DESIGN OF A SOCIAL DECISION SUPPORT SYSTEM FOR ORGANIZATIONS

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Abstract: The growth of Web technologies and collaborative Web-based software as means of tapping and making useful knowledge and perception distributed among people, makes evident the potential interest and application of the paradigm of Socially Supported Decision Systems (SSDS) for organizations.
This paper describes on-going research on SSDS and development of a concept prototype of such a system, named Amplidir. Research highlights similarities and differences between control at the machine level and decision at the human organizational level. An initial set of specifications for Amplidir is also given.

Keywords: decision support systems, decision-making, systems concepts, systems design, systems methodology.

1. DECISION SUPPORT SYSTEMS

The growth of Web technologies is many-folded: on one side it makes today's societies viable. On another, it adds to their complexity. Yet in another, it promises solutions for many problems of societies' growth, be them to accommodate rise in the number of people or to ensure their quality of living.

One most promising solution enabled by the growth of Web technologies is social support to decision. There is much evidence pointing that social support may increase the intrinsic quality of decisions and their acceptance. As a side effect, it augments the possibilities of people getting more involved in the social, which in turn paves the way for them to better their social performance.

According to (Power, 2002), the history of decision support systems (DSS) goes back to 1945. Also according to (Power, 2007) one can classify DSS upon the emphasis they put on aspects of the decision process as:
– Model driven
– Data driven
– Document driven
– Knowledge-driven
– Communications-driven

To clarify the meaning of each emphasis, one adapts the following paragraphs from (*Wikipedia*, 2007a).

A model-driven DSS emphasizes access to and manipulation of computer models pertinent to decision. Model-driven DSS use data and parameters provided by users to assist decision makers in analyzing a situation, including simulations; they are not necessarily data intensive.

A data-driven DSS or data-oriented DSS emphasizes access to and manipulation of a time series of internal company data and, sometimes, external data.

A document-driven DSS manages, retrieves and manipulates unstructured information in a variety of electronic formats.

A knowledge-driven DSS provides specialized problem solving expertise stored as facts, rules, procedures, or in similar structures.

A communications-driven DSS supports more than one person working on a shared task.

Any of the aspects emphasized are important for decision but they are not complete. Except for the communications-driven type, they do not consider explicitly the fact that human organizations are made of *people*. People need organizations and

organizations need people. People need healthy and wealthy organizations to produce value for society as a whole and to produce value for them in exchange for their work and investment in the organizations they are members or participate. Organizations need involved, performing, adapting and creative people to become healthy and wealthy. One must address the fact that organizations are made of people in DSS design and this is obtained naturally by considering its *social* nature. A growing flow of research results is emerging.

Social Decision Support Systems (Turoff *et al.*, 2002) are designed to carry into decisions the perceptions and knowledge a group of people disposes collectively, in-line with the proverb "*n* heads think better than one"[1]. A related expression is Societal-Scale Decision Support Systems (Rodriguez, 2004; Rodriguez and Steinbock, 2004). While the formulation of Social or Societal-Scale DSS targets unstructured large groups of people in a deemed political context, the target considered here are organizations and the context is management, understood as a pervasive distributed process inside the organization. Therefore, it may be considered a generalization of a communications driven DSS to a level where the group served by the DSS is all the people in the organization and the shared task is attaining the top-level goals of organizations.

Our aim is to develop a DSS for organizations that will allow to extend the support managers have available to take decisions to the whole of the perceptions and knowledge distributed among the people in the organization. We have named the prototype in development for such a DSS, Amplidir.

Of course, Amplidir should integrate with other DSS. Ideally, it should contribute to making decisions more "automatic", that is with less human intervention. While this may seem contradictory with the intended participation of all people (not only managers), it is not. The reason is that it is expected that such a system may potentiate the learning and knowledge of people about organizational behavior and organizational management. This will create conditions for managers to intervene less.

In the following section, a formal description to base reasoning on SDSS is given. Section 3 analyzes some of the implications of the social nature of human beings for decision in organizations. Section 4 describes the current specifications for Amplidir. Section 5 concludes indicating perspectives on future research and development.

2. DECISION PROCESSES AND CONTROL

One takes here a decision process being conceptualized as follows. Continuous time is divided into intervals with no restrictions on length other than being finite non-null. Intervals are referred by its initial instant. One assumes that an action becomes decided at the initial instant of an interval. Perceptions occurring along an interval are assumed stored in memory at the beginning of the next. Therefore, decisions 'tick' time. The following four entities are to be considered in the decision process.

– A *space of available actions* $\mathcal{A}(k)$, from which the process selects at each time instant k a subset $A(k)$ of *effective* actions. Actions should be understood not only as geared towards the exterior of the decision process but also to its interior.

– A *space of perceptions* $\mathcal{P}(k)$, from which the process selects at each time instant k a subset $P(k)$ of perceptions to be stored in its *memory* $P(0, k)$. This memory may record whatever is relevant, including the actions taken up to k: $A(0, k)$.

– A *policy space* $\mathcal{C}(k)$ from which a subset $C(k)$ is used to select $A(k + 1)$ with $P(0, k)$ as input:

$$A(k+1) = C(k) \cdot P(0,k) \qquad (1)$$

With the ' · ' denoting application.

– A *knowledge domain* $K(k)$ determining the choice of $C(k)$:

$$C(k) = K(k) \cdot P(0,k) \qquad (2)$$

Equation (2) must be interpreted as stating that change of policies may be made at *any k* rather than being made at *every k*.

A decision process makes sense if it is connected to a system or is part of a system which *behavior* it influences. By this, one means that there is a set of variables B, associated to the system, that evolve according to:

$$B(k+1) = F(k) \cdot \big(A(0,k), B(0,k), N(0,k)\big) \qquad (3)$$

where $F(k)$ is a time-varying probabilistic transition function and N is a set of variables that $A(k)$ cannot influence. Behavior over an interval of duration H, from k_1 to k_n, can be denoted as $B(H)$.

Besides being connected to a system, a decision process has *goals* assigned to it: decisions are made to get a behavior $B(H)$ satisfying a set of relations $R(k)$ defining the goals over the behavior.

The above can be taken also as an abstract description of a control process, as control is about getting systems behavior with given properties. These properties are specified by the set of relations $R(k)$. The expressions 'decision process' or 'control process' are synonymous up to a focus of perspective,

[1] And by the way: perceive more.

either on taking decisions (controller operation), or on the effects of the decisions taken (behavior control).

There is also a difference in connotation of the expressions. For the nonprofessional there is no special problem that one says control of a physical system. However, if one would say control of a social system, understanding social as being constituted by people, the word control will connote, more often than not, conflict with people's freedom and interests. For a control practitioner, this connotation is meaningless in content: it all depends on the goals one sets for the control or decision process. If one accounts for freedoms and interests of people in the design of the process then a 'well-controlled" social system may preserve and satisfy them much better than an 'uncontrolled' one.

3. IMPLICATIONS OF THE SOCIAL FOR DECISION IN HUMAN ORGANIZATIONS

Automatic control processes for machines usually do not need the flexibility given by the above description: most of its elements are fixed. The action space $\mathcal{A}$ is fixed by the actuators and the perception space $\mathcal{P}$ is fixed by the sensors chosen. The policy C (control law) is not time varying unless it is adaptive. The knowledge domain K may be interpreted as the knowledge supporting *control design*. The transition function F is often considered deterministic and of the state type – only a fixed number of values of A, B, and N before $k + 1$ affect $B(k+1)$.

Under the above, an automatic control process is set-up by putting (1) and (2) "into math". They are written and rewritten until a satisfactory control process emerges and it is implemented. Therefore, its design is a mathematical intensive activity.

Decision processes for human organizations present substantial differences. Human organizations are constituted by people supported by machines. The existence of people creates restrictions on one side and opportunities on the other.

A first difference to take in account is the ease / difficulty of putting things 'into math'. Surely, there is a lot of modeling of the organizations and their decision processes that can go (and goes) into clear and well-defined mathematical expression, allowing, in particular, its exploration by computers. A model driven DSS does exactly this. Models of operation and decision of an organization can be built at all levels. The recent emergence of digital dashboards (Wikipedia, 2007b) shows that this is a viable and useful way to go.

However, given the complexity of human behavior, there is a natural divide in what respects mathematical modeling. This divide is not of a fixed nature: it changes along time in the direction of growing modeling capabilities. This growth hinges on the understanding of what makes people different from machines, of what is human specific.

Humans are social beings. This manifests in particular by people resorting to conversations in natural language when problems arise or other means for solving problems fail. In the SDSS perspective taken here, this is a source of opportunities.

Let one consider the perception space $\mathcal{P}(k)$. In the limit, this space includes everything people perceived about the organization in the kth time interval. It spreads across the organization and its environment and gives an n-personal view of both. It is the prime source of information got by people about the state of the organization and the state of the environment, be it registered in $P(k)$ or not.

The same is true for the information on the actions made by people, their component in $A(k)$. Much important, it includes the action space $\mathcal{A}(k)$ because an action becomes only possible if it is perceived as such. Possible but unperceived actions cannot be chosen. Therefore, it is impossible for the organization to execute them or to have access to them.

The same holds for the policy space $\mathcal{C}(k)$. Possible but unperceived policies cannot be chosen (at least deliberately) and so become actually unavailable.

So, rather than emphasizing making available to decision mathematical modeling and data analysis, a SSDS for organizations will emphasize making available to decision the pool of perceptions of people about the organization and its environment, about possible actions and policies, in order to make operational the perception and knowledge the organization possesses as a whole.

This has a sound cybernetic basis: the principle of requisite variety (Ashby, 1956). It states that in order for a controller to cope with a disturbing environment it must have internal variety equal or greater than the variety present in the disturbances. Seeing the above emphasis from this perspective means a SDSS will try to make effective all the variety that exists inherently in a human organization.

A second difference to take in account regarding people and machines is that for people the distinction between perception, action and decision is fuzzy. Any person in an organization is required to do some of all the three. Surely, specialization exists and is necessary. However, an employee that is limited or limits itself to repeat the same task according to a set of rules that specify exactly what is to be done is not the ideal collaborator for an organization anymore. Individual performance and collective performance requires individual (emotional) involvement with the organization.

A SDSS perspective is inherently facilitating of people's involvement in an organization, as it requires contributions in decision at the several levels. Nevertheless, for this to happen it is required that people perceive that their contributions matter, even when they are not acknowledged in decisions. So the SDSS and its use by management should ensure that people perceive that due attention is given to their contributions.

Furthermore, the coherence or fundamental honesty of the process should also be evident. This reveals at the top goals set for the organization. A human organization exists to fulfill needs or wishes of society by orchestrating its members in producing goods or services that satisfy the needs or wishes. An organization cannot produce goods or services from nothing, so it must take from society an input flow of goods and services I_{gs} in order to create its output flow of goods and services O_{gs}. Measuring the values of these flows is far from being consensual in theoretical terms, but in practical ones, it is made in currency units along a civil year. The organization receives from society a given amount of money, which is taken as the value of the output along the year $V(O_{gs})$. It gives to society another amount of money that is taken as the value of the input flow along the year $V(I_{gs})$.

A basic goal for the global decision process of an organization is then:

$$V(O_{gs}) \geq V(I_{gs}) \qquad (4)$$

This is a basic goal because its accomplishment determines the persistence in time (or the survival if one wants) of the organization. Repeated violation of the relation (4) will end up with the organization being dissolved.

Nevertheless, to say that a human organization exists to fulfill needs or wishes of society is incomplete. It also exists to fulfill needs and wishes of its members and participants. This fulfillment is mediated by the money and other values members and participants receive for their work or investment in the organization. It is of course a necessary drive for involvement. It must be clear to all people that management has as a value to effect a fair distribution of the value received from society in exchange for the goods and services produced. In other terms, it must be clear that the return of value for work or investment is fair (and expected to grow). Without this, a SDSS for an organization risks to be a failure.

A third difference to take in account regarding people and machines is that *collectively* people are good estimators of outcomes, including decisions (Surowiecki, 2004). To take advantage of this a SDSS should allow management to have access to people's voting on possible choices. While this is the mean by which decisions are taken in a SDSS targeted to general domains, in an organizational SDSS it makes sense that this facility may be used by management, either as a what-if analysis, or as the mechanism for decisions, according to management judgment.

In short, when one considers SDSS for human organizations, one finds at least three properties of great interest:

– Potentially, they allow management to have available and explore the whole of perception and knowledge of the organization.

– If used upon an honest basis with regard to distribution of the value created by the organization for their members and participants, they potentially better the involvement of people with the organization. One should add here that inherently they might function as a tool for acquiring and disseminating organizational knowledge.

– They enable the possibility of collective decision, when this is justified according to management judgment.

Regarding the classification based on emphasis of DSS given in Section 1, SDSS lie more on the side of document, knowledge, communications driven DSS, rather than on the side of model, data driven DSS.

4. THE CONCEPT PROTOTYPE IN DEVELOPMENT

From a software point of view, a SDSS is a special type of system for managing and processing streams of messages among a group of users. The basic view a user is intended to have of the Amplidir system we are reporting on, is that of a structured space to / from which the user can send / receive messages.

Structuring of the space happens in several ways. Amplidir supports defining areas that can be assigned to users. Areas may be subsets of other areas or they may be overlapping, corresponding to the different sections, departments, project groups, etc, that may exist inside the organization. A user may address a message to the areas for which s/he finds the message relevant. Should the message be found to be relevant for an audience wider than it was originally intended, it can be relayed to a larger area up to the global area corresponding to all the organization.

Amplidir will be a Web based application. In principle, one instance of Amplidir will be run for each organization by a Web server. Users interact with the application server through a standard web browser, with no installation of specific client software being necessary in their computers.

Amplidir will allow for classifying user as 'decisors' and 'non-decisors'. Among other things, decisors may assign tasks to other users and change Amplidir parameters of functioning, accordingly to the area

their scope of decision applies. Decisors will dispose of tools for asking people to answer to questions.

Messages can be classified, their basic type being named an "issue". An issue is a message that states something of potential interest to a decision process inside the global decision process of the organization.

It is expected that once sent, an issue will go through a sequence of states. First, it must be validated as an issue deserving attention. If not, it should be closed. If valid, either it is a new issue, or an issue related to a previous existing one. In the last case, it will be included in the workflow of the existing issue.

Valid issues go through a process of resolution or workflow. A processing phase may include decisors getting more information on the issue and alternatives of actions. This first processing phase ends with a decision leading to the assignment of tasks. Upon completion of the tasks, the effectiveness of the decision is verified. If successful, the issue is closed. If not, another decision may take place.

Issues sent may trigger or be transformed in other issues. Let one suppose that an issue addresses some problem *x*. In the processing phase, it may be recognized that this a particular instance of a more global problem, say *X*. Then an issue corresponding to *X* should be generated.

In terms of software architecture, the specifications for the prototype version of Amplidir include the following.

– Users database. It must contain user information, area(s) s/he belongs to, decisor status, provided services, etc.

– Issues / knowledge database. It must be able to store the issues sent by users, according to their classification, as well as any documents / files / comments related to the issue.

– Simple voting engine. It will allow a manager to propose a voting with selected options and collect the voting results.

– Questions / answers engine. It will allow a manager to request help for an issue, in the form of voting possible decisions and providing additional information, with several modes (forum, brainstorm, open brainstorm).

– Search capability. It will allow searches on the databases.

– Workflow engine. It will allow defining a workflow for issues, according to areas.

– Web interface. It will allow interfacing users with Amplidir through a standard web browser.

– Email processing system. It will allow interacting with users through e-mail.

Amplidir is being developed as an open source software project, based on an existing application, the Mantis bugtracker (http://www.mantisbt.org/). Bugtrackers are SDSS tailored for (open) software developers. They usually contain a number of the functions needed for a SDSS.

As an open software project, a version of Amplidir should be available for download from http://ampli.dei.uminho.pt. Any feedback will be gratefully acknowledged.

5. CONCLUSIONS AND PERSPECTIVES

This paper reported the main aspects of research made to specify a SDSS targeted to organizations, and the set of initial software specifications for the prototype in development.

SDSS appear as a useful line of research and development. Decision processes in organizations share a common conceptual framework with other decision processes, in particular control processes for machines. Meanwhile, the specificity of people requires that besides mathematically oriented decision support, as given by model driven DSS, other less mathematically structured aspects of the decision process be taken in account. In these, SDSS appear of strong interest:

– To enrich actually the variety of the organization, by giving a means to express perception and knowledge distributed among the people in the organization relevant to the decision process.

– To strengthen in general the involvement of people with the organization (and so their performance).

– To allow collective decision according to management judgment.

One may hypothesize that development of DSS for organizations will converge to three main emphases:

– Model oriented. This type of DSS will allow mathematical modeling of the organization and of the decision process along with mathematical analysis of data.

– Knowledge oriented. This type of DSS will allow storing, accumulating and exploring the knowledge gathered by the organization.

– Socially oriented. This type of DSS will allow supporting decision by means of conversational acts among the people involved in areas of the organization, from small groups to the whole organization.

It is also reasonable to expect that besides convergence to the emphases above one may assist in the future to integration of them.

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