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The application of organizational cybernetics and ICT to collective discussion of complex issues

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Abstract

Purpose – The purpose of this paper is to expose how organizational cybernetics (OC)-related concepts could be used in combination with information and communication technologies (ICT) to facilitate group discussions on complex issues, and to show its impact in a real case.
Design/methodology/approach – A software inspired by OC and team syntegrity concepts has been developed with the aim of helping groups of people to deliberate around complex issues through the internet. Two groups of persons with similar backgrounds were chosen to pursue a deliberation process around the same issue. One had the support of ICT while the other did not. The authors used the same questionnaires with both groups, aimed at getting qualitative and quantitative information about the results obtained in each case.
Findings – The results obtained show that the group working with ICT support did produce a better output (quality and quantity) than the group not supported with ICT as well as a higher degree of satisfaction in practically all indicators than the second group.
Research limitations/implications – The authors are dealing with only one experiment and therefore cannot make a generalization. It would be desirable to repeat the experiment with various groups and in different contexts.
Originality/value – An internet-based software inspired by OC concepts was created to facilitate the first phases (generation and aggregation of ideas) of a deliberation process and the authors measured, in an experiment with two groups of people with similar backgrounds, the impact of using it on the quality and quantity of information produced through the process.

Keywords ICT, Organizational cybernetics, Debates organizer, Deliberation, Variety
Paper type Case study

1. Introduction

Over the last few decades the world has changed dramatically. Many interrelated factors are involved in that change (socio-economic crisis, globalization, demographics, etc.). The consequence is that we live in a very complex social system. To qualify the level of complexity of a system (or a situation), Ashby (1956) proposed the concept of variety (the number of possible states of a system) and postulated in his Law of Requisite Variety that "only variety can destroy variety". At the start of the 1970s, Conant and Ashby (1970) had argued, in the famous theorem that bears their name, that "a good regulator of a system must be a model of the system" and that the variety of the regulator must be at least equal to the variety of the system that it pretends to regulate. If the managers of organizations are "governors" of those organizations, then they need models adequate to the task of governance, that is, models with requisite variety. The systems-thinking field and in particular organizational cybernetics (OC) provide certain

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models, such as the Viable System Model, and tools like Team Syntegrity® (TS)[1], that can help decision makers to tackle the complex problems facing them.

Pérez Ríos (2008, 2012) has summarized the critical value of facilitating decision making and communication processes of many kinds. "The new frontier of humanity is, at the start of the twenty-first century, not so much scientific or technological development as an understanding of the complex social systems in which we are immersed. Such understanding is fundamental for our being able to deal effectively with the problems of social tension facing mankind. We must explore new ways to organize and engage in relations that will enhance the processes of communication and decision making […], certain fundamental challenges which still have not been resolved in a satisfactory way: for example, the development of group-decision processes which are at the same time democratic, creative and efficient, or the replacement of hierarchical organizational structures by other more democratic ones in which all points of view can be effectively taken into consideration" (Pérez Ríos, 2012, pp. 201-202).

Also, at the same time that the world grew in dynamic complexity, a whole new set of technological tools related to information and communication technologies (ICT) became available, and with them a growing interest in how these tools can support higher levels of participation in discussions and decision making. These technologies include both "groupware", which includes software for planning and programming in groups, computer-assisted cooperative undertakings, as well as the whole arsenal of tools that have appeared within the so-called Web 2.0 (Almuiña *et al.*, 2008, pp. 253-265). "The conjunction of these two cornerstones – namely, on the one hand, the new conceptual framework for the design of organizational structures and decision processes, and, on the other, the availability of a technological support allowing remote collective inter-communication – opens up new horizons for relations between individuals and institutions" (Pérez Ríos, 2012, p. 202).

In this paper we focus our attention on the application of concepts taken from the systems-thinking field, and in particular OC (Beer, 1979, 1981, 1985; Schwaninger, 2006; Espejo and Reyes, 2011; Pérez Ríos, 2012), to help decision makers to study complex issues with the help of the ICT. We present a software tool developed within the Systems Thinking and Organizational Cybernetics Research Group (STOCRG-INSISOC) at the University of Valladolid (UVA) that is based on OC concepts and uses ICTs to help groups study complex issues in a collaborative way through the internet. The paper is structured as follows. First, we refer to how OC has been applied to help collective decision making, showing in two pioneering international cases how ICTs have been used in combination with OC concepts. The purpose in one case was to create a collective scientific book by a group of scientists working at a distance, and in the other case to organize a major academic international event. Second, we show an example of specific software developed in the STOCRG over the last 15 years with the aim of helping groups of any size to organize debates on complex issues through the internet. In the third and last part of this paper, we present the results obtained with the application of this tool in a real case, in which two groups of people explored the same issue, one group having the support of the above-mentioned internet-based software tool and the other not.

2. OC and group decision-making

Among the diverse conceptual tools that OC can provide to help collective decision making, we will focus on TS®, of proven value in facilitating decision processes (Espinosa and Harnden, 2007). "Team Syntegrity® consists basically of a methodology developed by Stafford Beer (1994) with the aim of offering a creative, synergetic and participative

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platform for studying complex problems […] which we might regard as a structured means of creating and communicating a group awareness" (Pérez Ríos, 2012, p. 203).

The goals of the TS application can be summarized as follows: "(1) To generate a high level of participation among the individuals concerned (2) To provide a structure and a system of communication that guarantee the non-hierarchical nature of the process (3) To benefit from the variety and wealth of knowledge supplied by each individual within the group, putting into practice the synergies derived from the interaction among all its members (4) To create a collective awareness, if possible shared among all the members of the group, regarding the central issue being considered and analysed" (Pérez Ríos, 2012, p. 205).

Main phases of TS

To describe the various phases into which TS structures the process of application we use the description made by Pérez Ríos (2012, pp. 205-212). First of all a TS application process starts when a question is asked concerning the issue to be studied or discussed. Let us see its main stages. The following description of the process is based on the protocols designed by Stafford Beer and laid out in his book entitled *Beyond Dispute: The Invention of Team Syntegrity* (Beer, 1994). Despite the fact that there are many types of application depending on the number of participants, we will restrict the explanation to the phases of the basic method. Here the group involved in the process comprises 30 people. This group meets for a time which may vary according to the circumstances but which generally ranges from three and a half to five days, during which it will endeavour to develop responses to the question posed.

Although initially the number of responses tends to be very large, application of the protocols dealt with below will finally reduce them to 12; thus, at the end of the process, we will have 12 considerably developed sides to the problem. Each will represent a matter to be discussed and developed at a later stage. The reason for the number of group members and responses to the question being 30 and 12, respectively, lies in the geometric reference employed in the basic form of TS, which is an icosahedron, with its 30 edges and 12 vertexes. Each of the edges represents a group member and each vertex one of the 12 issues into which the response to the initial question has been broken down. Nonetheless, we should point out that the features of the process described below are not restricted to a specific geometric form.

The stages characterizing the application of TS can be summarized as follows.

First stage: statements of importance. In this stage each participant prepares statements they consider relevant (statements of importance (SI)) to the central question. These statements are written down and pinned, for example, to vertical panels so that all members of the group can see them. Once issued, SI are discussed and grouped according to degrees of affinity. The aim of this is to identify issues which are dealt with by different SI so that they can be included within the same thematic group.

Second stage: grouping. After issuing and grouping SI, we go on to generate Aggregated Statements of Importance (ASI). Once the SI have been examined, any member of the group can make one or several proposals as regards main issues to be discussed. For each proposal the group member has to indicate the SI that are related to the issue identified. They do this by writing on a clearly visible panel (poster) a brief text describing their proposal, and will then try to get people interested in the suggestion. The fact that an individual proposes an ASI indicates simply that she/he regards that question as worthy of debate.

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Once the ASI have been put forward by all the members of the group wishing to do so, they undergo a farther process of aggregation. The idea is to group together those which deal with similar questions or which, despite not being identical, may be integrated under the same issue for discussion. This aggregation process is aimed at avoiding the loss of "variety", and ensuring that the 12 issues finally selected incorporate all the possible information contained in the SI and the ASI. These final 12 issues from now on referred to as Consolidated Statements of Importance, will be the 12 topics to be debated.

Third stage: assigning topics to people. When the 12 topics for discussion have been identified, it is necessary to determine the people who, of the 30 in the group, are going to take part in the debate on each of them. We need therefore to find out their preferences. This we do by asking every group member to indicate which are the topics that interest them most. Once the preferences of the members of the group have been ascertained, this information is processed with the aid of a computerized assignation algorithm which tries to maximize the degree of satisfaction in the group. The maximum degree would be an assignation in which each individual was included in teams corresponding to their two favourite topics.

Distribution of individuals and assigning of topics are performed with the spatial structure of the icosahedron as a reference. Each person is represented by an edge and each vertex represents one of the 12 issues. The five edges that converge at each vertex are the members of the team responsible for discussing the topic. As each edge (person) is connected with two vertexes, each person takes part in debating the two topics linked by the edge he/she represents. The optimal situation would be that in which these two topics corresponded with the first two on the list of each individual's preferences. The chance of conflicts and incompatibilities between diverse interests makes it necessary to employ a computerized assignation algorithm to search for the best possible solution.

Fourth stage: generating contents. According to this structural disposition of the discussion process, each topic (vertex) is consequently discussed by five individuals who make up a team (the five edges which come together at each vertex). The function of each team is to explore and develop their topic, following a process whose aim is to produce a declaration which provides a response. Nevertheless, the teams are not made up solely of the five "members" indicated, but also of another five individuals whose role is one of "critics". Their task is to question both the content of the discussion carried out by the five "members" of the team as well as the process employed.

The meetings corresponding to the 12 teams/topics are held in sequence with two running simultaneously. In other words, during one day two parallel groups of meetings take place. Therefore, whilst the meetings are being held, there are ten individuals occupied as "members" of the two teams and another ten acting as "critics" within the same teams. When meetings, then, are taking place, 20 of the 30 individuals that constitute the group are occupied as members or critics, with the other ten doing nothing. The latter may devote this free time to either participating as observers at one of the meetings being held at that moment, or to any other activity they wish (exchanging information with other people who are also free or simply resting).

The process involves a certain amount of organizational complexity, which is resolved with the aid of the available computer applications. These deal with the assignation of the topics, members and critics, as well as the corresponding time sequencing.

It is appropriate to bear in mind that the composition of the teams is different in each of the 12. Each person fulfils the role of "member" in two teams (topics) and that of

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"critic" in two more, and perhaps acts as an observer in another four. As a result, each individual is exposed to the information generated in eight of the 12 topics. The only topics which are inaccessible to them are those whose meetings are held at the same time as the ones in which they are participating. All the same, this difficulty can be partially overcome with the organization of specific encounters between people in positions exactly opposite one another (polar opposites) (Truss, 1994, pp. 296-297). Thus, each group member could have information on all 12 issues discussed. This sequence of six simultaneous meetings is repeated over three days.

This programming of meetings and variable team composition generate a "reverberation" effect, causing ideas to be transmitted via the "edges" (individuals) of the structure and to come together at the "vertexes" (teams/topics), where they are subsequently digested and transformed, and so on and so forth. In this process of diffusing and transforming information a key role is played by the teams' "members", "critics" and "observers". It should be remembered that the composition of these is different for each of the 12 topics. Through this sequence of formal and informal meetings, both individuals and the group take part in a learning process which, over the three days this lasts, brings about an enhancement of the level of discussion and degree of maturity regarding the conclusions drawn. Furthermore, programming the meetings means that each topic is directly influenced by the information and results generated as a consequence of the other topics discussed.

At the close of each session, every team has to produce a sufficiently detailed declaration with the conclusions reached in all three sessions held over the first, second and third days. At the end of each of the first two days, the declarations of the 12 teams are publicly displayed for observation by the group, in order that any of the members may make whatever comments they deem appropriate. The use of a system to evaluate the quality of each group's work may act as an incentive. The meeting ends with a plenary session, during which each team puts forward the conclusions that have been drawn over the three iterations. These must be sufficiently developed for giving substance to each of the 12 topics into which the response to the question which initiated the whole process was divided.

The configuration described does correspond to a group of around 30 persons. But of course other group's sizes can be handled with TS. For example, if we have a group of around 12 persons we can use the octahedron form. In it we have six vertex (topics) and 12 struts (participants). Each topic is studied by a team made up of four persons (members) and two persons (critics). In this configuration there are not observers because the 12 persons are involved in discussing two topics (six on each). This is the configuration that was used in the case experiment described in Section 5.

In the next section we will see some examples of how TS was used to help two different groups of people to work collaboratively through the internet.

3. ICT and group decision-making: two examples

The fast development and diffusion of ICTs opened new ways to apply elements of the OC to help people to debate complex issues without needing to be in the same place. Two pioneering examples of this are the Stafford Beer Festschrift Project (SBFP) and the Horizonte 2000 Project.

The SBFP is the first application in the world of TS, using ICTs. The purpose of the project was to set up a collective study in which over 30 cyberneticians (among them JPR, one of the authors of this paper) from four continents and 16 countries could create a

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scientific work, revealing the usefulness of S. Beer's different theories for all kinds of organizations and for society in general. The undertaking was carried out between October 1995 and July 1996. Almost all of the work, consisting of both identifying the chapters it would include (12) and drawing up the content (more than 600 pages), was done remotely via the internet. This scientific work has been published under the title: *To be and not to be that is the system: A tribute to Stafford Beer*, CD ROM (Espejo *et al.*, 1997).

The second example is the Horizonte 2000 Project. The aim of this project was to promote cooperation among the universities from Iberoamérica and those of Spanish influence in the USA. The project was presented in the event named "I Encuentro de Rectores de Universidades Hispano-Americano-Filipinas" which, organized by the UVA, took place in Valladolid (Spain) on 23-27 March 1998. Its purpose was "To identify and to start new ways of relationships among the various Spanish speaking universities. It intends, from 1998 on, to open a new historical period of relationships based upon equality, democracy and mutual trust. To make it possible and to foster this process the new information and communication technologies will be used" (Almuiña *et al.*, 2000, pp. 14-15). The communication system created to make this possible was based on OC principles, using a software tool created specifically for this event (Iberforo-98 Project). We will comment on this tool in some detail in the next section.

4. Group decision-making software tools. Debates organizer

Based on OC principles and on some elements of the first phases of the TS approach, in 1997 we initiated within the ST and OC Research Group of the UVA the development of software tools to support several phases of the process of knowledge capture and debate organization.

One group of tools (based on TS) includes: software to optimize (maximize participant satisfaction) the assignments (persons to topics) in the physically organized sessions; and software to facilitate through the internet the 3D visualization of the various TS configurations (view of topics and participants, as vertex and struts respectively, in figures corresponding to various group sizes/configurations as represented by the icosahedron-30, octahedron-12, etc.). Another group of tools was aimed at helping decision makers to study complex issues through the internet. Here we will refer to a software application (debates organizer) developed to facilitate the organization of debates about complex issues by any number of persons through the internet (www.debatesorganizer.org).

The advantage of using this internet modality of debates vs the physical meetings (i.e. the meetings organized with TS, as mentioned above) is that the persons who compose the group can be located anywhere in space and can intervene at the time that best fits their needs or availability. Another advantage is that a person is not limited to belonging only to two specific teams (topics), as happens in the physical applications of the TS (the two vertices connected by a strut). A person can participate "virtually" in as many teams/topics as she/he likes. Of course there are practical limitations about the number (time availability, etc.).

The first version of this software was used in the above-mentioned Project Horizonte 2000 (Pérez Ríos, 1998, 2000) to organize the "I Encuentro de Rectores de Universidades Hispano-Americano-Filipinas" mentioned in Section 3 (see Almuiña *et al.*, 2000). This project, financed in part by the BSCH (Banco de Santander), was the precursor of the *Universia* project created in 2000 by the BSCH. The ICT-based software tools used in this project constituted the Iberforo-98 project. One component was the debate software (www.debatesorganizer.org). Let us see how the actual version of this software works,

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using the data generated in the case that allowed us to evaluate the impact of ICT on a deliberation process (described in the next section), using two groups of students. One had the support of the debate organizer software, while the other group had no ICT support.

The organization of a debate starts with the identification of the people who are going to intervene in the process (who can be located anywhere because they interact through the internet), and the configuration of the debate. In Figure 1 (screenshots from the software debates organizer) we can see some of the menu options with which the administrator can configure the application.

The first step in the debate is to launch the question that expresses the issue to be clarified/answered. In this case, the group was presented with a manifesto; the kick-off issue proposed to the students of information science engineering was: "How can the ICTs help to improve public and private organizations?"

Members of the group were allotted a period of time in which to generate their responses to that issue. Figure 2[2] shows one of the screens listing ideas produced by the participants. If we click on any idea we can see a more detailed description of it. The software also allows one to comment on any idea.

Once the period allowed for this stage (generation of statements), which can be determined by the organizer, is over, we move on to the "Aggregation of Ideas". Any participant can create an aggregated idea (see Figure 3). The software allows one to select pertinent components simply by clicking on any number of the ideas introduced in previous phase. Comments on the aggregated ideas are also possible. The software allows one to navigate among all elements (ideas, comments, aggregated ideas, etc.) simply by clicking on them. This phase concludes with the selection of the final number of topics established when configuring the debate.

In addition to the functionality provided by the software to facilitate the deliberation process described, it also includes additional components to help the organizer monitor the degree of participation of all team members. Notably, all information generated through the deliberation process is accessible to all participants at any time. The software acts as a repository of all the information produced in all phases of the process.

In the next section we describe the results of the experiment made with the purpose of evaluating the usefulness of the TS-based deliberation process and of the internet-based software tool just described.

5. Collective discussion of an issue with and without ICT support

The research on collective intelligence is starting to provide some clues about its existence, determinants, etc. (Salminen, 2012) and also about how can organizations approach it's harnessing. The use of ICTs is key in that endeavour. In relation to the first issue Woolley *et al.* (2010) provide some evidence for the existence of what they call the "c" factor (collective intelligence in groups). They relate it to the composition of the groups (e.g. average member intelligence) and on factors that emerge from the way group members interact (Woolley *et al.*, 2010, p. 688).

Researchers as Bonabeu (2009) talk about the emerging era of "Decisions 2.0" and a new paradigm shift in the way that companies make decisions originated by the increased use of "crowdsourcing", "the wisdom of crowds" concepts, social networks, collaborative software and other web-based tools (McAfee, 2006). Bonabeu indicates that collective intelligence tend to be most effective in correcting individual biases in the overall task of idea generation in contrast to ideas evaluation. He considers that feedback loops between generation and evaluation of ideas tend to be week or

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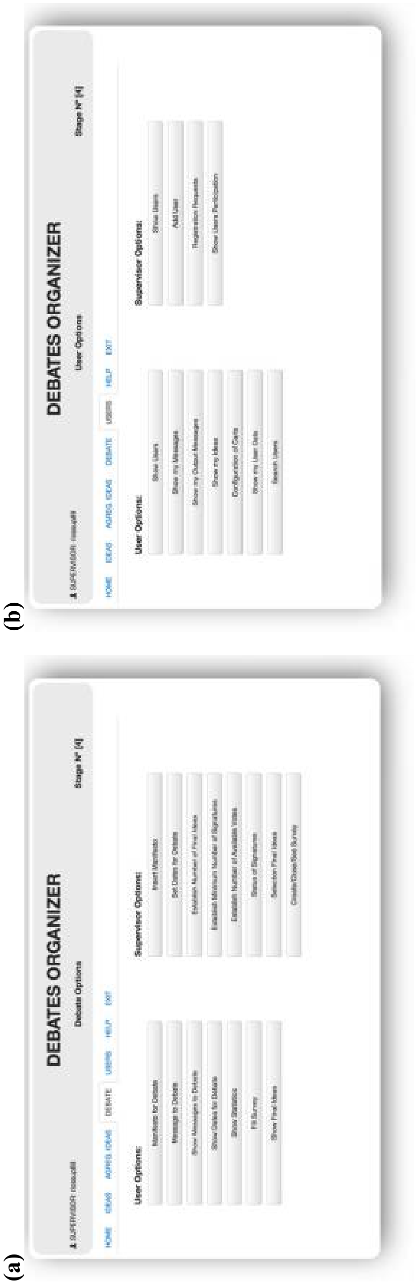

Figure 1.
Debates organizer main screens (administrator and users options)

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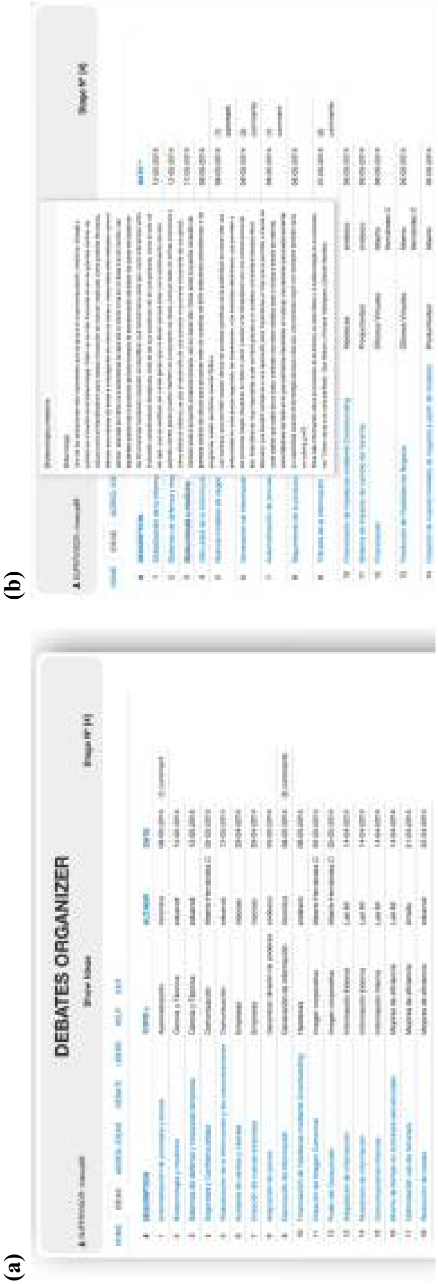

Figure 2.
Debates organizer (list of statements/ideas)

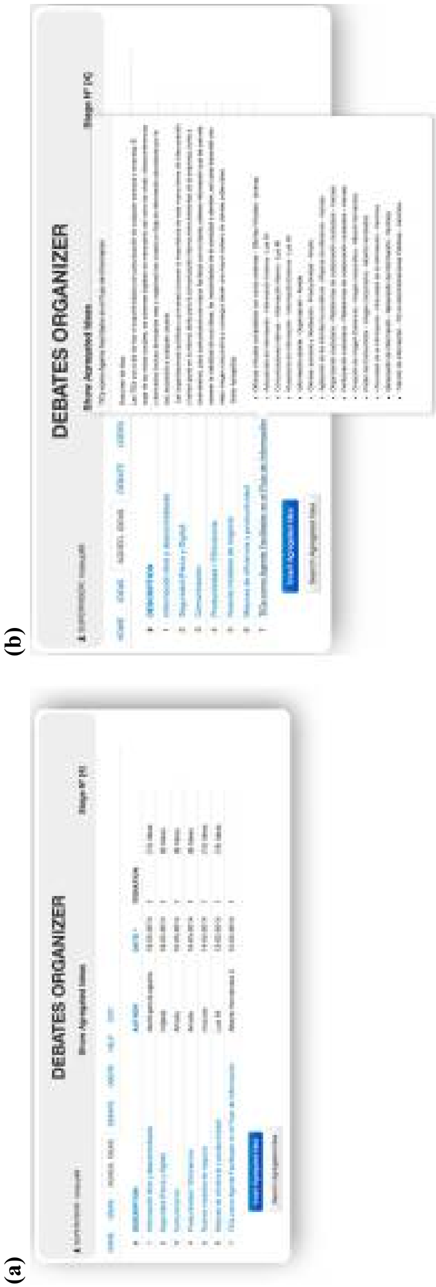

Figure 3.
Debates organizer
(list of aggregated
statements)

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non-existent, so he suggest that ideas be generated and evaluated, and the output of that assessment to be used in the creation of the next generation of ideas. This iterative process taps more fully into the power of a collective.

Other researchers studied the differences in social influence between face-to-face and computer-mediated communication (CMC), as Sassenber and Rabung (2005) who explored the impact of trait and state private self-awareness on interpersonal influence during face-to-face and CMC. Paulos and Philips (2008) focused on finding out the behaviour difference produced in using CMC tools in asynchronous (more participatory moves to establish presence) or synchronous (more interactive moves) environments.

Michinov and Primois (2005) studied the impact of social comparisons process on productivity and creativity in a web-based context of asynchronous electronic brainstorming, finding out that there is a positive impact only when participants have access to a shared table facilitating the comparison among group members.

Min's studies in the context of civic engagement also confirm that online deliberation is not necessarily inferior to face-to-face-deliberation. In fact and due to its many advantages it is proposed as a good alternative to the more costly face-to-face deliberation. Among other benefits it is much more economical, and can hold a larger number of participants regardless of geographical boundaries (Min, 2007). Michinov and Michinov (2007) explored the convenience of inserting face-to-face contact at the midpoint of an online collaboration.

Part of our work in the SCOCRG-INSISOC research group is oriented to developing software tools that using current ICTs and based on OC principles may contribute to improving decisions in organizations. As we will comment later the variety of designs that could be selected is huge. There are many factors that could be taken into consideration to configure these tools. For example, a major decision is to choose between using online tools (synchronous and/or asynchronous) only or the combination of online tools with face-to-face arrangements.

In what refers to our experiment we first wish to clarify its two main aims. Our first objective was to evaluate the impact (in various dimensions) of using an adapted (simplified) version of TS in two groups of people that were asked to explore an identical issue (see opening question in Section 4). This impact was evaluated by comparing the difference in the results obtained by each group after going through this TS process. To do that we used a questionnaire which all members of both groups answered before and after the deliberation process. The comparison of these results gives an indication of the usefulness of the TS-based process used.

The second aim of the study was to evaluate the impact produced by using ICT help in some of the initial phases of the TS protocols. The comparison made in this case is between the final results obtained in Group II (with ICT help) vs Group I (with no ICT help). The set up for Group II (with ICT help) was a mix of asynchronous/synchronous deliberation process and face-to-face. The web-based tool used was the software described in the previous section.

In relation to this software we must clarify that when designing this experiment in which we had a mix of face-to-face, and online synchronous/asynchronous deliberation processes, we did not pretend to evaluate all the many dimensions that can be taken into consideration when designing an online deliberation process and to make a comparison between this software and the many other software tools available which may offer functionalities to help web-based deliberation processes. One of the reasons, among others, is the very high number of dimension that we could take into consideration. Just to give an example Davis and Chandler (2011) in a work about

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online deliberation design propose five group categories representing the highest level questions faced by the deliberation designer: first, purpose (why is the deliberation being designed – in other words, what objectives should the design reflect); second, population (who will be involved); third, spatiotemporal distance (where and when will participants be interacting with each other); fourth, communication medium (how will communication occur); and fifth, deliberative process (what will occur among the participants). These categories, and all of the choice dimensions (13 design dimensions that contain 29 additional options) described within them, could be applied both to offline (i.e. face-to-face) and online deliberation.

Having made these considerations about the variety of issues and configurations that might be taken in the design of ICT supported deliberation process let us see the configuration that we used in our experiment. Since the purpose of the study was, on one side, to evaluate the impact of using a deliberation process based on TS in the quality of each group work and, on the other, to evaluate the impact of providing one of the groups ICT support in some stages of the process, we configured two groups of people. Both groups were composed by students of information science engineering and had highly similar level in education and background. The first group (Group I) was composed of 17 students, all in their final year (fourth) of their degree in information science. The second group (Group II) was composed of ten students, all in their first year of a master in information science (a programme running 1.5 years).

In this deliberation process we used some components of the TS protocols. In particular we used the first two stages (generation of ideas and aggregation of issues) in the first part of the experiment, with two different modalities for the two groups. One of them (Group I) did these stages face-to-face and the other (Group II) did it in an asynchronous/synchronous online mode. The generation of content stage (fourth TS stage) was done face-to-face in both groups. Since the number of persons was in one case 17 (Group I) and in the other ten (Group II) we took the octahedron form as a reference to organize the face-to-face content generation deliberation sessions.

The opening question

The "opening question" for both groups was the same: "How can the ICTs help to improve public and private organizations?"

We can safely assume, given the character and vocation of all these students, that the issue was motivating enough for them. In fact, all students were previously consulted as to what kind of issue they would prefer. There was unanimity in accepting this opening question as the one to be answered.

The sessions

The organization of the sessions for both groups was similar with respect to space, layout and auxiliary elements (overhead projector, etc.). The main difference between the two groups was the use of ICT tools to support the process. Group I had no support of ICT. The process (opening question, generation of ideas, aggregation of ideas and selection of the six final topics to be explored in teams) was done in the traditional way. The generation of ideas, aggregation and selection of the six final topics, was done during a two-hour session. The deliberation and exploration of the six-topics content was done on two different days. One day (two hours) was dedicated to making two iterations and another day (one hour) to making a plenary presentation of the six teams' results.

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In the case of Group II, the phases that correspond to generation of ideas, aggregation of issues and selection of the six final issues to be explored in teams, were done through the internet over 38 days. The participants were free to enter into the deliberation system when they preferred, without limitation. The deliberation and exploration of the six-topics content was done in a 3.5-hour session during which two iterations were made.

The form used to configure the six teams was the octahedron (six vertices and 12 struts). Since the number of students in Group I was 17 we doubled five struts. This means that in five of the six topics there were five persons instead of four on the team. In the case of Group II, since the number of students was ten we had to use a "fictitious member" to create the six groups. This means that in two of the groups the number of members was three instead of four. As we will see later when comparing the results between the two groups, this difference in the number of persons seems not to have produced much impact.

The assignment of persons to topics

In both groups we used an optimization software developed in our research group to maximize the degree of satisfaction of the participants with the topics assigned to each of them, both as actors and critics according to their preferences. The software provides a satisfaction index, in which 100 per cent means that all participants have assigned the topics number one and number two of their list of preferences. The software allows selecting different criteria to make the assignments, but the one selected in this case is the one that tries to put the participants in their preferred topics teams[3]. The degree of satisfaction obtained for the two groups has been 89.3 per cent for Group I and 90.9 per cent for Group II.

The technology

As we have mentioned, Group I had no ICT support, while in Group II we used the software described above to organize debates through the internet (www.debatesorganizer.org). In the preceding sections, we have described how this software was used and have shown screen-examples of the lists of ideas, of aggregated ideas and the ideas contained in each aggregated ideas, etc. Now let us see some of the results obtained in both groups.

Results

First of all we should remind that the two main goals of this experiment were, on one side, to evaluate the benefits that the use of a deliberation process based in TS produced in two groups of students exploring a common issue of interest to both and, on the other, to evaluate the impact of using, in one of the groups, a web-based software tool to facilitate the first stages of the TS process. The objective here was to see if by doing so the quality of the deliberation process (content and process) improved.

It is also convenient to indicate that the purpose of these experiments were not to make a comparison of TS vs other group-decision approaches[4], neither to compare our software tool as such with other alternative software tools available today. In the case of ICTs tools to help groups of people to take decisions, the number of software tools available for that purpose is extremely big (and keeps growing)[5]. Let us see the results obtained in both cases.

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Results comparison (process)

We did two kinds of evaluations. In the first evaluation we measured the improvement in both Groups I and II before and after going through the whole experiment (in one group with ICT help and in the other without it). So in this case we assessed the results obtained by each group compared with itself (before and after the experiment). In the second evaluation we compared the results obtained by the two groups with each other, both before and also after the experiment. Let us see the results obtained.

Questionnaires

We used two questionnaires: one pre-task and the other post-task. The questionnaires were made up of: first, a set of questions related to the perceived degree of knowledge of the students in relation to the issue to be explored in the deliberation process. These were divided in perception of the individual about her/his degree of knowledge and perception of the individual about the degree of knowledge of the group; second, a second set of questions related to the deliberation process itself (three components were measured: motivation, how well the process worked and expectations about its usefulness); and third, questions about interest in repeating the experience and suggestions. A rating scale of seven-points was used (from 1 = very low or strongly disagree to 7 = very high or strongly agree).

The perception about knowledge was measured through these six items: "What is the level of knowledge about the information needs of organizations (both public and private)?" What is the level of knowledge about the use of ICT in public organizations? "What is the level of knowledge about the use of ICT in private organizations?" "What is the level of knowledge about software applications available for organizations?" To what extent do you feel qualified to explain to a business manager the benefits of ICT in their business?" "To what extent do you feel qualified to implement ICT solutions in an organization? The same questions were also formulated to the individuals but asking their perception about the group (e.g. what do you think it is the group level of knowledge about the use of ICT in private organizations?). These set of questions were grouped under the components "perceived degree of knowledge (individual)" and "perceived degree of knowledge (about the group)". The Cronbach's α for the various groupings were the following: individual knowledge perception (Group I $\alpha = 0.772$; Group II $\alpha = 0.777$); group knowledge perception (Group I $\alpha = 0.849$; Group II $\alpha = 0.912$).

In relation to the questions about the process the set of questions related to "motivation" were: "Do you think you'll have fun?"; "Do you find the process interesting?" "What it will be your level of involvement with the results?" "Do you think it's going to be useful?" "What is your level of motivation to act on what you learn in the process?" The set of questions related to "How well the process worked" were: "Do you understand how syntegration works?" "Do you think that the physical environment is an enabler of success?" "Is this method different from others?" "Do you perceive the equality character in the syntegration design?" "To what extent do you consider important the number of people to make the process work?" The set of questions related to "Expectations about its usefulness" were: "Do you think that the generation of relevant statements will work?" "Do you think that the generation of consolidated relevant statements will work?" "Do you think the group process will work? (the meetings)?" "Do you think that your understanding of the issues will improve?" "To what extent do you expect to bring in your skills?" "To what extent do you think the syntegration will work?"

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The Cronbach's α for the various groupings related to the process were the following: motivation (Group I $\alpha = 0.922$; Group II $\alpha = 0.834$); how well the process worked (Group I $\alpha = 0.693$; Group II $\alpha = 0.649$); expectations about its usefulness (Group I $\alpha = 0.837$; Group II $\alpha = 0.873$).

With the results obtained through the questionnaires we did two kinds of comparisons. In one we compared the average value given by each of the two groups (Group I and Group II) before and after doing the deliberation process, to each of the five main issues: "perceived degree of knowledge (individual)", "perceived degree of knowledge (about the group), motivation", "how well the process worked", "expectations about its usefulness". This comparison should provide an indication of how useful it was the deliberation process (TS-based process) to produce an improvement in each of the groups.

In the other comparison we used the results obtained for Group I and Group II for each of the same five issues. Here what we get is an indication of how the results obtained in Group I (no ICT help) compare with the results obtained Group II (with ICT help).

Let us review some of the results obtained. In first place and related to our first objective, "Evaluation of the impact of using a TS based deliberation process in two groups of people". The results confirm that in this experiment it was beneficial. As we can see in Table I, the mean values for practically all the components measures (scale 1-7) went up (post-deliberation vs pre-deliberation) in both Group I and Group II. Particularly strong is the change experienced in Group I (the initial values for this group were much lower than those in Group II): individual knowledge (3.62-5.29); group knowledge (3.58-5.29); motivation (4.94-5.46); process (4.83-5.50); expectations (5.07-5.33). And for Group II: individual knowledge (4.97-5.66); group knowledge (5.02-5.70); motivation (5.71-5.56); process (5.56-5.63); expectations (5.53-5.63). In Group II the values, both initial and final, were higher than in Group I. The fact that the initial values for Group II were so high compared to Group I will have an impact in the comparison between Group I and Group II, in which what we measured was the impact of using ICT in this group and not in the other. As we will see the final results obtained for Group II are better than for Group I but since both obtained quite high results the difference between both has not statistical significance.

Besides this straight means comparison between pre and post for both groups we used the Mann-Whitney-Wilcoxon test to check if the differences have statistical significance. The results are shown in Tables II-VI.

The distribution scores for the measures for the various groupings deviated from normal distribution (Kolmogorov-Smirnov and Shapiro-Wilk tests) so to examine whether there were differences in the results obtained (pre/post and Group I/Group II) a Mann-Whitney-Wilcoxon rank-test was used. This is recommended for data which deviate from normal distribution (Bradley, 1968).

Table I.
Mean and std. deviation (Group I-Group II/pre-post)

	Group I		Group II	
	Pre	Post	Pre	Post
Individual knowledge perception	3.6218 (0.86003)	5.2857 (0.72627)	4.9714 (0.70566)	5.6571 (0.74139)
Group knowledge perception	3.5843 (0.75001)	5.2857 (0.68696)	5.0167 (1.06704)	5.7000 (0.84181)
Motivation	4.9471 (1.20940)	5.4643 (1.05072)	5.7150 (0.70002)	5.5600 (0.85790)
Process	4.8353 (0.97528)	5.5000 (0.96742)	5.5600 (0.64498)	5.6333 (0.81952)
Expectations	5.0686 (0.83968)	5.3333 (1.17851)	5.5333 (0.88471)	5.6333 (0.69744)

In Tables II and III we may see that in the difference (pre-post) in the perceived degree of knowledge (both individual and group) there is statistical significance for Group I. Also there is statistical significance in the difference (both in individual and group knowledge) in Group II vs Group I (before the deliberation process). This indicates that

Table II. Mann-Whitney-Wilcoxon test: perception individual knowledge

	Test statistics			
	Pre vs post		Group I vs Group II	
Individual knowledge perception	Group I	Group II	Pre	Post
Mann-Whitney *U*	16.000	22.000	18.500	48.000
Wilcoxon *W*	169.000	77.000	171.500	153.000
Z	−4.104	−2.129	−3.360	−1.299
Asymp. sig. (2-tailed)	0.000	0.033	0.001	0.194
Exact sig. (2*(1-tailed sig.))	0.000[b]	0.035[b]	0.000[b]	0.212[b]

Note: [b]Not corrected for ties

Table III. Mann-Whitney-Wilcoxon test: perception group knowledge

	Test statistics			
	Pre vs post		Group I vs Group II	
Group knowledge perception	Group I	Group II	Pre	Post
Mann-Whitney *U*	12.500	30.000	26.500	49.000
Wilcoxon *W*	165.500	85.000	179.500	154.000
Z	−4.234	−1.518	−2.942	−1.237
Asymp. sig. (2-tailed)	0.000	0.129	0.003	0.216
Exact sig. (2*(1-tailed sig.))	0.000[b]	0.143[b]	0.002[b]	0.235[b]

Note: [b]Not corrected for ties

Table IV. Mann-Whitney-Wilcoxon test: motivation

	Test statistics			
	Pre vs post		Group I vs Group II	
Motivation	Group I	Group II	Pre	Post
Mann-Whitney *U*	88.500	46.500	51.500	68.000
Wilcoxon *W*	241.500	101.500	204.500	173.000
Z	−1.213	−0.266	−1.684	−0.118
Asymp. sig. (2-tailed)	0.225	0.790	0.092	0.906
Exact sig. (2*(1-tailed sig.))	0.230[b]	0.796[b]	0.093[b]	0.931[b]

Note: [b]Not corrected for ties

Table V. Mann-Whitney-Wilcoxon test: how well the process worked

	Test statistics			
	Pre vs post		Group I vs Group II	
Process	Group I	Group II	Pre	Post
Mann-Whitney *U*	70.000	47.500	47.000	65.500
Wilcoxon *W*	223.000	102.500	200.000	170.500
Z	−1.947	−0.189	−1.915	−0.264
Asymp. sig. (2-tailed)	0.051	0.850	0.056	0.792
Exact sig. (2*(1-tailed sig.))	0.053[b]	0.853[b]	0.059[b]	0.796[b]

Note: [b]Not corrected for ties

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the initial level of knowledge about the issue to be studied was high within this group and also higher than in the other group. We think that this is one of the reasons why when we compare the level for Group II (pre-post) we do not find statistical significance. One reason may be that if the initial value was already very high it is difficult to improve it very much (there is less room for it). The same comment applies to the comparison between Group I/Group II after the deliberation process. Both groups reached a notably high value for knowledge level (individual and group).

In Tables IV-VI are shown the results for "Motivation", "How well the process worked" and "Expectations about its usefulness".

In what concerns the three other components "Motivation", "How well the process worked", "Expectations about its usefulness", the comparison between pre/post in Group I and Group II, can be appreciated in Tables IV-VI. In this case we only find a difference with statistical significance in the component "How well the process worked" for the Group I. The reason for this difference at the starting time of the process may be due to the fact that the members of Group II were briefed about how the deliberation TS-based process worked. This was necessary done with them because since they were going to use the software "debates organizer" they needed to know how it was configured and how they should use it. Once the deliberation process finished the knowledge of Group I about how the process worked obviously increased because they went through it in the experiment.

The same reasons apply for the comparison between Group I and Group II knowledge about "How well the process worked" before starting the process. We appreciate also here a difference with statistical significance (Table V). For the other two components "Motivation" and "Expectations about its usefulness" the various differences do not have statistical significance. Once more we think that this may happen due to the already high values given for these components before and after the process. In what refers to the comparison between Group I and Group II, we also think that since both reached a very high value after the process the difference between them, even it exist, it is not sufficient to have statistical significance.

Results comparison (content)

Table VII summarizes the results for both groups. We evaluated both quantitative and qualitative results obtained within each group. First, with respect to certain quantitative aspects, Group I generated 90 ideas (5.3 ideas per participant on average) and Group II generated 48 ideas (4.8 ideas per participant on average). The number of aggregated ideas was eight for Group I and seven for Group II. In both groups the selection of the six final topics was a relatively fast and straightforward process.

Table VI. Mann-Whitney-Wilcoxon test: expectations about its usefulness

	Test statistics			
	Pre vs post		Group I vs Group II	
Expectations	Group I	Group II	Pre	Post
Mann-Whitney *U*	86.000	49.500	58.500	59.000
Wilcoxon *W*	239.000	104.500	211.500	164.000
Z	−1.314	−0.038	−1.335	−0.649
Asymp. sig. (2-tailed)	0.189	0.970	0.182	0.516
Exact sig. (2*(1-tailed sig.))	0.200[b]	0.971[b]	0.187[b]	0.546[b]

Note: [b]Not corrected for ties

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	Group I (no ICT)	Group II (with ICT)
No. of participants	17	10
No. of ideas	90	48
Ideas/participant	5.3	4.8
No. of agregated ideas	8	7
Final no. of topics/no. of pages	6/6	6/22
Ideas generation and topics	2 hours (physical)	38 days (virtual DO)
Topics deliberation in 6 teams (two iterations)	2 hours	3.5 hours
Presentation of conclusions for the 6 topics	1 hour	1 hour
Satisfaction with topics assignement	89.3%	90.9%
Content final output	Not focused	Highly focused
Degree of issue knowledge (after vs before process)	Significance in improvement	Significance in improvement
Would you repeat the experience?	69.2% YES	100% YES

Table VII.
General data. Group I and Group II

With respect to the content produced during the physical (teams) deliberation process around the six final topics, there is a considerable difference between the two groups, both in quantity (number of pages) and quality. Group I presented one page for each topic with generally quite simple content, while Group II presented a very elaborated set of topical conclusions totalling 22 pages. In terms of quality, the conclusions corresponding to Group I were unfocused and simple in content, indicating a rather weak effort to reach sound conclusions, with only a few sentences in the final-topics conclusions. By contrast, Group II presented much more focused and reasonably deep conclusions, indicating an intense effort to produce valuable content and a quite detailed (long) document (22 pages in total) describing their final conclusions. It is also interesting to observe that 69.2 per cent of participants in Group I answered yes when they were asked if would like to repeat the experience in comparison to 100 per cent in Group II. We would need to research further about why this happened but we think that one reason, among others, may be related to the fact that the process supported with ICT (Group II) reduces the stress level, since in it all members have much more time (in this case 38 days) to go through the first two stages of the deliberation process and interactions facilitated by the permanent available access to all information generated during the process. This helps to obtain a much deeper knowledge about the characteristics and benefits of this kind of deliberation process.

6. Limitations of the study

Although the results produced in this case by the use of ICT to support the deliberation process are promising, we must consider certain limitations of this study which recommend the pursuit of further research in order to confirm these results. Among these, we must first consider the brief period dedicated to the deliberation process, especially in the physical meetings. Another limitation is the number of iterations (two) in both cases. Three iterations would be recommended for teams to produce the final content. Another factor to consider is the possible existence of even a small differential in the level of technical knowledge between the two groups (last year of a degree level vs first year of a master level). Another limitation is that we deal with only one sample of two groups. It would be desirable to repeat the experiment with various groups, in different contexts and specially with a much bigger number of participants.

Finally, mention of some of the comments by participants might be useful. Some indicated that the final topics should be more focused. Others suggested that the

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iterations should be separated in time. Others proposed giving more time for the role of critics in the teams. A generally expressed wish was that participants be able to intervene in all six topics, not only in three (two as actors and one as critics).

7. Conclusions

The availability of ICTs opens new opportunities to obtain better results when applying systems-thinking approaches. While some approaches, for example, system dynamics, have long applied these tools, others have not used them extensively. This paper presents examples in which OC concepts were used in conjunction with ICTs so as to improve the quality of collective deliberation processes.

We described a software tool (www.debatesorganizer.org) created so as to facilitate collaborative exploration of a common issue by groups working at distance.

In this paper we also described an experiment carried out with two groups to establish, on one side, to what extent the use of TS-based deliberation processes could improve its quality and, on the other, to assess the impact of using ICTs combined with OC in the quality of a deliberation process. Each group explored an issue of common interest to them both. With one group the process involved no ICT support, while the second group used the above-mentioned software, which supported the initial phases of the deliberation carried out by the group.

Our aim was to evaluate the impact produced by the use of TS and the ICT tool above-mentioned both on the quality of the deliberation content produced by the group as well as on the quality, as perceived by the participants, of the process itself. The results of this experiment show a significant improvement in the quality of both group's work as well as a higher satisfaction with the whole deliberation process and higher values in general for the group supported by internet-based software.

In closing we must say that although the results of this study are quite promising, we must also take into account its limitations. Additional experiments with groups of different sizes and contexts are necessary to validate the results set forth here.

Notes

1. Team Syntegrity® and Syntegration® are registered trademarks by Team Syntegrity Internacional Inc. and Malik Management Zentrum St Gallen.
2. The language used in the test was Spanish. This is the reason why we decided to keep in the screen's captures the original text introduced by the participants.
3. The preferred topics have a decreasing value: first choice-six points, second choice-five points, third choice-four points, fourth choice-three points, fifth choice-two points, sixth choice-one point.
4. To see a study in which we did an empirical evaluation of the benefits derived from using TS in a group-decision context, see: Martín-Cruz *et al.* (2014).
5. Just as an example of this tool's proliferation, in the "Participaedia" site (http://participedia.net/en/browse/methods) they are identified 114 different methods classified in function of what they were good for: type of interaction among participants, completeness; content language; facilitation; geographical scope; governance contributions; issue interdependency; issue polarization; issue technical complexity; type of organizing entity; what was the intended purpose? What was the intended purpose? Types of supporting entities; method of recruitment; typical funding source.

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