chapter 5 together with the analysis of the results.

Chapter 4: Data Collection

4.1 A Description of Collected Data

In this chapter, we discuss the results collected for this research project and address the problems and conjectures regarding scalability and the possibility of process losses listed in chapter 1.

a. The long process taken to obtain consensus for desired culture for only 13 people points to the need for scability when applied to a large number of students, staff and faculty.

b. Non-responsiveness of faculty and staff members to the manual version of the OCAI survey could be an indication of both problems of scalability and of process losses. First, members of the faculty and staff stakeholder groups were not fully responsive to the request to participate in our survey and subsequent group discussions. In our initial days of trying to initiate culture change through the OCAI sessions, only 15% of the faculty and 25% of the administrative staff participated in the scheduled sessions. Compared to staff, the low faculty participation rate could be due to several reasons: (1) most faculty-members travel extensively and may not be able to participate in a scheduled meeting that is stipulated for a "same place – same time", culture assessment and discussion session. (2) The face-to-face sessions are lengthy and time consuming, and faculty members may not have the time to participate in such sessions. (3), Some faculty members may not be interested in participating, and consider the culture change exercises a waste of their time. (4), Unlike the administrative staff who were asked by their supervisors to participate, the faculty members are typically much more independent and may not heed requests to participate by their academic administrators or pillar heads. (5), Due to potential problems of scalability and process losses of which that the faculty members may already be aware, they may not consider the results of the group process credible and therefore may choose not to participate in the initial survey. Even though the participation rate of administrative staff was higher at 25%, it was still considered quite low as compared to what was needed to achieve a common understanding and potential consensus about the culture change.

c. Second, given the large numbers of potential participants (120 eligible faculty members, 250 eligible administrative staff and 600 eligible students) the process of collecting OCAI data from these large groups, tabulating this data in real-time for feeding it back to the participants for a subsequent discussion regarding the "current" culture profile; reaching a potential consensus on the "desired" culture, and agreeing on the measures taken for culture change is likely to be extremely time and effort intensive, and therefore not scalable. For large groups, it may not be feasible to complete this process in timely manner. When the pilot test was conducted with staff and faculty on the OCAI questionnaire and subsequently face to face sessions, it took many weeks to meet only a small number of people. Moreover the manual process was very tedious.

d. Third, face-to-face sessions can be subject to process losses. (See Chapter 2 for a list of potential process losses (Nunamaker et al., 1991). In our sessions, we observed several types of process losses which included evaluation apprehension, free riding, domination, failure to remember as well as air time fragmentation.

e. Fourth, it is difficult for a human scribe to capture the comments and suggestions by most participants. It is also possible that the human scribe may subconsciously filter out comments by the participants, or state some of the comments in a distorted manner.

f. Fifth, in a manual process, it was found to be difficult for people to arrive at a common understanding regarding their perceptions of the current organisational culture, agreement about the desired cultures, and the means (projects) designed to move from the current to the desired state. This was especially true in the early days when we tried to bring everyone into agreement.

g. Sixth, as culture change is a gradual process, Process Step (7) above requires ongoing measures at frequent intervals, and therefore requires frequent iterations of process steps (1) to (6). This is not only time consuming and obtrusive; for the reasons previously stated but iterations may not be possible.

The objective of this research is thus to design, develop, and test a computer-based meeting support system (a group support system). This GDSS will be used for:

(1) Collecting, grouping, summarizing, graphing, and reporting OCAI data from multiple participants;

(2) Supporting group discussion and decision-making at both intra and inter group levels for arriving at consensus, and agreeing upon culture-change measures; and

(3) Regularly and iteratively measuring progress towards the culture change project.

DESCRIPTION OF THE ARTIFACT

4.1.1 OCAI Integration Software

We set out to overcome all these issues with the use of the OCAI-Spilter tool that was developed to automate and improve the participation rates of the survey. The tool was formulated to take participants through and complete the survey phase as it was done in the manual sessions. Methodology for deploying the OCAI-Spilter usds the concept of action design research in which the tool was tested out in an initial group of participants from the Human Resources division and based upon their evaluation and feedback, subsequently refined to improve the flow. The underlying objective behind the tool is that a relatively large number of people can participate in group processes.

4.1.2 Methodology for Deploying the tool

The typical process losses evident in face-to -face meetings was reduced through the following capabilities being built into the electronic meeting support system for culture change. These capabilities included:

a. Sequential flow of meeting that enables participants to be able to focus on one task at a time. This makes it easier for participation and decision making.

b. Ability for everyone to participate and share their ideas for culture change all at the same time, thereby reducing the time required to bring out ideas, increasing their variety, and thus addressing attention blocking issues and air time fragmentation as observed in manual meetings. (Nunamaker, et al)

c. Allowing anonymity so that users are free to share their ideas without fear of retribution and without apprehension and need of conformance to pressure.

d. Allowing all participants an equal chance to participate and share their ideas without being singled out

e. Ability to process and sort out vast amounts of information, while reducing information overload

f. Allowing people to be able to participate from different locations (different-place) at different-times, without travelling to and assembling at a specified location. The reduction in effort and time required to travel and assemble, will presumably increase the rate of participation.

The OCAI-Spilter was built with the above requirements in mind and was deployed organisation wide amongst SUTD senior administration, faculty, staff and students.

We report on the results and usefulness of the tool and will subsequently describe the outcomes of the survey.

4.2 Description of Data for Tool and Methodology in Use

The OCAI-Spilter was deployed to four key groups of stakeholders in SUTD, namely senior management, faculty, staff and students. Design principles of the artifact included:

- Building the OCAI survey tool using the Spilter system
- Building usable screens to automate the flow of the OCAI survey
- Building process flow for cultural alignment within the Spilter platform
- Developing a platform for the easy participation and contribution of ideas for culture change

- Testing the software with a pilot group of users to assess its usability and user-friendliness
- Refining the final prototype and deploying to the larger group

4.2.1 Response and Profile

The entire SUTD population including senior management, staff, faculty and students participated in the survey. For ensuring that participants had a good understanding of the SUTD culture, only persons who had been with SUTD for at least one year were surveyed. Inclusion criteria were staff, faculty, and senior management who had at least 1 year of service, and sophomore and senior students in their 2nd and third year of studies. The general demographics and participation rate are illustrated in the next following graphs.

a) Participation Rates

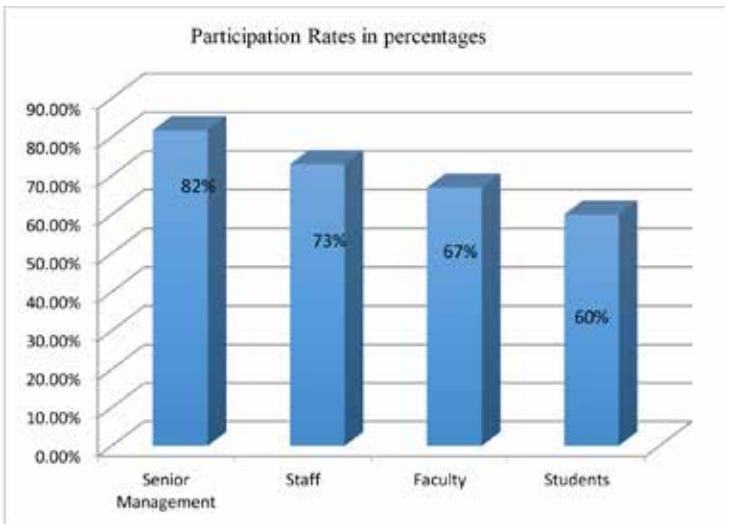


Figure 11. Participation Rates.

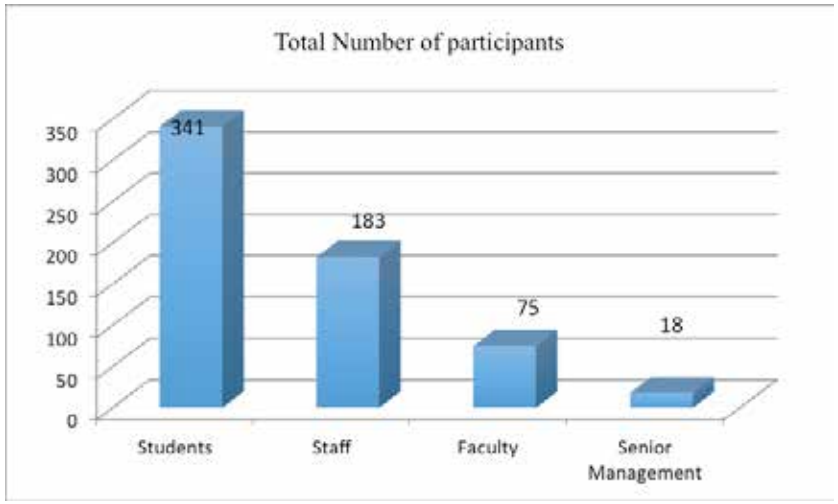


Figure 12. Total Number of Participants.

b. Participants Profile

Table 11. Percentage distribution of Nationality of participants

	Nationality of participants				
	Asia	Europe	North America	Antarctica	Australia Oceania
Senior Management	72.3%	0.0%	27.7%	0.0%	0.0%
Faculty	65.0%	27.0%	5.0%	1.0%	2.0%
Staff	100.0%	0.0%	0.0%	0.0%	0.0%
Students	99.7%	0.0%	0.0%	0.0%	0.3%

Table 12. Length of Service of Participants

	Length of Service	
	Less than 3 years	More than 3 years
Senior Management	88%	11%
Faculty	17%	83%
Staff	75%	25%

4.2.2 Results on Efficiency of the Artifact: OCAI-Spilter versus Manual Method

Table 13. Results with respect to Efficiency.

	Face to Face Sessions	Spilter	Improvement Rate
Participation Rate	Admin Staff: 24.65% Faculty: 14.9%	Admin Staff: 73% Faculty: 67%	Admin Staff: 48.5% Faculty: 52%
Time taken to fill in Survey	1 hour per person	30 minutes per person	Time Savings: 30 minutes per survey
Generation of ideas to achieve desired culture	3 hours at Senior Management retreat conducted a year before using pens and flipcharts	1 hour for session using OCAI-Spilter	2 hour improvement for idea generation session

(The senior management team only participated in the manual version of the OCAI survey, so no data is available for comparison)

1. The results showed a major improvement in the participation rate of stakeholders for the manual method versus using the OCAI-Spilter based method. The percentages by which participation improved ranged from 48% for staff to 52% for faculty.

2. The results also showed a time savings of 30 minutes for every survey undertaken by the OCAI-Spilter versus the manual version

3. There was a 200% improvement in the time needed to generate ideas for a culture change session with the OCAI-Spilter versus the face to face interaction when the system was pilot tested with the senior management team. In the initial manual pilot test, it took the team half a day to derive five general ideas to faciliate collaboration and innovation within the university. After the OCAI-Spilter artifact was introduced, it took only 1 hour to generate more than 20 agreed ideas for culture change. These ideas revolved around reducing hierarchy, introducing innovation through entrepreneurial activities and improving teamwork through social lubrication.

4.3 Description of Data about Culture Change Using the Tool and Methodology

With the deployment of the OCAI- Spilter for survey building and alignment of desired culture, we collated and gathered the following data:-

a. The current and desired states of culture

b. The current and desired states of culture amongst the different stakeholder groups

c. The current and desired states of culture for each dimension of culture

d. The current and desired states of culture for each dimension of culture for each stakeholder group

e. The current and desired states of culture for different geographical regions, mainly Asia, Europe and North America

4.3.1 OCAI Validity and Reliability

The instrument validity and reliability for the OCAI has been established through numerous studies (Berrio, 2003; K. Cameron & Freeman, 1991; Collett & Mora, 1996; Quinn & Spreitzer, 1991; Zammuto & Krakower, 1991). More recently, Yu and Wu (2009, p. 40) reported on a large number of empirical studies that have established the reliability and validity of the CVF and OCAI citing Howard (1998), Lamond (2003), Denison and Mishra (1995), and Ralston, Terpstra-Tong, Terpstra, Wang, and Egri (2006).

Since this is a digital version of the OCAI, we would need to re-evaluate reliability. Cronbach's alpha was used to assess the inter-correlations of test items to determine reliability through internal consistency of test scores. Alpha was developed by Lee Cronbach in 1951 to provide a measure of the internal consistency of a test or scale; it is expressed as a number between 0 and 1. Internal consistency describes the extent to which all the items in a test measure the same concept or construct and hence it is connected to the inter-relatedness of the items within the test. (Tavakol, M., & Dennick, R, 2011).

Table 14 illustrates that values in this research study are in agreement with a study of culture conducted by Zammuto & Krakower (1991) to investigate culture completed by 1300 respondents from higher education institutions. Both the current culture and preferred culture alpha coefficients in our study are greater than 0.70, which is deemed to indicate internal consistency or reliability (Vierra, Pollock, & Golez, 1988).

Table 14: Internal Consistency.

	Reliability Coefficients for Current	**Reliability Coefficients for Preferred**	**Compariso Reliability Coefficients**
Culture Type	SUTD	SUTD	Cameron & Quinn (2006)
Clan	0.80	0.78	0.82
Adhocracy	0.79	0.82	0.83
Market	0.79	0.74	0.67
Hierarchy	0.79	0.79	0.78

4.3.2 Results of Organization-Wide OCAI Scores

We will now go through in detail the results of the OCAI culture survey administered to the entire community.

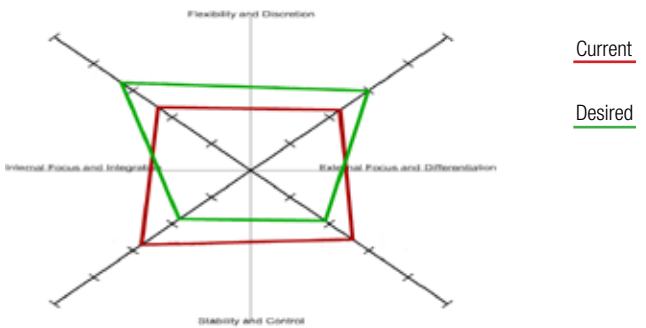


Figure 13. Results of Organizational Wide OCAI.

Table 15. OCAI Numerical Results for Overall Culture.

	Current Mean	Desired Mean
Clan	23.61	32.92
Adhocracy	22.64	29.87
Market	25.81	18.92
Hierarchy	27.85	18.22
Dominant	Hierarchy	Clan
2nd Highest	Market	Adhocracy
Lowest	Clan	Hierarchy
Main Dimensions	Stability and Control	Flexibility and Discretion

Current Culture: The dominant current culture as perceived by all stakeholder groups was hierarchy (mean = 27.85). The second dominant perceived culture is market (mean = 25.81). The lowest current culture quadrant was that of adhocracy (mean = 22.64). No strong dominant culture was demonstrated due to the equally strong current perceptions of Hierarchy and Market balanced with quite similar mean scores for Clan and Adhocracy.

Preferred Culture: The dominant preferred culture as perceived by all stakeholder groups was clan (mean = 32.92). The second dominant preferred culture is adhocracy (mean = 29.87). The lowest preferred culture quadrant is that of hierarchy (mean = 18.22) which previously was the most prevalent culture.

4.3.3 Results of Each Stakeholder Group

A) SENIOR MANAGEMENT

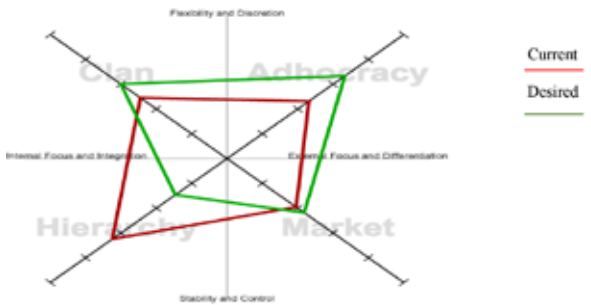


Figure 14. OCAI Graph for Senior Management Group.

Table 16. OCAI Scores for Senior Management Group.

	Current Mean	Desired Mean
Clan	24.51	30.09
Adhocracy	23.19	33.33
Market	19.54	21.81
Hierarchy	32.45	14.63
Dominant	Hierarchy	Adhocracy
2nd Highest	Clan	Clan
Lowest	Market	Hierarchy
Main Dimensions	Internal Focus and Integration	Flexibility and Discretion

Current Culture: The currently dominant current culture as perceived by senior management was hierarchy (mean = 32.45). The second dominant perceived culture was clan (mean = 24.51). The lowest current culture quadrant was that of market (mean = 19.54). In the case of Senior Management, a strong perception of hierarchy exists about the current culture.

Preferred Culture: The preferred dominant culture as perceived by senior management was adhocracy (mean = 33.33). The second preferred dominant culture is clan (mean = 30.09). The lowest preferred culture quadrant is that of hierarchy (mean = 14.63). Both clan and adhocracy score quite high as the preferred culture. The senior managers would prefer significantly lower hierarchical and control scores for the organisation.

B) STAFF

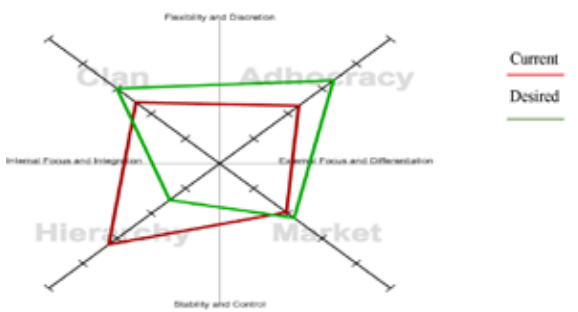


Figure 15. Results of OCAI Graph for Staff Group.

Table 17. OCAI Results for Staff Group.

	Current Mean	**Desired Mean**
Clan	23.61	31.83
Adhocracy	23.04	25.18
Market	26.68	20.35
Hierarchy	26.67	22.64
Dominant	Market	Clan
2nd Highest	Hierarchy	Adhocracy
Lowest	Clan	Market
Main Dimensions	Stability and Control	Flexibility and Discretion

Current Culture: The currently dominant current culture as perceived by the staff is with almost equal strengths, both market (mean =26.68) and hierarchy (mean=26.67). The lowest current culture quadrant is that of adhocracy (mean =23.04). The clan scores do not differ significantly from the adhocracy scores.

Peferred Culture: The dominant preferred culture as desired by staff groups was clan (mean=31.8). The second dominant preferred culture is adhocracy (mean=25.18). The lowest preferred culture quadrant is that of market (mean =20.35).

C) Faculty

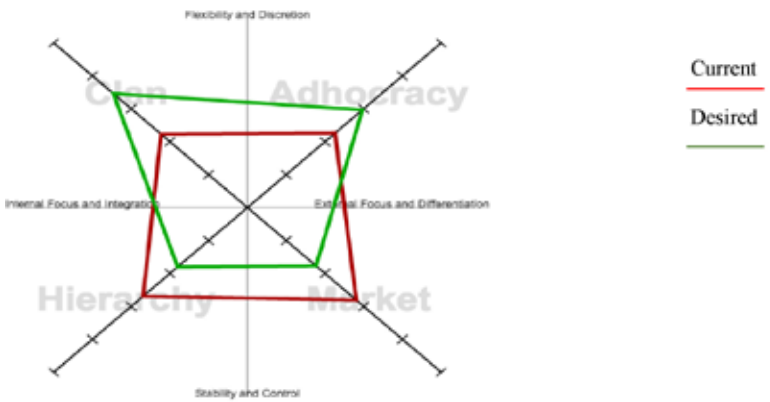


Figure 16. Results of the OCAI Survey for Faculty.

Table 18. OCAI results for Faculty.

	Current Mean	**Desired Mean**
Clan	22.36	34.56
Adhocracy	22.60	29.68
Market	28.13	17.74
Hierarchy	26.92	18.03
Dominant	Market	Clan
2nd Highest	Hierarchy	Adhocracy
Lowest	Clan	Market
Main Dimensions	Stability and Control	Flexibility and Discretion

Current Culture: The currently dominant culture as perceived by faculty is market (mean = 28.13). The second dominant perceived culture was hierarchy (mean = 26.9). These two scores suggest that the faculty perceive that the current SUTD organisational culture emphasizes a market and control orientation. The lowest current culture quadrant was that of clan (mean = 22.8) but that does not differ very much from the market quadrant. No strong dominant culture was demonstrated due to the equally strong current perceptions of hierarchy and market balanced with quite similar mean scores for clan and adhocracy.

Preferred Culture: The dominant preferred culture as perceived by faculty was clan (mean = 34.56). The second dominant preferred culture was adhocracy (mean = 29.68). The lowest preferred culture quadrant was that of market (mean = 17.74). The strong dominant score here was for a clan culture. The significant increases on the clan and adhocracy dimensions, and the decreases on the market and control dimenstions strongly indicate that the faculty would like to see an increase in collegiality and innovation, even at the expense of control and market-orientation, at SUTD.

D) Students

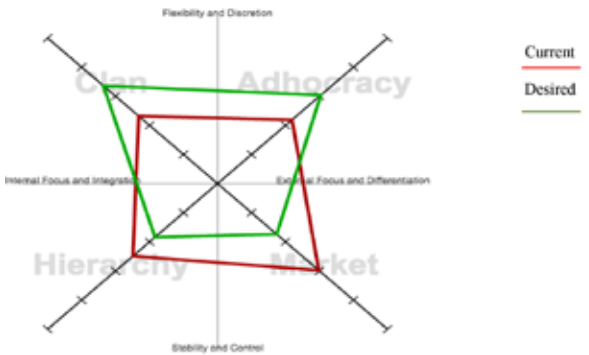


Figure 17. Results of the OCAI Survey for Students.

Table 19. OCAI Scores for Students.

	Current Mean	**Desired Mean**
Clan	23.28	33.62
Adhocracy	21.97	30.48
Market	29.85	17.48
Hierarchy	24.91	18.42
Dominant	Market	Clan
2nd Highest	Hierarchy	Adhocracy
Lowest	Adhocracy	Market
Main Dimensions	Stability and Control	Flexibility and Discretion

Current Culture: The currently dominant culture as perceived by students is market (mean = 29.8). The second currently dominant perceived culture was hierarchy (mean = 24.9). The lowest current culture quadrant is that of adhocracy (mean = 21.9) suggesting that, despite its stated mission, students do not currently perceive SUTD to be a particularly innovative university.

Preferred Culture: The dominant preferred culture was clan (mean = 33.62). The second dominant preferred culture was adhocracy (mean =30.48). The lowest preferred culture quadrant was that of market (mean = 17.48).

E: Diagrammatic view of perceived current culture by all stakeholder groups.

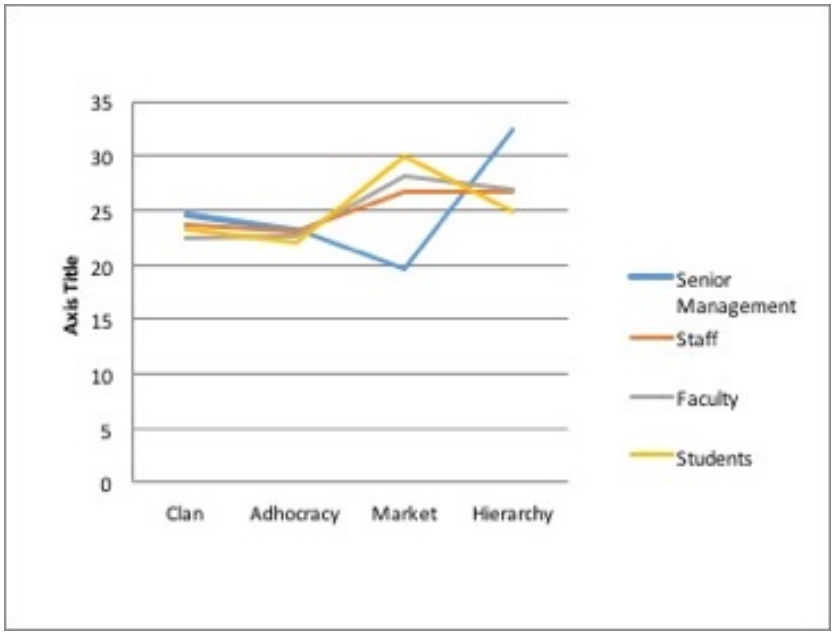


Figure 18. Estimated Mean Scores of Each Category on Current Culture

As can be seen from the graph, there was quite a wide variation in the way senior management and the rest of the groups perceived the current culture, particularly in the market and hierarchy quadrants. Senior management and students have the most differing views about the existence of market and hierarchical cultures at SUTD.

F: Diagrammatic view of desired culture by all stakeholder groups

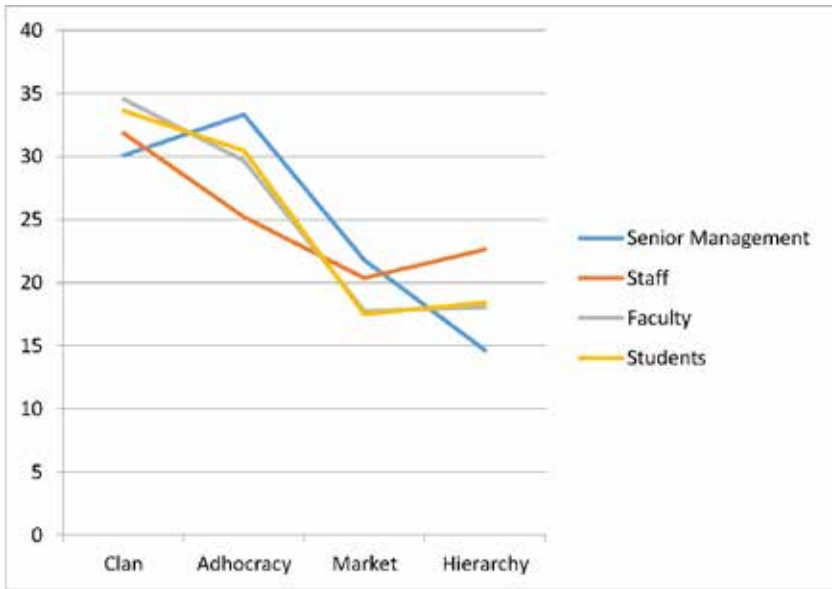


Figure 19. Estimated Mean Scores of Each Category on Desired Culture.

As for the desired culture, we saw an extremely good alignment of all the four major stakeholder groups, the preferred culture type, which is clan. This strongly indicates that all stakeholder groups are seeking a more collegial culture at SUTD.

On the other hand, there were however differing views on the desirability of adhocracy and hierarchy cultures. While the senior management team prefer to attach greater desirability and importance to an innovation culture, the staff prefer greater levels of control. This is to be intuitively expected. Greater levels of adhocracy that lowers the preference for hierarchy and control is likely to make the work lives of staff more difficult; they would prefer a greater level of hierarchical control. In designing mechanisms for culture change, these opposing preferences of staff vs. senior administration, faculty and students need to be kept in mind and be balanced if success at change efforts were to be sustained.

4.3.4 Perception of Culture by Regions

Since SUTD has employees from over 25 countries, it was interesting to review perceptions of culture by region. For the purpose of this study, we segment the population by 3 regions, namely: Asia, Europe and North America.

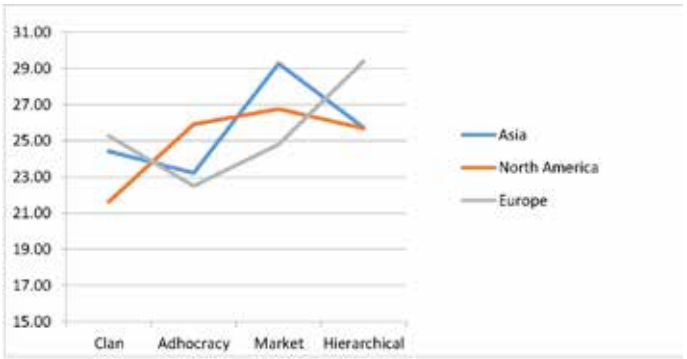


Figure 20: Estimated Means Score of Each Region on Current Culture.

Stakeholders in Asia viewed the current SUTD culture as market-oriented followed by North Americans. Stakeholders in Europe however viewed the current SUTD culture as dominantly hierarchical.

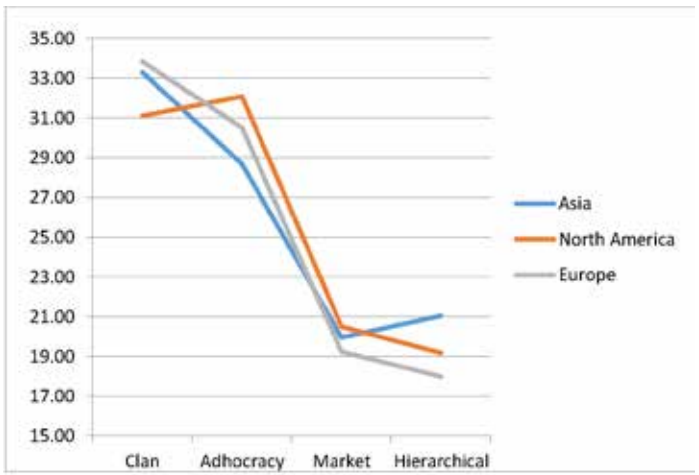


Figure 21: Estimated Means Score of Each Region on Desired Culture.

Stakeholders in both Europe and Asia desire to have greater levels of the collegial clan culture while stakeholders in North America desired a greater adhocracy culture, although the difference between clan and adhocracy is minimal. These results too are intuitive, as North Americans aer considered to be more innovative than Europeans and Asians, whereas the Asians and Europeans are supposedly more collectivist and clan oriented.

4.3.5 Results on four orthogonal Cultural Dimensions

Table 20. Summary of Current Cultural Dimension as Perceived by Different Stakeholder Groups.

	PERCEPTIONS OF DIMENSIONS OF CURRENT CULTURE			
	Senior Management	**Faculty**	**Staff**	**Students**
Flexibility and Discretion				
Internal Focus and Integration	X			
External Focus and Differentiation				
Stability and Control		X	X	X

The senior management team view internal focus and integration as the current culture whereas the rest of the stakeholder groups viewed stability and control as the current culture.

Table 21. Summary Table Outlining the Desired Cultural Dimension for Different Stakeholder Groups.

	PERCEPTIONS OF DIMENSIONS OF DESIRED CULTURE			
	Senior Management	**Faculty**	**Staff**	**Students**
Flexibility and Discretion	X	X	X	X
Internal Focus and Integration				
External Focus and Differentiation				
Stability and Control				

All stakeholder groups were aligned in terms of a desired culture of flexibility and discretion.

4.3.6 Perceptions of Each of the Six Dimension of Culture

As explained in Chapter 2 (section), in an OCAI measurement, an organisation's culture is reflected along six behavioural dimensions. The next set of results are derived from these six cultural dimensions of the OCAI survey. We reviewed the degree in which all four stakeholder groups were aligned (or not) in terms of their dimensions of cultural values. The six behavioural perception of the dimensions current clwere:

1. Dominant Characteristics: The overall characteristics of the organisation
2. Organisational Leader: Perception of the leadership style that currently dominates the organisation
3. Management of Employees: How employees are managed and how they view the working environment
4. Organisational Glue: The mechanisms that hold an organisation together
5. Strategic Emphasis: This defines the key strategic areas and emphasis on which an organisation places its key goals and priorities
6. Criteria of Success: The factors that determines success for an organisation and are greatly valued

Table 22. Top Dominant Cultural Dimensions.

	Current State		**Desired State**	
Dimension	Mean	Culture Type	Mean	Culture Type
Dominant Characteristics	28.45	Hierarchy	32.16	Clan
Organizational Leadership	26.78	Clan	33.83	Clan
Management of Employees	27.37	Hierarchy	34.22	Clan
Organizational Glue	29.17	Hierarchy	33.83	Clan
Strategic Emphases	28.69	Hierarchy	31.55	Clan
Criteria for Success	26.60	Market	31.85	Clan

There are mixed views for perceptions of each of the dimensions of current culture. While hierarchy and control were perceived to be currently dominant in three of the six dimensions, all stakeholder perceived SUTD as not bing particularly dominant in innovation and adhocracy.However, there was a concurrence in the desired culture state for each cultural dimension, which was clan culture. All stakeholder groups are seeking clan and collegiality along all six behavioural dimensions.

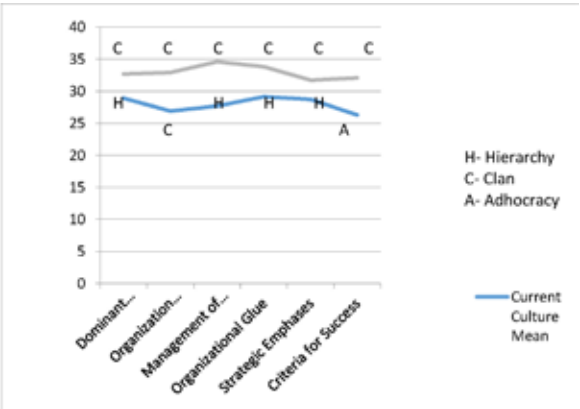


Figure 22. Diagrammatic View of Current and Desired States of Each Cultural Dimension.

Table 23. Perceptions of the Six Dimensions of Culture by Different Stakeholder Groups.

	Senior Management		Faculty		Staff		Students	
DIMENSION	**Current**	**Desired**	**Current**	**Desired**	**Current**	**Desired**	**Current**	**Desired**
Dominant Characteristics	Hierarchy	Adhocracy	Hierarchy	Clan	Market	Clan	Market	Clan
Organisational Leadership	Hierarchy	Adhocracy	Clan	Clan	Clan	Clan	Market	Clan
Organisational Glue	Hierarchy	Clan	Hierarchy	Clan	Market	Clan	Hierarchy	Clan
Management of Employees	Hierarchy	Clan	Clan	Clan	Clan	Clan	NA	NA
Strategic Emphases	Hierarchy	Adhocracy	Market	Clan	Hierarchy	Clan	Market	Clan
Criteria of Success	Hierarchy	Adhocracy	Market	Clan	Hierarchy	Clan	Market	Clan

The results for the six dimensions of culture as viewed from the above chart tell us that:

1. Senior management viewed most existing dimensions of culture as hierarchical. However the scores between hierarchy and adhocracy were only differentiated by 0.2 for the behavioural dimension on criteria of success. It was rated at 27.5 for adhocracy and 27.72 for hierarchy.

2. Senior management would like to see more adhocracy in the desired culture for most dimensions except for organisational glue and management of employees. This may set up opposing expectations among faculty, staff, and students. While they see senior management asking for adhocracy alng four behavioural dimensions, they see them as opposing adhocracy along the two dimensions that may threaten their managerial control.

3. Faculty viewed the dominant characteristics and organisational glue of the current culture as hierarchical while the leadership style and management of people were viewed as clan. They did see elements of the university being market driven when it came to its strategic emphases and success factors. Faculty would desire a clan approach towards all dimensions of culture. This desire emphasizes faculty desire for collegiality in all behaviours.

4. Staff viewed the current dominant characteristics and organisational glue to be that of a market driven culture and agreed with the faculty that the management of employees and the leadersship orgnaisation were that of a clan type. Interestingly they viewed the current strategic emphases and criteria of success to be that of hierarchical.

5. Similarly to faculty, staff would prefer a clan approach towards all dimensions of culture.

6. Students viewed most elements of the current culture to be that of a market driven culture. However, similarly to both staff and faculty, they prefered a clan approach to all behavioural dimensions of culture.

4.3.7 Description of Culture Change Using the Tool and Methodology

As the process of culture change is a long continuing process, we will only illustrate the use of the tool for culture change discussions with pilot groups that included the senior management team, staff and faculty. The culture change discussion sessions will continue to evolve beyond this PHD dissertation. These three sessions were facilitated using the GDSS technology in Spilter to create a Decision Room where stakeholders were invited to share their ideas for culture change, poll and rank the ideas, and critique them. Following are the results collected from conducting three sessions of such focus groups.

Session 1: Pilot Testing with the Senior Management Team (22 participants)

A Spilter brainstorming session was conducted with the senior management team on March 2014, in which the GDSS tool was used for brainstorming of culture change initiatives. Whereas the first computer-unassisted session for cultural alignment took half a day. The GDSS tool for culture change took about one hour to complete, and participants used the tool to suggest ideas for culture change.

Within the one hour session, a total of 50 ideas were generated out of which 10 ideas were prioritized for culture change.

Ideas for promoting a clan culture included:

1. Introduce a "Be Happy" hour every last Friday of the month, where staff, faculty and senior management can interact with each other on neutral terms.
2. Create an intellectually vibrant and open campus for students and faculty
3. Promote flexible working hours
4. Streamline work processes to reduce bureaucracy
5. Organize a family day to promote a clan culture

Ideas for promoting an adhocracy culture included:

1. Introduce SUTD awards to recognise adhocracy and innovation
2. Review and consolidate work activities to remain focused on what we want to achieve

3. Developing innovative processes and re-engineering existing ones to build an innovative culture
4. Organise an annual innovation festival
5. Encourage revenue and resource generation as part of entrepreneurship culture

While this was desirable, these sessions did not focus on reducing the levels of control and hierarchy and market-orientation in the SUTD culture. This could be due to the unforeseen strengths of these cultures; and their existing strength in Singapore. Moreover, it is possible that the stakeholders were avoiding these measures because of their anticipation of blow-back by some groups that may feel threatened by such changes.

Session 2: Pilot Testing of OCAI-Spilter Session with staff

The OCAI-Spilter system was used to faciliate culture change with a group of 8 staff who contributed the following ideas for culture change.

Table 24. Table of Change Ideas from Staff.
(In verbatim)

	Ideas for culture change
CLAN CULTURE	Provide mentoring sessions at work
	Create an environment where people feel safe to voice their ideas regardless of seniority or position
	Organise social activities for interaction in an informal setting
	Organise more events like movie nights
	SUTD Corporate Affairs should be fun
	Ideas for culture change
ADHOCRACY CULTURE	Train employees to think out of the box
	Organise design thinking workshops between students and faculty to crowd source suggestions and ideas for growing SUTD
	Quarterly online surveys to gather ideas
	No fear of making mistakes, allow risk taking. Current culture promotes doing bare minimum to avoid making mistakes
	Provide thinking space to inspire creativity and innovation
	Management staff should be willing to take responsibility for the mistakes of their subordinates and not push blame

Session 3:Pilot Testing OCAI-Spilter Session with faculty

The OCAI-Spilter system was used to faciliate culture change with a group of five faculty who contributed the following ideas for culture change.

Table 25. Table of Change Ideas from Faculty.

	Ideas for culture change
CLAN CULTURE	Blur boundaries between administration and faculty. There is currently an "us" versus "them" perception
	Organise more bonding sessions outside campus
	Don't make us compete for limited resources.
Adhocracy	Need to have more negotiating powers and opportunities for growth. More directorships could be offered to faculty and allow them to apply
	Rewards and recognition should be based on clear, transparent criteria and carried out consistently. Need more rewards and recognition for people who work hard and work smart
	Right people for the right task?

Validation of the instrument:

A user survey was conducted with this group of thirteen staff and faculty who piloted the use of the OCAI-Spilter session for culture change. We collated the following responses regarding the usability of the software.

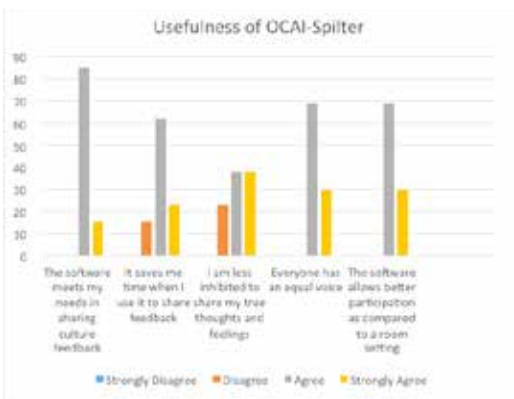


Figure 23. Usefulness Of The Ocai-Spilter Artifact.

91% of respondents rated the artifact as useful

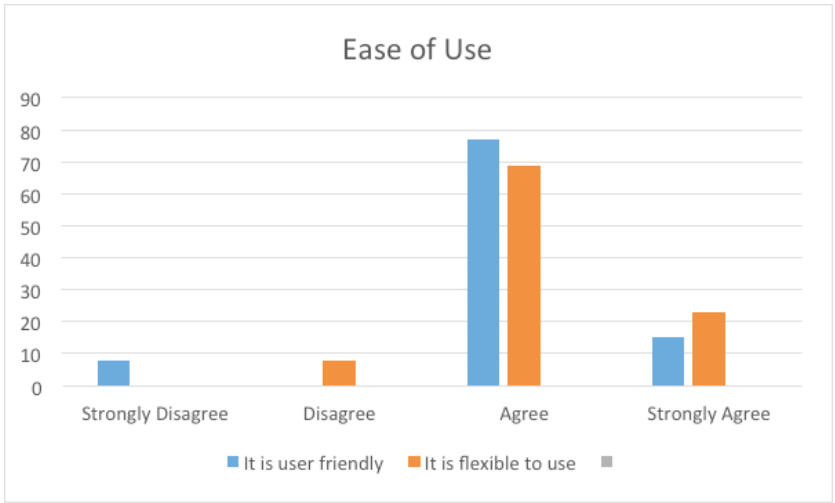


Figure 24. Ease of Use of Ocai-Spilter Software.

91% of respondents rated the artifact as easy to use.

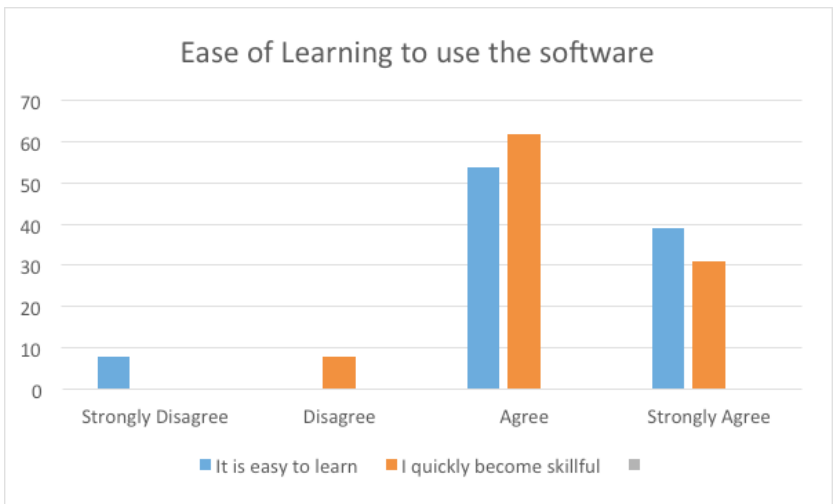


Figure 25. Ease of Learning OCAI-Spilter.

96% of respondents indicated that it was easy to learn how to use the artifact

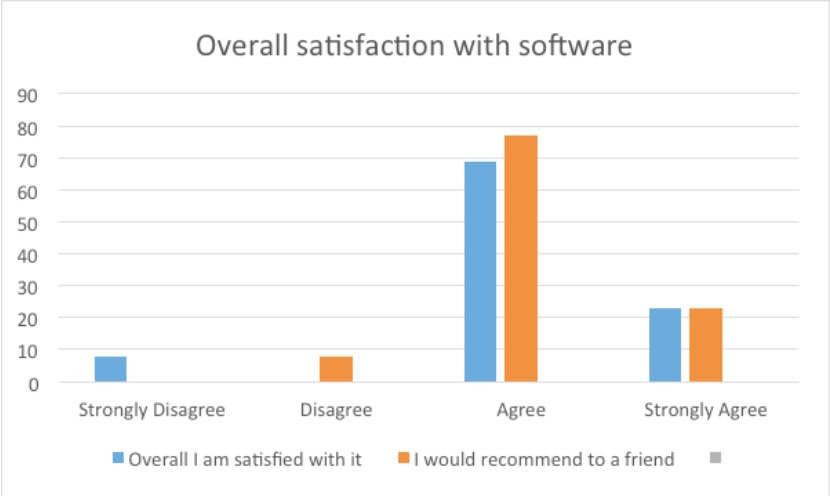


Figure 26. Overall Satisfaction with the Ocai-Spilter Artifact.

96% of respondents indicated that they are overall satisfied with the artifact.

In summary, this chapter focused on reporting data on the efficiency of the OCAI-Spilter artifact when deployed in real life conditions. Efficiencies in terms of improving participation rates, time taken to complete the survey, as well as idea generation were reported. We also analysed data that were generated using the tool and methodology. The reliablity of this data was confirmed through a high co-efficient generated through this study as compared against a study of culture conducted by Zammuto and Krakower (1991) completed by 1300 respondents from higher education institutions. The overall results of this culture survey indicated a current perception of SUTD as having a hierarchical and market driven culture. Stakeholders seemed to be desiring increases in a clan and adhocracy-orientation; where as desiring lesser amounts of hierarchy and control. However, consideration of compensating measures to reduce hierarchy seemed to be limited, due to the potential for blow-back.

The survey results were further analysed by stakeholder groups, regions of origins, and by cultural dimensions. Perceptions of current and desired cultures, dominance, as well as main dimensions were analysed for each stakeholder group. We also did a comparative study of the marginal mean scores of each

category of stakeholders in the way they viewed the current and perceived culture. Results showed a congruence of the current perceived culture by each stakeholder group with the exception of senior management. On the other hand, there was a clear consensus on the desired cultural dimension by each stakeholder group. Next, we looked at perceptions of culture by regions. It was interesting to note that Asia and North America had the same current perceptions of the current culture as compared to Europe. In terms of desired culture, both Asia and Europe preferred a clan culture while North America preferred a more adhocracy culture. Lastly, perceptions of current and preferred culture were analysed along the six cultural dimensions of dominant characteristics, organizational leadership, organizational glue, management of employees, strategic emphasis and criteria of success. Stakeholders viewed most dimensions of the current culture as hierarchical except for success criteria and management of employees. It was however, noteworthy to find that all stakeholders groups wanted a clan approach to all dimensions of culture.

Then next portion of the results chapter focused on the use of the OCAI-Spilter for obtaining consensus on the agreed culture and for facilitating discussions on ideas for culture change. The tool was tested with 18 senior management participants and proven that it was able to effect more ideas within an hour of brainstorming as compared to the manual method. In a second pilot testing with staff and faculty, the tool proved effective in eliciting new ideas and obtaining consensus. A user survey was conducted on this group of 13 users to rate the usefulness, ease of use and learning, as well as overall satisfaction with the OCAI-Spilter artifact. The high results of over 90% confirmed the successful deployment and use of the OCAI-Spilter tool.

The results presented in this chapter are discussed in Chapter 5 and concluded with a discussion on future applications in Chapter 6.

Chapter 5: Discussion of Results

5.1 Discussion of Results about Tool in Use

The objective of this dissertation was to develop a computer artifact, OCAI-Spilter, that could help improve and speed up the process of culture change through the use of this instrument. This platform also allowed for the generation of ideas for culture change and reduced issues related to process losses commonly encountered in group meetings.

Previously, OCAI was completed manually using paper and pencils, flip charts and power point slides. The process was onerous as it took a long time to collect and analysed the data. Additionally, it was difficult to obtain participation. Collecting data manually from 13 persons took more than 2 weeks, and it took about half a day to reach consensus among these 13 persons on the desired cultures. When the survey was further administered manually to staff and faculty, it took more than 2 months, and the survey only reached 15% of faculty and 27% of staff.

We thus used an action design research methdology to develop an IT artifact, called the OCAI-Spilter Integration Artifact. This artifact was used through a organisational intervention platform (a methodology) to facilitate culture change in an SUTD setting. ADR adopts the principles of problem formulation followed by building, intervention and evaluation, reflection and learning and finally formalizing that learning.

The design principles of the OCAI-Spilter artifact were thus a computer based discussion tool that could elicit response and participation as well as, present and explain them to large groups of people to discuss, come to a common understanding, hopefully consensus, and to make the process of culture change highly effective for most organisations. The requirements for this tool defined in the first chapter of this research were to:

1. Measure and identify the perceived current and desired cultural profiles of each group.
2. Represent these current and desired culture profiles explicitly, and present the representations to all members in a group, for all to review and understand them.

3. Provide a means for discussing these profiles to arrive at a consensus profile.
4. Allows a large number of people to participate in the discussion process (be scalable), and
5. Ameliorates the possibility of process losses.

The secondary research questions arising from developing this tool to measure culture will be:

a. Measure and make explicit the perceived current and desired cultures of each stakeholder group. Each group may need intra-group (within the group) discussions to make sure that most members of the group agree upon the group's perceptions of the current and desired cultures.

b. Discuss these explicitly represented, agreed-upon perceived current and desired cultures, to come to an inter-group (across groups, e.g. top-management, faculty, administrative staff, and students) agreement or consensus understanding.) agreement or a consensus understanding.

c. Identify the differences or gaps between the consensus current and desired cultures for each group.

d. Collectively discuss and come to an agreement about the possible means of reducing these gaps between current and desired cultures.

e. Collectively assess the progress towards the reduction of these gaps.

At the beginning of the dissertation, we examined several cultural instruments and selected the OCAI culture-measurement instrument as it measured the propensity to clan and adhocracy cutlures which had the most relevance for the SUTD culture change project. The culture tool by itself was not automated. Today the tool is mainly administered through paper and pen, PPT slides and flipcharts. It is currently a tedious process. Typically face-to-face sessions are needed to bring stakeholders together to begin the painful journey of culture change.. The current manual process may also result in significant process losses, as well as the inability to reach large groups of people (that is a lack of scalability). Typically, this process takes a long time to complete. For larger groups of people this process may not be feasible, producing and using uncredible data.

In Chapter 2, the literature search focused on the definition of culture, instruments that measures culture, and the process of culture change. We also looked into the foundations of design science research, action research and the literature behind the development of Group Decision Support Systems (GDSS) and their ability to allow group decision making simultaneously with only limited process losses.

Developing a computer artifact that could provide an organisational intervention to solve the current tedious and ineffective methods of culture change required the research methodology of action design research. ADR combines the idea of building a physical computer artifact and the actions of organisational change and intervention.

There were continuous reflections on the design process that could make a deep organisational impact. This theory-driven artifact, the OCAI instrument, through the use of GDSS technology, was used to identify the desired culture for SUTD through the use of GDSS technology. The foundation of the ADR process was in the integration of the two systems. GDSS systems allow for scalability and (Tavakol, M., & Dennick, R. (2011). reaching large groups of people all at one time while at the same time reducing process losses.

In stage 2 of the ADR process, which is the BIE cycle, we began examining the artifact and methodology to intergrate these two systems to solve the issue of culture change in SUTD. The objective was to develop a set of design principles that can provide guidance for the process of developing a culture change tool that could effectively help SUTD to obtain cultural alignment within a large group of stakeholders in a short duration of time. The principles include addressing the issues of a) group process losses, b)enabling higher levels of participation through easy navigation screens, c)allowing a platform for developing a consensus about the current perceived culture profiles, d) enable a discussion and consensus building change measures to change the current perceived profiles to desired profiles, implementing the change measures and assessing and re-assesing these goals on a regular iterative basis.

The system design would also take into account:

A. The ability for large numbers of people to participate in group processes

B. The ability to elicit time(and elapsed-time duration) savings through the use of this online tool

C. The ability to improve participation rates as a result of “easy to navigate” screens

D. Ability to allow participation anytime and anywhere in the world

E. The reduction of process losses that can occur in face-to-face meetings. The following capabilities to be built into the GDSS process for culture change:

   i. The sequential flow of meeting enabling members to be able to focus on one task at a time

   ii. The ability for everyone to participate and share their ideas for culture change all at the same time, thus addressing attention blocking issues and air time fragmentation

   iii. Anonymity so that users are free to share their ideas without apprehension and fear of conformance to peer or top pressure

   iv. The ability of all participants to have an equal chance to participate and share their ideas without fear of being singled out

   v. The ability to process and sort through vast amounts of information

The ADR team, comprising of HR personnel from SUTD, a University of Twente undergraduate student, an SUTD undergraduate ISTD student and Professors Kuldeep Kumar and Jos Van Hillergersberg began identifying the current problems with the manual process of administering the culture instrument and examining if the Spilter GDSS system would be able to incorporate the culture tool into its functionalities. At the alpha cycle, the ADR team began to develop an initial functional specifications based on the needs of SUTD culture change requirements, the literature review and Spilter capabilities. The HR team developed the flow of the screens to take participants through the process of articulating their current and desired culture using the OCAI culture instrument. The undergraduate programmer from SUTD and the team from Twente designed the flow of the culture surveys and consensus alignment into the Spilter screens.

An introduction page was also designed with a key message from the President to all staff, faculty and students. The tool navigation was designed to make it easy for staff and faculty to answer the questions. In addition, the survey was designed on a web browser platform that could be assessed anytime, anywhere in the world for easy participation. Explanatory pages were designed to help participants understand the survey methodology and to be able to quickly go through the survey with only a few screens, allowing time savings. This first prototype was called RS1. In the beta cycle, end users from staff departments were involved in the process of evaluating the screens, and giving feedback on the interactiveness of the OCAI-Spilter system over a two-week period. The iterative cycle of prototyping was employed where the user interface and screens were continuously improved and modified to allow for maximum ease of use, elicit higher levels of participation, and to ensure anonymity in the process. The senior management team was also involved in the user testing of the Spilter system for initiating culture change through an off-site retreat program. The consequences for the BIE cycle are listed in Table 26.

Table 26. Consequences of building, intervention, and Evaluations of OCAI-Spilter.

DESIGN PRINCIPLE	**CONSEQUENCES**
Allows for maximum participation	-The OCAI tool within Spilter was successfully built for anytime, anyplace participation of the culture survey using a web browser. This resulted in easy participation.` (anticipated). -Spilter does not work well on the Internet Explorer browser, posting some problems with the accessibility (unanticipated) -Survey data has to be exported to Excel as Spilter does not have a data processing function for customised surveys (unanticipated)
Reduce process losses	-Reduction in process losses using the OCAI-Spilter for the survey as compared to face to face meetings required in the manual administration of the surveys. As the survey allowed for anonymity, reduce attention blocking issues and air time fragmentation, it gave everyone an equal voice to express their thoughts (anticipated) -As the survey was administered through an online GDSS system, participants also felt the system was less intrusive as compared to a face-to-face meeting and manual surveys. -In the implementation of the survey, users had issues with the demographics profile under Nationality, department and job title. Users felt that this will lead to the survey being non anonymous (unanticipated)
Time Savings	-Successfully reduced the elapsed and clock-time it took to fill up the OCAI questionaire using of the GDSS platform as compared to a manual platform. This was done by building the screens such that one could view the entire survey at one glance and understand the flow quickly. In addition, unlike typical surveys, users only needed to navigate through 4 to 5 screens and this made participation easy (anticipated) Time savings was also achieved through using the Spilter platform for discussion on culture change initiatives. The building of the discussion workflow onto the Spilter platform allowed for easy navigation and inputing of new ideas into the system. The ability of the GDSS system to allow for everyone to participate at the same time sped up the process, thus reducing discussion time significantly (anticipated) Spilter does not work well with Internet Explorer (unanticipated)
Generation of ideas for culture change	-The structured sequencing of the GDSS system allowed for maximum participation from key stakeholders at each phase of the idea generation process (anticipated) -Anonymity allowed for freedom to share ideas and suggestions without being subjected to problems associated with group process losses (anticipated) -There were unexpected software compatibility issues with the Internet Explorer browser (unanticipated) -More many ideas were collected than we could possibly handle. This created unanticipatead difficulties in the ranking phase (unanticipated)

After going through some of the unanticipated consequences, the design team reviewed these design principles and made adjustments and enhancements. Table 27 outlines our revised set of design principles.

Table 27: Revised Set of Design Principles for OCAI-Spilter.

Design Principle	**Descriptions**
Allows for maximum participation	-The incompatibility of the Spliter software with the Internet Explorer browser was resolved by the survey administrator redirecting participants to use the Chrome.browser. In subsequent email invitations to participate in the survey, the message made it clear that Chrome was the best supported browser -The data analysis function of Spilter couldn not be resolved immediately. The system currently does not have an analytics platform to crunch statistical data. Meanwhile, the survey team exported the data to Excel to analyse the statistical data and results
Time Savings	-Compatibility issues with IE was resolved by directing users to Chrome
Reduce process losses	-The demographics portion was reduced to getting participants to only register the continents from which they came from, i.e., Asia, Europe or North America. Subjects were also not required to fill in their job titles and departments. Despite these restrictions, there was still enough demographics information for analysis.
Generation of ideas for culture change	-Compatibility issues with IE were resolved by directing users to Chrome -An expert facilitator was introduced in the subsequent sessions to guide participants in the idea generation phase. The facilitation was necessary to navigate participants through the flow of the Spliter screens. This resulted in more controlled discussion sessions.

5.2 Summary of the ADR process in the OCAI-Spilter Project

Table 28: Summary of the ADR Process in the OCAI-Spilter Integration.

Stages and Principles	**ARTIFACT**	
Stage 1: Problem Formulation		
Principle 1: Practice Inspired Research	Research is driven by the need to develop and test a computer based group discussion tool for group discussions and deliberations about coming to a group consensus for culture change using the results of OCAI	Recognition of problem: a. Shortcomings of the existing manual process used to reach consensus using the OCAI instrument b. Scalability of the tool
Principle 2: Theory Ingrained Artifact	Use of the OCAI instrument to reach the desired culture of SUTD through the use of GDSS theory and knowledge from empirical studies in GDSS use	
Stage 2: BIE		
Principal 3: Reciprocal Sharing	Group process losses were expected to be an on-going problem as a result of manual method of administering the OCAI questionnaire and culture discussions. Problem encountered will be used as design principles for the OCAI-Spilter Artifact	Alpha Version: The artifact conceived should address the issue of participation and group process losses
Principal 4: Mutually influencing roles	The ADR team will include HR personnel from SUTD, UT undergraduate student, SUTD undergraduate student, together with Professor Jos Van Hillegersberg who will guide them through on developing the prototype. Together, they incorporate theoretical, technical and practical perspectives	Beta Version: Prototype developed to speed up the decision making process of desired culture will be called the OCAI-Spilter Artifact.
Principal 5: Authentic and concurrent evaluation of the artifact produced in Research	The OCAI-Spilter software will be tested out with focus groups to gauge the usability of the survey. The GDSS platform for culture change will be tested out with the senior management team for group decision making before it is rolled out to the wider group	

Stage 3: Reflection and Learning		
Principle 6: Guided Emergence		Emerging Version and Realization: The IT artifact should be continually refined through continuous feedback
Stage 4: Formalization of Learning		
Principle 7: Generalized outcomes	GDSS platform for achieving culture change	Ensemble Version: An ensemble embodying the design principles for achieving the desired culture through OCAI-Spilter

After the building of the artifact and deployment to the stakeholders vis-à-vis staff, faculty and students, we noted from Table 23 in Chapter 4 that the OCAI-Spilter was able to improve participation rates of faculty and staff by a large percentage.

1. Increase in participation rate of OCAI survey by faculty = 52 %
2. Increase in participation rate of OCAI survey by staff = 48.5 %
3. Time taken to complete each survey was reduced by 30 minutes using the online OCAI-Spilter tool versus using the manual method
4. Time taken for idea generation was one hour on the OCAI-Spilter versus three hours using the manual method

As noted, we can conclude that the OCAI-Spilter tool was highly effective in improving participation in the OCAI Survey. It was also effective in bringing about intra and inter-group alignment and consensus on perceived current and desired cultures. From the analysis of the results, we can infer that due to the busy schedule of staff, faculty and students, it is much harder to get them to fill up a paper and pen survey form and to come to a meeting at a particular time and place. The artefact makes it easier for the members to participate. The OCAI-Spilter system allows the individual stakeholdres to participate in the survey and for working towards a common agreement, and the cultural alignment process in the comfort of their own home or office and at a self specified time. Secondly, the sequential flow of the Spilter screen made it very easy to understand and participate in the project. When the OCAI-Spilter artifact was designed,

it allowed for anonymity so that participants need not reveal who they are, or which department they worked, making it less intrusive for them to participate in the survey.

Another key reason for success of the tool may be the fact that people are now very savvy in using technology in many aspects of their lives. They may view the OCAI-Spilter tool as the latest and innovative technology and therefore, were more willing to participate in such a study as opposed to traditional culture change projects that utilise manual processes.

The effectiveness of the OCAI-Spilter artifact as a tool for culture discussion and idea generation was pilot tested with with a group of 13 users. The users were invited to participate in a discussion on their views of the current and desired culture and to share their thoughts and ideas on how to close the culture gap. After the session, users were asked for their views on the usefulness, ease of use, ease of learning and overall satisfaction with the software. A more than 95% satisfaction rate was achieved with the pilot test. The results were reported in Chapter 4. In addition we also conducted focus groups on aspects of the OCAI-Spilter that they either liked or did not like. The results of these focus group sessions confirmed the usability of the software with some room for improvement. Some of the comments captured included:

Question 1: What did you like best about the OCAI-Spilter tool?

(Verbatim answers to the above question)

1. I can see what others are saying.
2. Easy to use in general.
3. The software was easy to use and pick up, and allows for anonymous feedback to be shared openly.
4. Convenient.
5. Interesting way of doing it
6. Easy navigation
7. Is a place where I can freely voice my thoughts and comments
8. Can be done at your desk.

9. Answers are anonymous, people feel less inhibited to share their true thoughts.
10. It is stable as a platform

Question 2: What did you like least about the Spilter survey software?
(Verbatim answers to the above question)

1. Not being able to see a summary of both questions
2. Higher anonymity with larger set of concurrent users.
3. It may get a little slow if there is a big group. But overall, am fine with it.
4. I think overall it is ok. Nothing in particular that I do not like about.
5. It needs to be navigated in a sequential manner. Everybody needs to wait for everyone else to complete a session before moving on to the next.

Question 3: What, if any other improvements, would you suggest or recommend for the Spilter survey software?
(Verbatim answers to the above question)

1. A timer so we know how long we should take.
2. Allow option to merge similar opinions before voting
3. Perhaps there can be a previous button so the survey respondents can go back to the previous screen if they need to change or adjust their responses.
4. No at the moment.
5. Perhaps people can do it at their own time instead of a synchronized fashion.

5.3 Discussion on the Culture Results and Inferences on Similarities and Differences

5.3.1 Discussion on Results of the OCAI survey on different stakeholder groups

When we reviewed the original objectives of this organisational development project in Chapter 1, our objectives were to move towards an adhocracy and clan culture and reduce the hierarchical and control culture quadrant. Reviewing the global results of the culture survey, we observed that SUTD stakeholders as a whole viewed the current culture type as hierarchical and market driven and have the same desire as SUTD to move towards a clan and adhocracy culture. There are many factors that could have resulted in this alignment. Firstly, the university has embarked on the culture transformation journey since 2011 through its many staff activities and programs. The programs in this journey had already been reinforcing the desirability of adhocracy and clan culture. Secondly, being a start-up university, its key vision and mission was to recruit staff, faculty and students, who were willing to embrace the new curriculum and were prepared to take risks.

Drilling down to the results of each individual group of stakeholders, we did find a stark difference between the senior management team and the rest of the stakeholders. The senior management team viewed hierarchy and clan as the existing dominant culture type. Morever they desired adhocracy as a preferred culture more than clan culture. The rest of staff, faculty and students viewed market and hierarchy as the existing dominant culture type and sought clan and adhocracy as the desired culture.

One reason for this difference could be that the senior management team views the key mission and vision of SUTD as that of an innovative university that needs to have major breakthroughs in ideas and execution, while the rest of the staff/ student/faculty view the desired culture to be of one that promotes a great deal of collegiality, teamwork and co-operation to achieve the vision of a multi-disciplinary institution.

Analysing the graphs of the marginal mean scores of each stakeholder group, we also noticed major differences in the perception of existence of current market culture between students and senior management. Senior management viewed SUTD as currently lower in its market emphasis, whereas students thought it

was very much higher. There was also a distinct difference in the way senior management viewed hierarchy as compared to the other three stakeholder groups. They thought the organisation was more hierarchical than the rest. One reason for this stark difference could be the different roles senior management played as compared to the rest of the stakeholders. Senior management typically have to achieve organisational goals and one of their key objectives was to increase SUTD"s presence and mind share in Singapore and globally. All these requires a market mindset. As for their views on SUTD being too hierarchical, this could be a result of senior management having to interface with governmental bodies that can be seen as rigid and inflexible.

As to the perception of each stakeholder group of the desired culture, there is generally a very good inter-stakeholder alignment in the desired clan culture. Moreover, all stakeholder groups see Flexibility and Discretion, rather than Stability and Control as the desired culture for SUTD.

A last point to note is the interesting way the current and desired culture was perceived by different nationality groups. When comparing the results of the perception of current culture by regions of Asia, Europe and North America, we saw an alignment of the perception of an existing, current market culture at SUTD by both Asians and Europeans. At the same, the same culture was perceived as hierarchical by North Americans.

As for the desired culture, Europeans and Asians favored a clan culture while the North Americans favored a more adhocracy-oriented culture. Hofstede's theory (Hofstede 1983) on dimensions of national culture could explain some of these differences. In the four dimensions of national culture; namely; Individualism versus Collectivism; large and small power distances, strong or weak uncertainty avoidance and masculinity versus femininity, Hofstede found out that the values and behaviours of individuals are usually consistent with the countries in which they reside in. Countries in North America tend to have higher small power distances and high individualism, whilst certain European countries (excluding Finland, Norway, Germany, Switzerland, Ireland, Sweden and Denmark) and Asia tend to have a larger incidence of power distances and low individualism (Hofstede, 1983). This could be explained by the cultural differences in the ways they feel about and the current perceived organisational culture, i.e., North Americans viewing SUTD as more hierarchical than their counterparts in Asia and parts of Europe. North Americans also preferred a more adhocratic culture as compared to the Asians and Europeans who prefered more of a clan culture.

5.3.2 Analysis of the Effect of the OCAI–Spilter Tool on the Culture Survey Results

We also noticed an interesting pattern of alignment between the three stakeholder groups, namely; staff, faculty and students in the way they view the current culture as well as of the desired culture. As to whether the tool has been effective in bringing out an alignment of the values between the three groups is currently more deductive than conclusive. We do postulate that the structured way in which GDSS systems guide culture discussions could result in common understanding amongst stakeholders groups. A study done by Huang, Wei, Watson, and Tan (2003) discovered that GDSS with a goal setting structure could support virtual team-building better than a standard GDSS (without the goal setting structure) in terms of team cohesion, team commitment, and a collaborative climate. This better support for virtual team-building improved the output of teamwork in the form of better perceived decision quality.

5.3.3 Perceptions of Each Dimension of Culture

Next we review the degree to which all four stakeholder groups are aligned in their views of the current and desired culture in terms of the six dimensions of culture within SUTD. The six dimensions (Cameron and Quinn, 2011) were:

1. Dominant Characteristics: The overall characteristics of the organisation
2. Organisational Leader: Perception of the leadership style that dominates the organisation
3. Management of Employees: How employees are managed and how they view the working environment
4. Organisational Glue: The mechanisms that hold an organisation together
5. Strategic Emphasis: This defines the key strategic areas and emphasis and organisation places on its key goals and priorities
6. Criteria of Success: The factors that determines success for an organisation and are greatly valued

Dominant Characteristics: Faculty and senior management viewed the dominant characteristics of SUTD culture as hierarchical while staff and student viewed it as market driven. This difference could be as a result of faculty being driven by academic freedom and they view administrative processes within the institution as bureaucratic. This perception of bureauracy could be further enhanced by the fact that SUTD is wholly owned by the Ministry of Education, and there are strict rules governing research grants, finance and procurement. On the other hand, staff viewed the dominant characteristics as market driven as funding of the university is pegged to university enrolment, financial prudence and management. Students on the other hand, viewed the culture as market driven perhaps as a result of their constant exposure to the marketing efforts of the university to attract enrolment, and the strong emphasis of the curriculum to be industry focused.

Organisational Leadership and Management of Employees: Faculty and staff viewed the current management style of its leaders and the way they are managed as being a clan culture. This is very congruent with the desired culture, and shows that SUTD leaders have adopted the right strategic approach to managing staff and faculty. Students on the other hand, viewed organisational leadership as a market culture. This could be due to the fact that SUTD faculty have been emphasizing a market driven curriculum, and teaching students skills, knowledge and abilities that can be transferred to the real world. Lastly, senior management views the leadership as hierarchical. This could be due to the fact that SUTD is a public university and has to abide by many of the regulations and processes of the Ministry of Education.

Organisational Glue: Senior Management, faculty and students viewed the current organisational glue as hierarchical. This shows that while SUTD is striving to be innovative and market driven, most of its current processes could still be perceived as very bureaucratic. This could be a result of strict procedures and processes required in a government funded university. On the other hand, staff members viewed the current organisational glue as market driven. This could be due to the fact that performance of staff members are pegged to university revenue generation, brand positioning, efficiency as well as cost control.

Strategic Emphases: Faculty viewed the current strategic emphases quadrant of the cultural dimension to be market driven. Staff viewed it as hierarchical. This

contrast could be due to the different nature of faculty and staff functions. The core duties of staff functions are to ensure compliance so that processes and resources can be managed with transparency. Thus these employees viewed the current cultural dimension of success to be that of a hierarchical system. On the other hand, faculty viewed the current cultural dimension of strategic emphasis to be that of a market driven nature because of the strong need for faculty to publish, to be innovative and entrepreneurial, as well as to connect their work to industry. However, when we delve into the desired cultural state of this dimension, both staff, faculty and students cited a preference for a clan culture.

Criteria for Success: This was the only criteria that had differing views for most stakeholders. Senior Management viewed the current cultural dimension of for success as one of a hierarchical nature. Students and faculty viewed it as market-driven and staff viewed it as hierarchical. The senior management group viewed the organisation as using too much of a hierarchical approach in managing outcomes while faculty sees it as market driven. Faculty and students sees the current success to be that of market driven and this could be a result of the constant push for enrolment and performance. On the other hand staff members viewed the current cultural dimension of success as hierarchical because of the need to ensure that key stakehoders abide by processes and proceures of a public institution. As for the desired culture for criteria of success, all stakeholder groups desire a clan approach while senior management preferred an adhocratic approach. This .difference in perception could be explained by the fact that senior management is responsible for driving SUTD's innovative strategy and they see an adhocratic culture as the key to success in driving the university's mission and vision.

5.3.4 Results for Idea Generation Using Spilter

When the first pilot test of the OCAI-Spilter tool was used to generate ideas for culture change with the senior management, a total of 50 new ideas were generated and 10 projects initiated as a result of the ensuing discussion. The tool proved to be very effective in eliciting ideas and suggestions. We attributed this effectiveness primarily to the fact that the tool alllowed for anonymity of the people proposing the idea and their equal participation in the change process. Many of the barriers to culture change outlined in Chapter 2 of the literature search were overcomed by the OCAI-Spilter tool. We can also see from the design principles earlier in this chapter that the screens were designed to encourage participation.

During the pilot testing of the OCAI-Spilter tool for idea generation, the feedback from the three pilot test groups confirmed a high level of satisfaction with the tool. The high level of satisfactioin isa result of the ability of the tool to elicit a high level of participation from each member. The user surveyed has actually reported a high satisfaction rates of over 95 percent.

5.4 Discussion about the Effectiveness of the Methodology in Bringing about Culture Change

The ultimate purpose of this project was to use an action design research methodology to design and develop a computer tool that can help to facilitate and intervene in the process of culture change. In the beginning part of the project, when a manual method was introduced for culture change, the results were dismal, with minimum participation and alignment. Actually the results from this pilot project suggested that it would not be feasible to scale up the manual methodology to all the SUTD population, and if we did so, the outcomes may not be credible due to extensive process losses. For example, In addition, in a meeting with 13 members of the senior management team, a total of 3 hours was needed just to reach alignment among the memers of the relatively homogeneous senior administration group about the desired culture.

The introduction of the OCAI-Spilter artifact and the ADR methodology using the organization dominant BIE cycle, allowed us to use the tool for culture change and intervention. The BIE cycle incorporated the principle of reciprocal sharing where current problems encountered during the culture change process were used as design principles for the OCAI-Spilter tool. In the next stage of the BIE cycle, we use the principal of mutually influencing roles to form the ADR team, who then work jointly to develop the tool. A prototype of the tool is built and continuously refined to meet the expectation of its use for culture change.

Going back to the design principles of the tool, which were to elicit a high level of response rate in both the surveys and to develop a platform for discussion on culture change, we make the following analysis:

(1) Measure and identify the perceived current and desired cultural profiles of each group.

The OCAI-Spilter artifact was able to measure and identify the perceived and desired cultural profiles of each group effectively. It was also able to elicit an extremely high participation rate amongst staff, faculty and students as compared to the manual method. Key reasons for this higher rate of participation may be the ease of access to the system by the participants, its easy-to-use screens and the flow of the questionnaires in a sequential manner. The tool was able to secure a much higher participation rate at a faster speed compared to the manual method which took several weeks and with poor response.

(2) Represent these culture current and desired profiles explicitly, and presents the representations to all members in a group, for all to review and understand them.

The tool was also able to collect all of the results from the surveys in a relatively short period of time. The only set back was the system's inability to automatically calculate the scores. The scores had to be exported into an Excel file for collation of the results. We had earlier mentioned this deficiency in Chapter 3, section 3.2.2 Once the results were tabulated, it was relatively easy for the screens to display the results to participants. We used a sequential method for the screens to be displayed, starting from the results of the culture survey and explaining to them the culture gap. The next screen explains to them the desired culture state that stakeholders have voted. This sequential flow proved effective as participants were allowed to digest the information on each screen before going to the next screen.

(3) Provide a means for discussing these profiles to arrive at a consensus profiles.

Using a sequential flow we were also able to use the Spilter tool for deriving on a common understanding for culture change. The results of the survey indicated that the tool has been a key driving instrument to help participants arrive at the desired clan culture, which was a unanimous selection for all stakeholder groups (students, faculty, senior management and staff)

(4) Allow a large number of people participate in the discussion process (is scalable) and

(5) Ameliorates the possibility of process losses.

For aims 4 and 5, the results of the survey as well as the participation rates have confirmed that the tool is scalable and able to reach large numbers of people. The spilter survey indicated participants' comfort level and ability to contribute ideas which may be a direct result of the ability of the GDSS system to reduce process losses.

6) Provide a platform for discussion and agreement upon the change measures that are needed to move from the current to desired culture.

In version RS2, we built the process for discussion on change measures using the OCAI-Spilter artifact. Participants were able to follow a sequential flow for decision making and agreement on the change measaures needed to close the culture gap. Participants in the software testing group were first introduced to a start screen, followed by an introduction screen where results of the survey were shared with them. The next screen prompted them to input their ideas to close the culture gap, and participants were able to see each other's screens and critique the ideas. The top 10 ideas were then selected. Three pilot tests were being conducted using the software. The first pilot test with the senior management team produced 10 ideas for culture change. Several of the ideas have been adapted for change projects and they have proven to be fairly successful. The successes of these change projects are elaborated in more detail in chapter 6.

Knowledge outcomes from ADR

In this dissertation, we used ADR methodology, applying design principles of ADR to the development of a culture change tool; the OCAI-Spilter artifact. This methodology involved building a computer artifact together with an organisational intervention to improve the participation rates of key stakeholders in culture change as well as engage them in the change process. New design principles (outlined in Table 27) were articulated through the building of the initial screens and prototypes for developing the culture survey, and new knowledge was generated through the use of GDSS technology for initiating conversations amongst stakeholders to obtain cultural alignment and culture change. We also learned new principles about how users respond to culture surveys, how to improve the interface, and how process losses can be ameliorated through the use of GDSS technology. This greatly facilitated conversations and improved participation as well as avoided process losses typically encountered in "face to face" sessions.

Through an initial experiment conducted with 13 senior management staff, and through using a manual version of the OCAI, we deduced that the current method of culture alignment and change is ineffective as shown by the poor participation rates and slow process to obtain consensus. We have clearly demonstrated through this research that the ADR methodology has produced substantive results detailed in Chapter 4 and Chapter 5 of this dissertation.

5.5 Generalizability

While the OCAI-SPilter tool was only tested at SUTD, we can say that it has generalizability as explained through the Task Technology Fit Model (TTFM) and the Technology Acceptance Model (TAM). Goodhue defines task technology fit as the fit between task requirements, individual abilities and the functionality and interface of the technology employed. (Goodhue, 1995; pp.1828) In order for the technology to have a positive impact, it needs to be 1) utilised and 2) there must be a good fit with the task that the technology supports. (Goodhue & Thomson, 1995). TAM on the other hand state that a behaviour is determined by the intention to perform the behaviour and it specifies usefulness and ease of use as the two external variables or beliefs that determine attitude toward an IT. (Dishaw & Strong, 1998) In the In the OCAI-Spilter artifact, we have taken into account these two models by first testing the usability of the software in terms of its usefulness and ease of use. The verification of the tool in terms of task technology fit was done through user feedback and the continuous improvement to the tool through a few iterations before it was deployed. We are confident that the OCAI-Spilter tool and the methodology that was developed can be generalized to other industries or sectors to initiate common understanding and alignment of desired culture states.

Chapter 6. Conclusion

6.1 Summary and Impact of Tool-in-Use

This Ph.D. dissertation employed the use of action design research to build an IT artifact; namely the OCAI-Spilter, used to intervene and facilitate in culture change at the Singapore University of Technology and Design. As reiterated in chapter 1, Smith (2003) reported that only 10-32% of companies in transformation attain the desired cultural shift. K. A. Baker (2002) stated that cultural change "is not easy to achieve; it is a difficult, complicated, demanding effort that can take several years to accomplish." Due to these difficulties, it is thus important that members of the stakeholder groups have an opportunity for genuine participation in group discussions to understand each other's point of view (arrive at a common understanding) to hopefully be able to align their values and perceptions collectively to a common vision in order to achieve consensus towards a shared culture.

As a result of the difficulty in achieving culture change and common understanding encountered in most institutions, we designed, developed and deployed a discussion tool to support this participatory process: This discussion tool allowed the members of various stakeholder groups and the groups themselves to participate in and collectively influence this discussion. In the use of this tool, all stakeholder groups were able to provide their inputs, and groups and members of the group should feel that they are being heard. Such a consensus building exercise is essential to get everyone's commitment to the culture change.

The requirements for this tool, in Chapter 1 specified that the tool should (1) measure and identify the perceived current and desired cultural profiles of each group, (2) represent these current and desired culture profiles explicitly, and present the representations to all members in a group, for all to review and understand them, (3) provide a means for discussing these profiles to arrive at a consensus profiles (4) allow a large number of people to participate in the discussion process (be scalable) and (5) ameliorate the possibility of process losses. These requirements of the tool came from understanding of the culture change process and the problems encountered during the process, the deficiencies in available tools currently in the market, as well as obtaining feedback from users. Our research also described the development of this tool

using extant literature regarding culture, culture change, barriers to culture change, design research, action research and group decision dupport systems as well as concepts of action design research to derive the functional specifications for the artifact. The artifact was deployed through iterative cycles and improved with each cycle to derive the final version.

The results reported in Chapter 4 and the analysis in Chapter 5 indicated that the tool was indeed very effective in improving participation rates in the OCAI survey and also obtaining alignment between stakeholders at SUTD. The pilot testings showed that the OCAI-Spilter is a very user-friendly tool and participants found the software to be effective for group discussions on culture change as well as generating ideas to facilitate culture change. Although outside of the scope of this PhD dissertation, we have also begun to see a few ideas generated from the Spilter system come to fruition in SUTD. These ideas include:

1. Introduction of SUTD Awards to promote a clan and adhocratic culture. This series of awards were introduced in 2014 to promote co-operative and team research innovation, teaching innovation, and cross-functional collaboration. This recognition aim to promote an adhocractaic culture. The awards also reviewed team spirit displayed by groups, and singled out individuals who have gone out of the way to promote a clan culture.

2. Social Lubrication. – This initiative called for a slew of activities to be organised to promote a culture of teamwork and clan culture. Many of the activities that have been organised include:

    a. Bring your family to work day. This activity was organised in June 2015 and was very well received by staff and faculty.

    b. Sports activities between staff, students and faculty. A series of exercise classes were introduced in early 2015, with senior management taking a role in leading the programs.

    c. Happy Hour. – This activity is currently being planned.

    d. Townhall gatherings – This was introduced approximately one year ago.

e. Staff newsletter – A brand new employee newsletter was introduced last year, with a tagline called "RENSHI" which is a Mandarin character. It English, it means nurturing human relationships. It was very well received by the university community.

3. Generating University Revenue: A project team has been formed to look at ways to generate revenue for the university as part of entrepreneurship. Two separate divisions have been formed to look at business development as well as skills training

4. New ideas for Student Admissions: A task force has been assembled to look at innovative ways of attracting potential students to join SUTD.

5. Reducing paperwork through elimination of unnecessary processes. The senior management team has attended a lean six sigma workshop to understand on workflow improvements. A taskforce has been formed and led by the Senior Director of Human Resources and Organisational Development to review all workflow and unnecessary processes.

Initial Impact and results of these change programs – These programs to build a clan and adhocratic culture started in early 2014. There has been an active push to implement many of these initiatives and some have seen immediate results, while others would take some time to be fully realized. Overall, the culture change project, starting with the OCAI-Spilter to the idea generation sessions have kickstarted a move towards a clan and adhocratic culture. We would be discussing some of the successes and obstacles encountered in the implementation of change intitiatives in the following few pages.

1. SUTD Awards:

The senior management team endorsed a budget for the STUD awards to be implemented in 2014. The first slew of awards launched in June 2014 saw very encouraging results. A total of 50 nominations were received, and the award categories were as follows:

a. SUTD Champion – Awarded to two SUTD employees who have exemplified and live the core values of SUTD

b. SUTD Award for service excellence – Awarded to two SUTD employees who exemplified exceptional service and attitude in their work

c. Best Team Award – Given to a team who have exemplified teamwork and innovation in organising an event or a project that reaped successful results

d. Excellence in Research, Teaching and Service to the university. Six awards are given out in these categories to academics who have demonstrated excellence in these areas.

A total of 11 awards were given out in January 2015 and the event was a success. Staff and faculty were very encouraged and enthused after the awards were given out. The awards will see a return in 2015

1. Social Lubrication – A slew of employee activities to encourage bonding and teamwork were introduced in 2014 and 2015. These included family day, sporting activities, townhall gatherings and a staff newsletter. Amongst the activity that was significant was the family day which came out as an idea in the Spilter brainstorming session. The event was succesfully organied in June of 2015 and while it might be hard to measure the actual results of the event in promoting a clan culture, video clips of family members being interviewed gave testimony to their perception of SUTD as a family friendly organisation.

2. Generating university revenue- A task force headed by the Associate Provost for Graduate Studies and International Relations was formed to look at entrepreneurial ways to promote university revenue. This was an outcome of the Spilter brainstorming session to increase the adhocracy quadrant of the university. The task force set some long term goals and short term projects to find innovative ways to increase revenue. A new initiative called the "Skills Future" project was launched in mid of 2015. In this project, the university will be tapping on government grants to offer core training programs in key technical skills to the

public and its employees.This project will be a key revenue generator if managed well. The taskforce and project team are currently working on the implementation plan and we will see the results in the longer term.

3. New ideas for admission – The spilter session highlighted the need for innovative ideas to improve student enrolments. A task force was formed to review new and better ways to engage with potential students and their schools. This resulted in a 20% improvement in student enrolment numbers in May 2015.

4. Reducing paperwork through elimination of unnecessary processes. This idea came as a result of the Spilter session to reduce the hierarchical culture of SUTD. Lean six sigma experts trained the entire senior management team in March 2015 in the concept of lean processes. A total of six project teams have now been formed in key administrative areas to improve workflow. The result of these projects will need some time to take fruition.

While some of the projects that were implemented such as the SUTD awards, family day and admission numbers saw quite visible results, others like revenue generation and reduction of bureacractic processes will take some time to see visible results.

The success in these few projects came as a result of excellent support from the top management team and clear alignment of vision and mission by everyone involved, to move towards a clan and adhocratic culture. The key obstacles observed in reducing bureaucractic processes could be a possible result of operating in a public institution that has clear accountabilities for using public funds. A second conjecture will be the changed attitudes, values and beliefs of stakeholders who were comfortable with the status quo.

Finally, this research has produced four key outcomes.

- A computer artifact that can facilitate culture change
- Design principles and design knowledge about using OCAI and organisational culture change. This is explained in Chapter 5, Table 27.

- A computer tool that can be scaled up to reach large group of stake-holders.
- Ideas and initial results for change projects

6.2 Contributions to Practice and Academia

This research has contributed to practice as currently there are no tools in the market that can help speed up culture change. We have demonstrated in Chapter 4 and Chapter 5 that the tool has reduced the cycle time it took for participation, discussion and coming to a consensus on culture change. It also increased the participation rate of employees in the culture change project. All of these factors facilitate change management in a more efficient and effective manner. Most of the culture change programs currently being executed in organisations are long and tedious and take years to complete. The advent of the OCAI-Spilter artifact has opened up the possibilities for organisations to successfully manage their culture change initiative in a speedy and effective manner. This can prove to be an invaluable resource to help align employees to achieve change in a rapidly globalised world.

As for academia, the new design principles developed can be used as learning points to develop future tools for cultural change and organisational intervention. The ideas can also be used in research pertaining to human resource development and organisation development projects that involved large groups of people.

6.3 Limitations of the Research

First, this study was primarily conducted in an educational setting that was localised and with no overseas subsidiary. The university was set up from scratch and from day one, the culture has been defined. The team could define what it wanted and the type of culture that it needed. The people that they set out to recruit were aligned with the vision and mission of the university. This could be one of the reasons why the project has been successful.

If this project was carried out in a global organisation with a long history, we might not see such quick positive results and successful alignment obtained in this PhD dissertation. Thus, in my suggested projects in the next section, I recommend testing the artifact in other types of organisations.

Second, OCAI by itself has quite a narrow definition and was mainly developed for educational settings. Thus, culture change using this tool in a complex multi-organisation might not be so easily achieved. Firstly, we are not sure if the assumption that the use of the artifact and availability of the discussion tool can actually help move the current culture values towards the preferred culture. Although successful initiatives can be launched as in the case of SUTD, this will have to be measured over time to see if the culture has actually shifted to the desired culture. Secondly, even if the above change took place; the innovativeness of the organisations may not actually change within a short period of time. This would require an objective measure of innovativeness such as more patents, more publications etc. The research does not test for this.

Finally an assumption inherent in the averaging process was that each stakeholder group has equal influence over the desired culture and culture change. That may not be true; as top management may have more influence; or perhaps staff or faculty may have more influence as they may passively resist change. We need to test this assumption and weigh the influence of each stakeholder group.

6.4 Future Research

6.4.1 Further Improvements in Tool or Methodology

The following improvements are needed to make the artifact more effective. They are derived from user feedback and also from the team that developed the OCAI-Spilter artifact.

(1) Analytics

Analytics in Spilter that can be used to calculate OCAI scores and analyse cultural results. This is an important feature as currently spilter does not have a function to analyse the OCAI survey data. An in-built analytics platform would help us to be able to immediately analyse the culture survey results and produce relevant statistical information. Some examples of these analytics would include:

1. Ability to analyse participation rates
2. Ability to aggregate the means of the culture survey and each dimension and group of participants

3. Ability to calculate marginal mean scores of each stakeholder group
4. Ability to perform comparative studies of each stakeholder group
5. Ability to categorize data into dimensions of culture and perform comparative studies
6. Ability to calculate demographics

(2) Built-in Timer

Currently, the facilitator has to be the one constantly reminding participants to keep within a certain time limit for each suggestion that they are writing. Implementing a timer within the browser which is synchronized across all participants in a decision room would allow the decision room leader to set a time limit for each of the sections in the session. Participants in the decision room will know how much time they have to complete each particular section.

(3) Back Button

Ideally, the program would allow for a back button to be visible for each question within the decision room and for this button to be made more explicit. Currently, the back button seems to appear haphazardly. While this is a good feature, it might not be fully useful at present

(4) Chat functionality and integration with social media

It would be useful to incorporate an instant messaging capability within spilter, so that participants in a survey room are able to chat with the leader and amongst themselves without the use of a third party solution such as Skype. This is an important feature as it will allow Spilter to be used in cyber space instead of being confined to a Decision Room. This has great potential for companies that operate globally and cannot afford the time and cost to bring everyone into a Decision Room.

(5) Clustering of Ideas

Currently Spilter does not support automatic clustering of similar ideas. When too many ideas are presented together, it can be confusing and difficult to sort. This feature twould prevent the overload of ideas that one typically has in large sessions.

6.4.2 Future Research Projects Using Tool/Methodology

Avenues for future research are derived from limitations of the present study. Since the PhD has a time limitation, only certain features of the tool can be tested. In addition, culture change takes time, so it will be interesting for future research to obtain before and after measures of stated and actual culture.

As explained above, the project is currently limited to SUTD, and the organization was already built in the beginning with some pre-assumptions. It would be interesting to test the OCAI-Spilter on other organizations to test if its effectiveness is applicable across different situations and scenarios. Two ideas are suggested here:

1. The tool could be tested at another educational institution which has an established reputation or has a longer history. Such an institution would have deeper pockets of entrenched beliefs and values that are steeped in the culture. It would be interesting to deploy the artifact in such an organisation to understand the differences in its perception of current vs desired culture vis-à-vis a younger institution like SUTD. Another interesting observation would be to compare the current and desired dimensions of OCAI culture between SUTD and an older educational institution. Does the tool really work or is it because of the nature of SUTD that leads to success of the tool. Lastly, we would also verify if the tool can elicit a high participation rate as obtained at SUTD.

2. Another great avenue for future research will be to implement this tool in a large multinational organisation. This scenario allows us to test the scalability of the tool as well as assess the use of Spilter as a platform to discuss change management initiatives in a larger and globalised organisation.

As explained in an earlier section, one of the key assumptions of this study is that all stakeholder groups have an equal influence on the culture as we are using an averaging method. That may not be true as different stakeholder groups might have differing influence based on the role they are playing in the organization. In future studies, we could test this assumption by asking who determines the culture and placing more weight on responses from this group of people. However, we will also need to be cautious about this at it might block culture change in large hierarchical organisatons.

Lastly, it is unknown whether the use of the artifact and availability of the discussion tool can actually help move the current culture values towards the preferred culture. If the change does take place, it may not actually change the innovativeness of the organizations. A future study could measure the effectiveness of the tool for culture change by looking at an objective measure of innovativeness.

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APPENDICES

Appendix A
Organizational Culture Assessment Instrument

The purpose of the OCAI is to assess six key dimensions of organizational culture. In completing the instrument, you will be providing a picture of how your organization operates and the values that characterize it. No right or wrong answers exist for these questions, just as there is no right or wrong culture. Every organization will most likely produce a different set of responses. Therefore, be as accurate as you can in responding to the questions so that your resulting cultural diagnosis will be as precise as possible.

Instructions for completing the Organizational Culture Assessment Instrument (OCAI).

You are asked to rate your organization in the questions. To determine which organization to rate, you will want to consider the organization that is managed by your boss, the strategic business unit to which you belong, or the organizational unit in which you are a member that has clearly identifiable boundaries. Because the instrument is most helpful for determining ways to change the culture, you'll want to focus on the cultural unit that is the target for change. Therefore, as you answer the questions, keep in mind the organization that can be affected by the change strategy you develop.

The OCAI consists of six questions. Each question has four alternatives. Divide 100 points among these four alternatives depending on the extent to which each alternative is similar to your own organization. Give a higher number of points to the alternative that is most similar to your organization. For example, in question one, if you think alternative A is very similar to your organization, alternative B and C are somewhat similar, and alternative D is hardly similar at all, you might give 55 points to A, 20 points to B and C, and five points to D. Just be sure your total equals 100 points for each question.

Note, that the first pass through the six questions is labeled "Now". This refers to the culture, as it exists today. After you complete the "Now", you will find the questions repeated under a heading of "Preferred". Your answers to these questions should be based on how you would like the organization to look five years from now.

1. Dominant Characteristics		**Now**	**Preferred**
A	The organization is a very personal place. It is like an extended family. People seem to share a lot of themselves.		
B	The organization is a very dynamic entrepreneurial place. People are willing to stick their necks out and take risks.		
C	The organization is very results oriented. A major concern is with getting the job done. People are very competitive and achievement oriented.		
D	The organization is a very controlled and structured place. Formal procedures generally govern what people do.		
	Total		
2. Organizational Leadership		**Now**	**Preferred**
A	The leadership in the organization is generally considered to exemplify mentoring, facilitating, or nurturing.		
B	The leadership in the organization is generally considered to exemplify entrepreneurship, innovating, or risk taking.		
C	The leadership in the organization is generally considered to exemplify a no-nonsense, aggressive, results-oriented focus.		
D	The leadership in the organization is generally considered to exemplify coordinating, organizing, or smooth-running efficiency.		
	Total		
3. Management of Employees		**Now**	**Preferred**
A	The management style in the organization is characterized by teamwork, consensus, and participation.		
B	The management style in the organization is characterized by individual risk-taking, innovation, freedom, and uniqueness.		
C	The management style in the organization is characterized by hard-driving competitiveness, high demands, and achievement.		
D	The management style in the organization is characterized by security of employment, conformity, predictability, and stability in relationships.		
	Total		

4. Organization Glue		Now	Preferred
A	The glue that holds the organization together is loyalty and mutual trust. Commitment to this organization runs high.		
B	The glue that holds the organization together is commitment to innovation and development. There is an emphasis on being on the cutting edge.		
C	The glue that holds the organization together is the emphasis on achievement and goal accomplishment. Aggressiveness and winning are common themes.		
D	The glue that holds the organization together is formal rules and policies. Maintaining a smooth-running organization is important.		
	Total		
5. Strategic Emphasis		**Now**	**Preferred**
A	The organization emphasizes human development. High trust, openness, and participation persist.		
B	The organization emphasizes acquiring new resources and creating new challenges. Trying new things and prospecting for opportunities are valued.		
C	The organization emphasizes competitive actions andachievement. Hitting stretch targets and winning in the marketplace are dominant.		
D	The organization emphasizes permanence and stability. Efficiency, control and smooth operations are important.		
	Total		
6. Criteria of Success		**Now**	**Preferred**
A	The organization defines success on the basis of the development of human resources, teamwork, employee commitment, and concern for people.		
B	The organization defines success on the basis of having the most unique or newest products. It is a product leader and innovator.		
C	The organization defines success on the basis of winning in the marketplace and outpacing the competition. Competitive market leadership is key.		
D	The organization defines success on the basis of efficiency. Dependable delivery, smooth scheduling and low-cost production are critical.		
	Total		

Appendix B

A Worksheet for Scoring the OCAI

Scoring the OCAI is very easy. It requires simple arithmetic calculations. The first step is to add together all A responses in the Now column and divide by six. That is, compute an average score for the A alternatives in the Now column. You may use the worksheet on the next page to arrive at these averages. Do this for all of the questions, A, B, C, and D. Once you have done this, transfer your answers to this page in the boxes provided below.

NOW Scores

	1A
	2A
	3A
	4A
	5A
	6A
	Sum (total of A responses)
	Average (sum divided by 6)

	1B
	2B
	3B
	4B
	5B
	6B
	Sum (total of B responses)
	Average (sum divided by 6)

	1C
	2C
	3C
	4C
	5C
	6C
	Sum (total of C responses)
	Average (sum divided by 6)

	1D
	2D
	3D
	4D
	5D
	6D
	Sum (total of D responses)
	Average (sum divided by 6)

PREFERRED Scores

	1A
	2A
	3A
	4A
	5A
	6A
	Sum (total of A responses)
	Average (sum divided by 6)

	1B
	2B
	3B
	4B
	5B
	6B
	Sum (total of B responses)
	Average (sum divided by 6)

	1C
	2C
	3C
	4C
	5C
	6C
	Sum (total of C responses)
	Average (sum divided by 6)

	1D
	2D
	3D
	4D
	5D
	6D
	Sum (total of D responses)
	Average (sum divided by 6)

NOW	
A (Clan)	
B (Adhocracy)	
C (Market)	
D (Hierarchy)	
Total	

PREFERRED	
A (Clan)	
B (Adhocracy)	
C (Market)	
D (Hierarchy)	
Total	

An example of how culture ratings might appear in a specific situation:

NOW	
A	55
B	20
C	20
D	5
Total	100

PREFERRED	
A	35
B	30
C	25
D	10
Total	100

SUMMARY ASSESSMENT DATA

OW

Scores									
A									
B									
C									
D									
Total	100								

Scores									
A									
B									
C									
D									
Total	100								

REFERRED CULTURE SCORES

Scores									
A									
B									
C									
D									
Total	100								

Scores									
A									
B									
C									
D									
Total	100								



MS JACLYN LEE (BIO)

Miss Jaclyn Lee is currently the **Senior Director, Human Resources and Organisation Development**, for The Singapore University of Technology and Design (SUTD). She handles the full spectrum of HR for the university and was one of the pioneer team members charged with starting up the new university from scratch. She has worked with the senior management team in developing the mission, vision and values of the new university when it was incepted. As the Senior Director for HR, she is also responsible for developing the Total Compensation Structure, Performance Management System, spearheading new HR policies and processes, recruiting key leaders, senior academics and faculty, as well as managing the Human Capital Development Strategy and Talent Framework. For the past six years, she has worked closely with the President and senior leaders in managing the culture development of the university.

Jaclyn was previously **Senior Vice President, Group Human Resources**, responsible for managing the full spectrum of human resources for Certis CISCO Security Pte Ltd, a security services company comprising of about 8,000 employees in Singapore and 25,000 in the region. Her role there included strategic HR planning for Singapore and the region, compensation and benefits, performance management and scorecard measurement, employee engagement, human capital development, employer branding, resourcing and other special projects. One of her key achievements in Certis was successfully managing a very difficult wage re-structuring project that involved thousands of workers.

She has over 20 years of HR experience, and has also managed Strategic Planning, organizational development, and regional HR in one of her precious roles as **Regional HR Director for NEC Solutions Asia Pacific**. In that capacity as Regional HR Director, she developed the talent and career development framework for Engineers and high potentials in the South Asia Region. She was also the Balance Scorecard leader for the region.

Jaclyn participates actively in conferences as a speaker and has spoken in more than 40 local and international conferences. She is the recipient of the Leading HR Leader Award at the annual SHRI Awards for 2008. She is also the Honorary Secretary of the Singapore Human Resources Institute and a Volunteer HR Director in SPRING Singapore's initiative to drive good HR practices in SMEs. In addition, she sits in several other volunteer committees for driving best HR practices in Singapore.

She is currently pursuing and due to receive her Phd in Management from the University of Twente(Netherlands). She also possesses a Masters in Management from Singapore Management University(Singapore), Masters in Human Resources Management from the State University of New Jersey, Rutgers (USA), and a Bachelor of Science Degree in Psychology from Brandon University (Canada)



Organisational culture change is a long and complex process that typically takes years to complete and has a very low success rate. This Action Design Research Study in an educational setting, addresses the problem by the proposed use of an Action Design Research Methodology to build and deploy an IT artifact named Organisational Culture Assessment Instrument-Spilter (OCAI-Spilter) to speed up cultural change while reducing failure rate. OCAI-Spilter should be able to fast-track culture change by addressing the problem of scalability and process losses encountered in most change projects involving large numbers of people. We deploy an iterative prototyping process using Component Base Software Development to continuously refine the tool in use. We also reviewed the design principles in Action Research Design to improve the usability of the tool. New design principles and learning were derived from this process. Finally, we showed the effectiveness of the artifact by measuring the results of the tool in use through culture surveys and alignment, as well as idea generation that was administered through the tool. Change initiatives and change projects that arise as a result of the OCAI- Spilter arifact were introduced in the organisation to start and effect the journey of culture change.