A Cross Impact Scenario Model of Organizational Behavior in Emergencies

Murray Turoff
NJIT
murray.turoff@gmail.com

Victor A. Bañuls
Universidad Pablo de Olavide
vabansil@upo.es

Starr Roxanne Hiltz
NJIT
roxanne.hiltz@gmail.com

Linda Plotnick
Jacksonville State University
linda.plotnick@gmail.com

ABSTRACT

A conceptual model is developed of the events that can comprise a dynamic cross impact model of performance of a collection of organizations seeking to respond effectively to an emergency or disaster. It might also be used to model a single organization made up of organizational units. This paper provides a concise overview of the literature that supports the creation of the cross-impact event set. The major goal is to engage other professionals who might aid in supplying a collaborative set of estimates for the relative impacts among the events in what would be an asynchronous online Delphi Process.

Keywords

Scenario Modeling; Cross Impact, Organizational Behavior, Emergencies, Disasters, Delphi Method.

INTRODUCTION

This paper represents an initial step in development of a dynamic cross-impact model of organizational behavior when an organization, or set of organizations, is faced with responding to a large-scale emergency. The model is based upon extant literature that will be reviewed in this introduction. The model includes a set of events that must be considered and quantified by experts (knowledgeable people) before it can be run.

As a starting point, the U.S. federal government sponsored from the late 1950's to the mid 1970's extensive studies of public and private organizations that experienced emergency situations. In 1976 Dynes and Quarantelli published a report summarizing 36 studies, papers, and major reports. They came up with 294 propositions about the cause and effects of variables dealing with communications and decision making. Furthermore, they proposed some very significant organizational behaviors we are using here. What they termed the "established" model is commonly referred to as the hierarchical model with line, middle, and upper management. An organization that attempts to respond to an emergency by utilizing this "established" model frequently fails in its response to an emergency. Dynes and Quarantelli (1976) proposed two "transition" models which allow such an organization to move to and become an "emergent organization." The key characteristics of an "emergent" organization include:

- Authority for actions delegated to line management in unexpected situations.
- Middle management and professionals moving down to support the added load at the line level.
- Upper management seeking needed resources and dealing with other organizations.

Added to the above was the factor of "coordination done by plan" verses "coordination by feedback." Organizations that tried to predict every decision in the plan also seemed to fail whereas those that used current external data on the situation to make decisions were much more likely to succeed. This latter quality is referred to as an organizational "sensemaking" process today. There is no room here to do justice to this study and the document is online via the University of Delaware library (see Dynes and Quarantelli, 1976). A related paper is Quarantelli (1988). A set of studies that helps to make the reasons for the need to transition from traditional to emergent structure clearer is the Bavelas (1950) experiments.

Although the studies described above are over 30 years old, they are still highly relevant today. Many organizations retain rigid hierarchical structures. The "emergent organization" that is described by Dynes and Quarantelli (1976) remains of interest and has characteristics that are still considered not common enough and are worthy goals. In fact, Weick and Sutcliff (2001) include the emergent organization characteristics noted above as characteristics of "high reliability organizations (HRO)" which are organizations that have fewer accidents than would be expected.

A recent study published in the proceedings of the NOKOBIT meeting (Turoff, Gonzalez, Hiltz, and Van de Walle, 2012) incorporated the above and a number of other related papers to design a flow model that could be used to implement a system dynamics model. This paper takes a different approach, the cross-impact method for constructing a model. However, a lot of the details we use in this scenario event model make use of the same references with the same observations. Ultimately, we hope to see both a system dynamics model and a cross-impact model of the same organizational behavior in emergencies. With both perspectives, a more robust understanding of organizational behavior in emergencies can be promoted.

Another source of knowledge for feeding our model is the organizational resilience literature. Resilience is the capacity of a system to absorb disturbance and reorganize to resume its original structure after deformation that does not exceed its elastic limit (Walker, 2004). In an organizational context, resilience means the capability to respond rapidly to unforeseen change, even chaotic disruption (Bell, 2002). A recent paper on organizational resiliency observes that resiliency necessitates the active participation of employees in all aspects of dealing with the unexpected (Lengnick-Hall, Beck, and Lengnick-Hall, 2011). In essence, it equates resilience with participation. In the emergency area, this would extend to an emergent organization considering also the participation of the public in not only response but also in planning and the implementation of plans. Traditional planning has viewed the crisis plan as an outcome of a process to be utilized in a step-by-step fashion during a crisis. Somers (2009) challenges this orthodox view and suggests a new paradigm, one that focuses on creating organizational structures and processes that build organizational resilience potential.

Another relevant recent paper about the history of the Roman Empire, points out that recent research into organizations in adverse environments observes that decentralized control tends to be open to new ideas and ways of dealing with new problems (Cameli and Markman, 2011). It states that the centralized system encourages "threat rigidity" as a more likely form of organizational decision making. It also ties organizational resiliency to the emergent organizational structure as long term decentralization in adverse circumstances as the long history of the Roman Empire.

Plotnick and Turoff (2010) developed a model of the underlying factors that may cause the threat rigidity syndrome, which include information overload, and negative feedback on the effectiveness of response decisions. Related to this is the work of Hiltz and Turoff (1985), and Turoff and Hiltz (2009), on information overload. The need to tailor systems based upon roles that multiple individuals can handle based upon a 24/7 operation is discussed in (Turoff, Chumer, Van de Walle and Yao, 2004). Training people in different roles independent of the level they are at and of the organization is extremely desirable.

A recent report by the U.S. General Accounting Office (2012) pointed out that recovery is often a poorer process when the collaborative efforts across organizations are broken apart too soon. It seems that the propagation of the emergent organization can also better serve the recovery period. It was pointed out in the original report that how long the emergent organization survives after an emergency is very variable and not clearly understood. Most organizations went back to their established structure after the emergency was over. However, this was before computer-mediated communications that could allow much more in the way of flexible communications across organizations.

One last relevant source of knowledge is the business continuity literature. Business continuity analyzes how disruptions can adversely affect the operations of corporations and how investments in resilience can give a business a competitive advantage over entities not prepared for various contingencies (Rice and Sheffi, 2005). A comprehensive approach to business continuity planning seeks to mitigate all major business interruptions of business systems (Cerulloa and Cerulloa, 2004). Among the most recent initiatives, we could underline the ISO standard 22301 focusing on Business Continuity Management Standard (BCMS). Business continuity management is can be defined as a "holistic management process that identifies potential threats to an organization and the impacts to business operations those threats, if realized, might cause, and which provides a framework for building organizational resilience with the capability for an effective response that safeguards the interests of its key stakeholders, reputation, brand and value-creating activities" (BS 25999 BCMS, BSI-1:2006). The ISO 22301 standard specifies requirements to plan, establish, implement, operate, monitor, review, maintain, and continually improve a documented management system to protect against, reduce the likelihood of occurrence, prepare for, respond to, and recover from disruptive incidents when they arise (ISO 22301:2012).

The following sections of this paper present the assumptions underlying our model and a proposed set of events to be included in the initial model. We then describe our plans for developing and testing the model.

OVERVIEW OF THE MODEL

Assumptions of the Model

The model presented can apply to many different organizations responsible for responding to an emergency or to one organization with many organizational units that must be involved in responding to an emergency. Clearly, we are extending the model to cover situations beyond the original investigations reviewed by Dynes and Quarantelli (1976). We are extending the model to one that could be applied to situations like Katrina, the BP Gulf Disaster, and the Japanese nuclear disaster as well as single organizations coping with a disaster.

The organizations or organizational units have an internal hierarchy that involves:

- Line (operational) units under line management and having professionals that react to external requests according to the operational plan governing its operation.
- Middle management and professionals responsible for analysis of unexpected situations in order to determine possible updates to operational plans.
- An upper management that determines the alternative operational reactions and extensions to new unexpected situations based upon the middle level units.

This proposed model is based on "cross-impact" of events on one another. Cross-Impact Analysis question methodology was first suggested by Theodore Gordon and Olaf Helmer in 1966 to help determine how relationships between events would impact resulting events and reduce uncertainty in the future. It was initially used in a planning game called "Futures" created for the Kaiser Corporation (Dalkey 1972). The basic idea of cross impact is:

1. An individual or group create a set of events that appear to be important for creating a specific scenario about the future.
2. Ask an individual or a group to estimate the probability of each event in the set.
3. Then go back and take each event in turn asking the individual to assume it is definitely going to occur (or alternatively to not occur) and under that condition how would it change the probabilities of any of the other events.

Once estimates have been made for all the N events taken one at a time a number of different approximation methods have been developed to attempt to create a single model for the whole set of events (Linstone and Turoff, 1975, chapter V). One could build a complete transition model for N events to follow every possible occurrence sequence into the future. The approximate number of transition probabilities is e*N! which for ten events would be around 10 million instead the 2nd order NxN estimates needed for the cross impact question (Turoff, 1972). Many complex business problems also get reduced to various table representations to handle estimated or subjective data relationships because a theoretically complete analysis is not possible. The cross impact model used here provides an explicit relationships between symmetric impact elements further reducing the number of estimates needed.

For a complete description of cross-impact analysis and an example of such a model, see Bañuls and Turoff, 2011; Bañuls, Turoff, and Hiltz, 2013; Bañuls, Turoff, and Silva, 2010; Turoff, Bañuls, and Hiltz, 2011; and Turoff and Bañuls, 2011. The events included in this model are divided into "source" or initial conditions, dynamic factors that interact during the emergency and outcome factors that measure the results at the end of the time period. The Delphi Method Book (Linstone and Turoff, 1975) has a chapter on the topic and along with references to early work in method including three different articles proposing different approaches to the analysis of the result.

In a recent paper (Turoff, Gonzalez, Hiltz, and Van de Walle, 2012), we took material on emergent organizations from Dynes and Quarantelli (1976), and merged it with a recent paper on modeling threat rigidity (Plotnick and Turoff, 2010). The result was a qualitative influence model that could be used to either create either a dynamic model of the process by System Dynamics or Cross Impact Analysis. This model is summarized in Figure 1 which is taken from the recent 2012 paper (page 218).

The influence flow diagram starts from a flow of External Observations and Internal Information Production and ultimately produces lower or higher internal "Human stress" as a fundamental factor that ultimately produces some degree of "Organizational stress." This factor as it increases produces the pressure for an organization to convert itself in a disaster to emergent organization to be better able to cope with an ongoing disaster. The external inputs and the degree to which there exists a feedback to make a realistic assessment of external events is what produces situation awareness. This far better performance than using rules derived from a fix plan of action. This is a critical factor to provide successful decision making and to minimize mistakes in the critical allocation of resources (Turoff et al 2004).

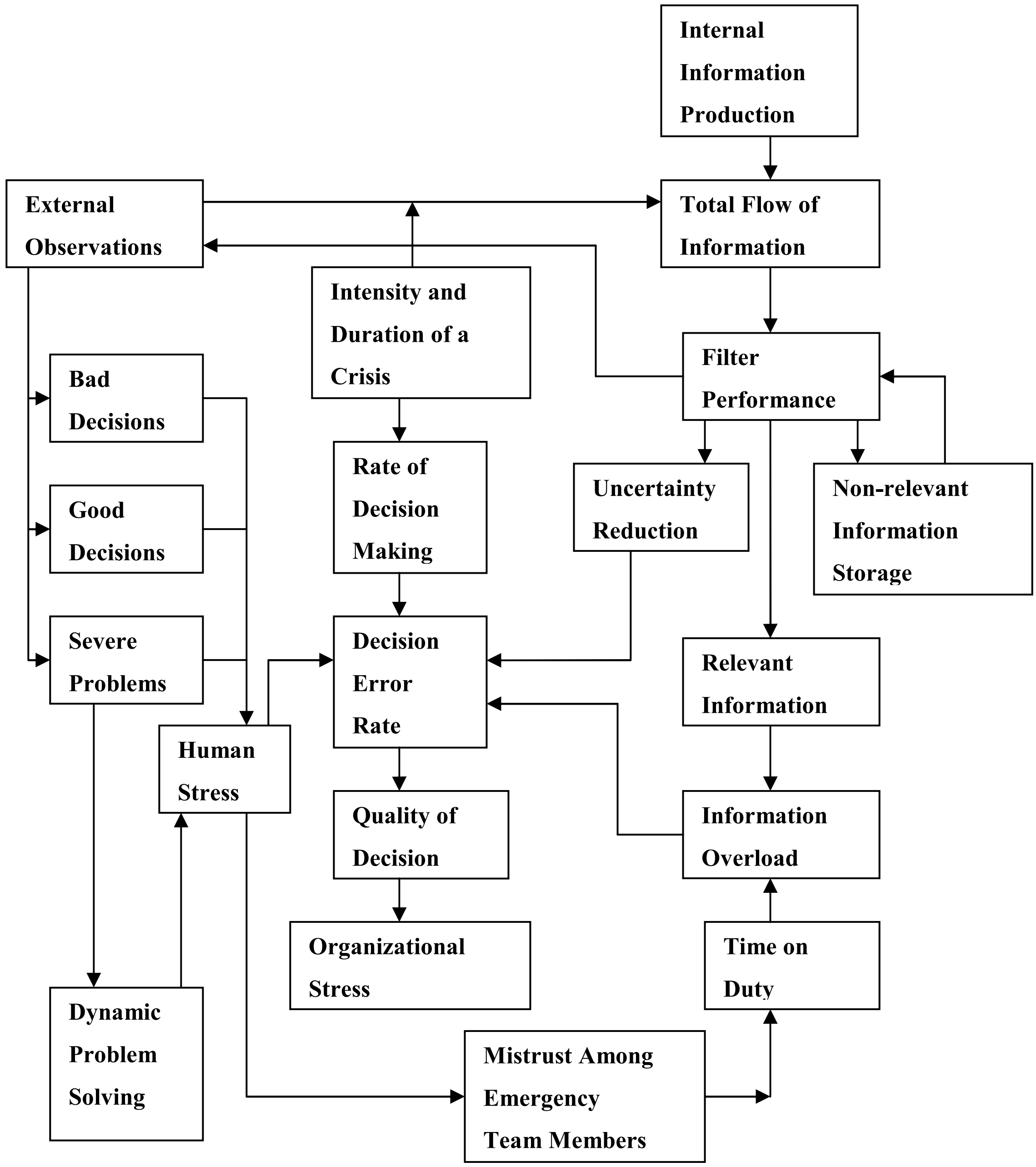

Figure 1: Model for Organizational Transition from Established to Emergent Organization (page 218, Turoff et al 2012)

Describing the path to create the cross impact model is the major contribution of this paper and it follows. We use the model to try and to configure a set of specific initial conditions that have a probability of being true at the start of the disaster. We then specify the dynamic events that have a probability of occurring during the time interval from the beginning of the disaster until the start of the recovery phase. Finally, we specify the outcome conditions that indicate the various degrees of success. The statements we create for initial conditions, dynamic events, and outcome conditions are meant to reflect various aspects of the model in figure 1. They are expressed in a manner that represents the qualitative statement that a typical emergency manager could perceive and are usually very specific in nature as opposed to the more abstract concept of the model. However, we would hope that the model created by their subjective estimates of the probabilities will in fact support the model we have expressed in the figure.

This is a current first draft of these key items and there may well be modifications before we create a model by getting estimates from practitioners. We would welcome suggestions from any interested parties. Once we have obtained a set of estimates we can build a model that allows anyone to change the initial Source events or Dynamic Events from their initial values of .5 probabilities and see what impact that has on the other dynamic events and the Outcome events. For planning one can see what impact changes in resources or conditions would have on the results either for training or for actual process and policy changes in the plans.

At the start of the model, these assumptions have a probability of being true or false. In the process of model design, they are all initially considered to have a .5 probability value (i.e. "maybe" true). The estimator is told to estimate what he thinks the prior value is for each assumption or event in set. If he estimates it is higher than .5 she/he is asked to assume the event or assumption did not occur (P=0) or if the estimate is below .5 he or she is told to assume the event or assumption did occur. The estimator then gives the value of probability for all the other events based upon the condition provided. This forces the estimator to think about relationships between these items opposite to what their current biases are. This has the impact on the resulting model of producing the widest possible range of influence for all the events or assumptions within the resulting numerical model. The following are those events and assumptions which reflect the model in Figure 1 for what influences an established organization to convert during a disaster to an emergent organization. What is in the parenthesis for each one indicates the direct relationship to the flow of influence reflected in Figure 1. If the resulting estimated cross impact model does not reflect this than it means the estimators do not mentally agree with the model and this can be exposed by the Interpretive Structural Modeling (ISM) analysis that is our current approach to this form of developing planning models in Emergency Management (Bañuls, Turoff, and Hiltz,. 2013).

Source Events or Assumptions

S1: Decision Plans:

The organizations have detailed plans defining all the reactions the organization can take based upon detailed analysis of the forecasted emergency/threat situations. (This is the predefinition of all response problems and predicted solutions or response by rules. There is no need and/or ability to get detailed feedback during the response.)

S2: Process Plans:

The Plans define the roles and processes for sensing the situation as it occurs and developing collaborative responses as needed. (The response system is oriented toward getting real time feedback on the situation at any point in the response as part of an integrated information system with good filtering.)

S3: Foresight of Threats

The emergency taking place fits the description and scale in the existing emergency plans and prior preparedness and mitigation activities by the organizations. (This means prior recognition of the possible severity of the disaster that could actually occur rather than preparing for something less severe.)

S4: Sensing Current Reality

There is an established information and communication system for gathering and tracking the effectiveness of responses to requests for services, materials, and/or personnel to handle both expected and unexpected situations. (This assumes that investment has been made to make sure observers, sensors, and communications are in place to gain accurate impressions of the resulting conditions during the response phase.)

S5: Continuous integration of EM professionals.

There is free and on-going lateral communications about plans, responses, and real or potential problems concerning emergencies by managers and professionals in different organizations or organizational units. (Assumes all the organizations are tied into the existing system and that there is open and unrestricted communications among all the professionals that should be concerned with any given problem.)

S6: Continuous integration of the public.

There is the ability to integrate quickly individuals, social media, and other organizations into the Emergency Management Systems. (Any person, group, or professionals needed at any time can be quickly integrated into the response operation and the command and control system.)

S7: Ignoring Errors

The organizations involved have a history of hiding errors they have made in the past and not encouraging workers to expose them for correction. (As contrasted to a practice in which errors in prior disasters are uncovered and noted in the prior post mortems and are conveyed to those updating and improving plans, on a regular basis.)

S8: Maximizing profit

Mitigation and Risk Avoidance have been sacrificed as part of maximizing organizational profits or reducing costs such as maintenance. (Gradual policies over time reducing maintenance, standby resources, and putting off necessary replacements.)

Dynamic Events

These are the events that take on a probability value during the period of time for the response based upon the impacts of the values for the source conditions and the influence each of the dynamic events have on one another.

D1: Increased unexpected requests

Unexpected requests for people, material, and services far exceed the current capacity of the organization. (The responders are unable to handle the unpredicted number and types of the requests caused by the disasters.)

D2: Delegation of Authority

Upper management passes the authority for determining the response to unexpected requests to the line management and professionals. (In emergent organizations, upper management passes authority to those closest to the disaster to handle unexpected situations.)

D3: Middle level role changes

Middle management and professionals are drafted into taking online management responsibilities. (Attempts to take up the overload by providing more "trained" individuals.)

D4: Upper level role changes

Upper management takes on the role of finding additional resources for response functions. (Upper management, in emergent organizations, shifts its focus to obtaining more resources for carrying out the disaster response.)

D5: Degrading Quality of response

More than a third of the emergency requests receive inadequate responses. (The overload of requests and the use of the original organizational processing of unexpected requests receiving middle management review and upper management approval add delays that interfere with the effectiveness of the response).

D6: Growing threat rigidity

Individual stress via the threat rigidity syndrome affects a significant number of managers and professionals involved in the response process. (Threat Rigidity for an individual is losing faith in trying reach a best solution to a problem and choosing (consciously or unconsciously) to go back to standard rules or routines which may not fit well with the real situation. An increase in making bad decisions causes feelings of loosing control and makes people retreat to using rules rather than problem solving approaches.)

D7: Collaborative Problem Solving

Problem solving collaborative groups are able to form to handle new problems when required, by networking those most concerned and knowledgeable. (Adequate computer and communications support allows individuals concerned with a particular problem to work together to solve it no matter where they are and what organizations they belong to.)

D8: Information overload problem

Information overload is a growing problem. (Inadequate resources to meaningfully filter and categorize all the information flowing among the organizations, so for individuals a lot of useless information makes it difficult to pick out what they need to utilize for good decision making.)

D9: Increasing Decision Making Load and Delay

Delays between requests and responses grow significantly with time. (Increasing failure of the decision response process to keep up with making timely responses.)

D10: Becoming Emergent

Significant pressures exist to make the organization more emergent. (A less than .5 probability means there is pressure to stay or become more "Established" or centralized. This leads to increasing organizational stress and the necessity for top management to make dramatic changes in organizations and relationships with other involved organizations.)

Outcome Events or Impacts

These conditions have some probability of being true or false at the end of the response period. They are influenced by both the source events and the dynamic events. They do not influence the source of the dynamic events.

O1: Excessive Damages

Damages greatly exceed original expectations. (A measure of the degree of failure of the response to be as effective as it should have been or what it was expected to be before the disaster occurred.)

O2: Minimum Recovery Efforts

Recovery activities are limited to replacing what existed before as opposed to improving the prior conditions. (There is no plan to do more than just replace what was harmed. No investment in mitigation activities or improved planning.)

O3: Major Mitigation Efforts

Major efforts at future mitigation will be an integral part of the recovery. (This disaster is considered a new larger threat level that should be the standard for plans and response needs.)

O4: Emergent Organizations for Recovery

Emergent organizations continue into the recovery period. (It is likely that many emergency management organizations will retain their emergency structure and their collaborative activities across organizations to guide the recovery phase.)

The respondents for estimating the subjective probabilities would be given a set of definitions of terms like "emergent organizations." They would also be given criteria about the nature of the disaster they should be considering. It should be a disaster that is a typical threat that they have to plan for. However, it should exceed in intensity any prior occurrence of that type of disaster, in their area, in the last 50 years.

CREATING THE DYNAMIC MODEL

The collaborative estimation process is explained below. The results of this process will provide linear measures of the degree of impact between any two events that allows one to observe which events have the greatest impact on a given event. The theory explanation is best understood by reading Turoff (1972) and Bañuls and Turoff (2011). Further justification of some of the suggest process below appears in Bañuls, Turoff, and Hiltz (2013).

There are 8 sources events that can influence the 10 dynamic events and the 4 outcome events which is 8*(14-1)/2 estimates that have to be supplied. There are also 10 dynamic events that influence one another and the outcome events 10*(14-1)/2. The result is 117 possible estimates to be made minus however many estimators feel that two items have no influence on one another. We plan to implement an online process to collect this data. The process will follow these steps:

1. An estimator will first look at all the items that are set with an initial .5 value and make an estimate for what he or she thinks is the most likely initial value for the parameter in a local area he or she specifies.
2. The estimator may choose the events he or she feels confident to estimate. The estimator may choose any or all events (e.g. a minimum of 5 items or all 18 of the source and dynamic events).
3. If he or she thinks the probability is higher than .5 for an event, he or she is asked to assume that event will not occur. If it is .5 or less, the estimator will be asked to assume the event does occur. We want to force the estimator to be stimulated mentally by having to estimate the impact of the change that would most cause him or her to think differently about the situation.
4. The estimator will then indicate what the new probabilities are for dynamic and outcome events given that a single event is assumed to occur (or be true) or to not occur (or be false).

This process is discussed in more detail in a related paper that describes the results of using three estimators to develop collaboratively a dirty bomb scenario (Bañuls, Turoff, and Hiltz, 2013). A summary of some of the considerations in that process follows:

- One would like to have enough estimators to get at least three entries for any interaction cell where there is felt to be an impact of one event upon another.
- One needs to check that all the estimates in a given cell are in the same direction (i.e. the new probabilities are either all above .5 or they are all below .5). If not, the estimators for that cell should try to explain their rationales so they can compare the reasons for the different direction of the impact. Also, it would be desirable to increase the number of estimators to at least five for that cell.

At this point, it is important to remark that Cross Impact Analysis is not focused on the forecast itself. The outcome of the cross-impact analysis is the result of the interaction among participants. This collaborative feature of Cross Impact Analysis is an added value compared to traditional emergency planning processes. The use of Cross Impact in this sense is an instrument of business intelligence that enhances understanding of possible risks and threats and their impacts. To reach this aim, the Emergency Planning process should involve key actors and sources of knowledge, in order to develop strategic visions and anticipatory intelligence.

CONCLUSION AND OBSERVATIONS

Setting up a Delphi process to allow a collaborative group to build a model is one of the open challenges for collaborative group processes (Linstone and Turoff, 2011). Creating challenging scenarios for testing plans and for training is one of the big gaps in Emergency Management. This type of approach would allow the development of evolving databases of threat models. This can be used as database of source, dynamic and outcome events, and estimated linear interaction factors to develop rapidly a wide range of models. It would be desirable to have such a system for any regional areas subject to similar threats without regard for man made boundaries. The requirements specified are generic and intended to be applicable to all organizations or parts thereof, regardless of type, size, and nature of the organization. The extent of application of these requirements depends on the organization's operating environment and complexity. Clearly, this would require organizations involved to decide to open the doors to true collaboration in the emergency management field. It also follows that it would be desirable to open to the public these models and the plans they would help formulate so they can evaluate the plans and resulting decisions for expenditures on resource and mitigation options that can be included in the basic models.

In the early days of simulation and modeling a very common comment applied to many such creations was: "garbage in, garbage out," which meant that what was buried in the code made it very difficult to determine what caused the results to occur. Since the structure of the model was hidden in the programming code the only thing that could be evaluated was the input values. System Dynamics was a revolution in that one needed a detailed description of the feedback loops among the variables used in the process which could only be determined by a detailed analysis, quantitative or qualitative, by professionals who understood the complex process being modeled or had found such a description from which to build their model.

Forrester actually developed an approach to teach grammar school children about Systems Dynamics modeling. He taught the process to many school teachers who did adapt it for early science classes. One could list in a matrix different variables such as the population of important plants, animals, birds, and insects in a garden for both the X and Y axis of the matrix and children would attempt from the discussion to fill in a + or – to indicate whether one variable species had a positive or negative influence on the others. This was quite independent of the development of Cross Impact which uses estimates of probability of negative or positive interaction between events.

The start of a cross impact model is the development of the events that must interact with one another. The analysis creates an influence matrix which could have been used to actually design a set of feed back loops from the influence matrix but it would usually be far more complex than the System Dynamics version. However, the introduction in our approach of Interpretative Structural Modeling (ISM) collapses the strong loops into macro events and produces a directed graph of influences between and among the events. This makes it much easier for a planner or for a responder to learn about many of the indirect influences that might be involved. The results can serve the planning function, the response functions, and/or the recovery function of Emergency Management. In fact, the outcome events of one model can be the input to another model as the source events. This allows modeling of the complete disaster process as Turner (1976) would define it. Turners approach considered the period before the disaster as one of the most critical to the success of the response and referred to it as the "incubation" period. The decisions made in this period impacted greatly on whether the response turned out to be good or bad. Both of the 1976 papers (Dynes and Quarantelli, Turner) represent rather significant early work in Emergency Management that have been too much ignored by the current generation Emergency Management literature. There will be a special issue shortly in Technological Forecasting and Social Change devoted to Planning and Foresight in Emergency Management with some very significant case studies using the Turner framework.

This research moves towards a new paradigm in disaster planning based on building organizational resilience capability. This new paradigm is based on the idea that is not a unique solution for improving resilience and responding disasters in complex societal systems such as organizations. This is due to the dynamic nature both of the environment and organizations. Walker (2004) claims that strategies for enhancing the resilience potential of socio-economical systems will be context dependent. They will themselves have to change over time. This is because of the inevitable changes inherent in complex systems. In this context, organizations need to develop capabilities, (such as flexibility, foresight, participation and communication) to deal with unexpected events and threats coming from the environment.

The current world economic crisis demonstrates the strategic relevance for organizations of adapting quickly to changing competitive conditions. During this crisis thousands of organizations - both private and public - did not expect the changes in the financial market and were not able to adapt to this new economic context, mostly because of the rigidity of their infrastructures. Another key issue to deal with this complex context is to not just focus on just the most likely scenarios. There are often new or unexpected events that occur in any major disaster and cause considerable problems because of their cascading effects (i.e. Fukushima or BP cases). In this paradigm resilience is not a technical but a strategic issue in organizations and should be addressed as part of their global strategy. One of the crucial aspects to fruitfully reach this aim is the understanding of the interactions among different variables, events, risks, and factors that can occur during a disaster. Cross Impact modeling is specially designed to deal with this level of complexity and might be used to support the next generation of business continuity management and planning processes. Moreover it might allow collaboration and interaction in participative disaster planning processes, empowering the (1) coordination of groups with different goals (2) reutilization and (3) knowledge-sharing over a long period of time.

ACKNOWLEDGEMENTS

The work of Víctor Bañuls has been partially funded by the Spanish Ministry of Science and Innovation by means of research grant TIN2010-19859-C03 {02}. Initial work on this model was partially supported by a travel grant from the University of Agder. Jose J. Gonzalez and Bartel Van de Walle contributed to the initial effort (Turoff, Gonzalez, Hiltz, and Van de Walle 2012).

REFERENCES

1. Bañuls, V. and Turoff, M. (2011) Scenario construction via Delphi and Cross-impact analysis, *Technological Forecasting and Social Change*, 2011.03.014.
2. Bañuls, V., Turoff, M. and Hiltz, S. R. (2013) Collaborative Scenario Modeling in Emergency Management through Cross Impact, *Technological Forecasting and Social Change* (Accepted for publication, expected early 2013).
3. Bañuls, V., Turoff, M. and Silva, J.L. (2010) Clustering Scenarios via Cross Impact Analysis, *Proceedings of ISCRAM 2010*, Seattle (EE.UU).
4. Bavelas, A. (1950) Communication patterns in task-oriented groups, *J. Acoustical Soc. America*, 22, 725-730.
5. BS 25999-1:2006 Business Continuity Management Part 1: Code of practice
6. Carmeli, A. and Markman, G.D. (2011) Capture, governance, and resilience: strategy implications from the history of Rome, *Strategic Management Journal*, 32, 3, 322-341.
7. Cerulloa, V. and Cerulloa, M.J. (2004). Business Continuity Planning: A Comprehensive Approach, *Information Systems Management*, 21(3) 70-78.
8. Dalkey, N. C. An Elementary Cross-Impact Model, Technological Forecasting and Social Change, 3, (1972), reprinted in the Delphi Method Book (Linstone and Turoff), 1975
9. Dynes, R. R. and Quarantelli, E. L. (1976) Organizational Communications and Decision Making in Crises, Report series 17, Disaster Research Center, University of Delaware, Newark, DE, USA. available online at http://dspace.udel.edu:8080/dspace/bitstream/handle/19716/1264/RS17.pdf?sequence=1
10. General Accounting Office (2012) Disaster Recovery: Selected Themes for Effective Long Term Recovery, Available online at www.gao.gov, Accessed June 27 2012.
11. Gordon, Theodore Jay, Cross Impact Method, United Nations University Millennium Project, 1994.
12. Hiltz, S. R. and Turoff, M. (1985) Structuring Computer Mediated Communication Systems to Avoid Information Overload, *Communications of the ACM*, 28, 680-689.
13. ISO 22301:2012 Societal security - Business continuity management systems - Requirements
14. Lengnick-Hall, C. A., Beck, T. E., Lengnick-Hall, M. L. (2011) Developing a capacity for organizational resilience through strategic human resource management, *Human Resource Management Review* 21, 243-255.
15. Linstone, H. and Turoff, M. (2011) Delphi: A brief look backward and forward, *Technological Forecasting and Social Change*, 2010.09.011 (http://is.njit.edu/turoff 11/28/12)
16. M.A. Bell. (2002), The Five Principles of Organizational Resilience, *Gartner Report*. http://www.gartner.com/id=351410 Last accessed
17. Plotnick, L. and Turoff, M. (2010) Mitigating Maladaptive Threat Rigidity Responses in Crisis, in: Walle,

B. V. D., Turoff, M. and Hiltz, S. R. (eds.) Information Systems for Emergency Management, M.E. Sharpe, Armonk, NY, USA, 203-220.

18. Quarantelli, E. L. (1988) Disaster crisis management: A summary of research findings, *Journal of Management Studies*, 25, 373-385.
19. Rice, J.B., and Sheffi, Y. (2005). *MIT Sloan management review*, 47(1) 41-48.
20. Turner, B.A. (1976), The organizational and inter-organizational development of disasters, *Administrative Science Quarterly* 21, 378-397.
21. Turoff, M. (1972) An Alternative Approach to Cross Impact Analysis, *Technol. Forecast, Soc. Change*, 3, 309-339.
22. Turoff, M. and Bañuls, V. A., (2011)Major Extension to Cross-Impact Analysis, *Proceedings of ISCRAM 2011*, Lisbon, Portugal.
23. Turoff, M. and Hiltz, S. R. (2009) The Future of Professional Communities of Practice, In Weinhardt, C., Luckner, S. and Stößer, J. (eds.), WeB 2008, LNBIP Vol. 22: Springer-Verlag, Berlin, Heidelberg.
24. Turoff, M., Bañuls, V., Hiltz, S.R. and Pemartin, A. (2011) A Dirty Bomb Scenario, *Proceedings of ISCRAM 2011* (Poster Sessions), Lisbon, Portugal.
25. Turoff, M., Chumer, M., Van de Walle, B. and Yao, X. (2004) The Design of a Dynamic Emergency Response Management Information System (DERMIS), *Journal of Information Technology Theory and Application (JITTA)*, 5, 1-36.
26. Turoff, M., Gonzalez, J.J., Hiltz, S.R. and Van de Walle, B. (2012) Modeling organizational behavior in emergencies, in: T. Fallmyr, (Ed.) NOKOBIT, Akademika Forlag, Trondheim, Norway, 2012, 213-223, http://www.tapironline.no/last-ned/1033 11/23/12.
27. Walker, B., Holling, C. S., Carpenter, S. R. and Kinzig, A. (2004). Resilience, adaptability and transformability in social–ecological systems. *Ecology and Society* 9(2): 5.
28. Weick, K.E. and Sutcliffe, K.M. (2001) Managing the Unexpected, John Wiley and Sons, Inc., San Francisco, CA, USA