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ORIGINAL PAPER

Problem Conceptualisation Using Idea Networks

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Abstract The social act of conceptualising a situation as problematic is thought to determine what will later be seen as a satisfactory solution. Pierce argues that conceptualising something (or an event) is a process of thinking about it through a set of conceptual frames. This paper presents a method for emerging those conceptual frames from preliminary discussions with participants. It draws on the work of Christopher Alexander and the Small Worlds phenomenon. Alexander suggests that participants' statements can be thought of as being networked. The Small Worlds phenomenon then suggests that this network will not be uniform but rather be made up of a number of clusters (small worlds). These can be used to identify the conceptual frames in the participants' statements. Therefore, the argument of this paper is that this method can be used to conceptualise problems. Having an explicit method is thought preferable to calling for unspecified creativity. The creativity comes from the method taking Dewey's advice to switch between analysis and synthesis. The paper's argument will be supported by explaining how the method can be practiced, while explaining why (theorising) the steps advised might be creative.

Keywords Problem conceptualisation · Analysis and synthesis · Christopher alexander · Ideas · Network · Small worlds phenomenon

Problem statement

One important message to come out of Rittel and Webber's (1973) description of wicked problems (later called 'messy' by Ackoff) is that how a problem is conceptualised will affect what is later seen to be a satisfactory solution. Problem solving starts from someone feeling concerned about some situation. Typically, this concerned person will start talking to others about the situation and thereby start to collect, formally or not, a myriad of disjointed statements. For example, someone may be concerned about the lack of plans in place to deal with the annual threat of wildfires to their town community. They might ask the council what

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they think, and receive a wide range of statements back. One of which may be, “Do not worry, we have not had a wildfire go through near here in my lifetime,” another statement might be, “When it gets chaotic around here, you cannot rely on the State emergency services because they lack enough local knowledge.”

Each statement collected, be it from a document or personal comment, presents in isolation, not clearly connected to any other. On first impressions, these statements do not form any sort of coherent whole, rather they are like the pieces of a jigsaw puzzle. So, the first task faced in problem conceptualisation is to make sense (Weick 1995) of them as a whole, to find some patterns in them, to identify what they have in common. To do this, to conceptualise the problem, requires the use of one or more conceptual frames, even if they are not explicitly recognised. This paper is suggesting that these frames need to be emerged explicitly from initial discussions about the problem. Further, they should be agreed upon by the stakeholders else there is a risk of the solution being rejected. That said, the conceptualisation also needs to be creative, to surprise and challenge stakeholders. An uncreative conceptualisation is expected to lead to an uncreative solution.

Whether assuming social issues are real or socially constructed, no method for creative thinking should take us beyond rationality (Dennett 1989). An attempt has to be made to explain how to conceptualise problems creatively from the jumble of starting statements. Bailin (2003) argues that those who claim to be rational are accepting that there is a method that can at least assist in thinking creatively. She recommends a semi-structured method, rather than a strict algorithmic process, to create ideas and surface the planners’ unconscious self. The pragmatic systems thinking literature (Ackoff 1994) suggests a further important element of this rational creativity. It is to include a process of switching between analysis (picking apart) and synthesis (analogy). This can serve to generate ideas aligned to the conceptual frame of those involved even if they are initially unaware of that frame. Dewey sees ‘analysis’ as reductionism (zoom in); looking inwardly at the problem not outwardly, dividing the problem into elements (variables) and studying these separately. This is the preferred approach of scientific thinking. By synthesise, he appears to mean standing outside the problem, seeing the problem as an example or subset of some wider problem (zoom out). Put anther way, what else has the same characteristics as your problem? Think of analogies to your problem. Dewey uses the historical example of water-pumps which would only pump water to a particular height. Analysis means looking at the parts of the water pump, the water and the vacuum involved in detail, perhaps even at a chemical level. Synthesis means asking what a tube full of unsupported water is analogous to. Dewey argues that synthesis led to understanding there must be some force pushing down on the water to force it up so high. This image was then used to design a series of detailed logical laboratory experiments (picking apart) which in turn led to the creative jump of appreciating the presence of atmospheric pressure. The synthesis aims to bring different perspectives to bear, and therefore generate a different set of questions about the problem. Put another way, creativity is thought to be generated by encouraging the problem solver to ‘zoom’ in and out on a problem, to change perspectives. Both analysis and synthesis are thought required for creative thinking. The method for problem conceptualisation suggested here intentionally uses this approach through the work of Alexander in conjunction with the Small Worlds phenomenon.

The paper will first briefly discuss the Small Worlds’ phenomenon and then Alexander’s work in *Notes on a Synthesis of Form* (1964). It will then demonstrate how the clusters predicted to emerge from drafting ideas as networks can be used to identify conceptual frames useful for conceptualising the problem. Therefore, the argument of this paper is that Alexander’s suggestions and the Small Worlds phenomenon can be used to conceptualise problems.

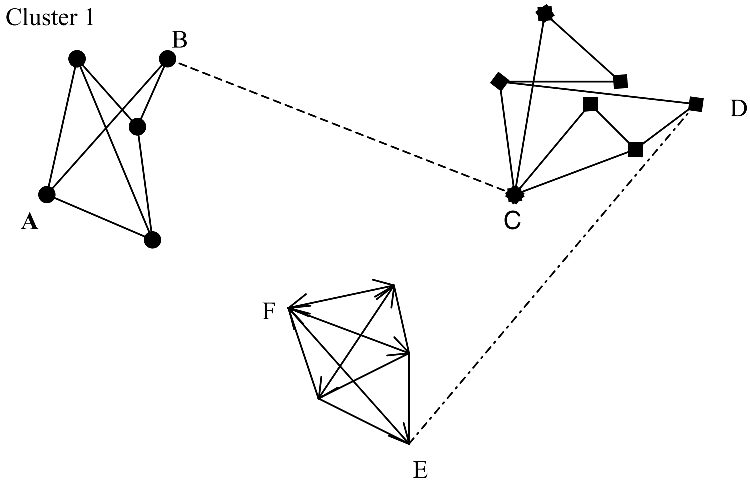


Fig. 1 Clustered network showing 'small-worlds'

Small-worlds

Simply put, the Small Worlds phenomenon is that social, indeed biological, networks adopt a particular pattern. They usually turn out to not be totally random, but rather turn out to display as a collection of small clusters (worlds). See Fig. 1.

In Fig. 1, solid lines represent knowledge sharing between people who talk to each other frequently and dotted lines are between people who talk infrequently. If one person (node) wants to send a message to someone they do not know in another cluster, it is usually possible for us to find a 'weak tie' between the clusters, someone who knows someone, who can carry a message through these clusters. For example, in Fig. 1, if A wants to send a message to F, whom they do not know, then first they would ask friends in cluster 1. B says they know someone C in cluster 2 who may be able to pass the message on. When C gets the message she asks her friends and D suggests E who does know F. A cluster may be created from any connected activity such as a committee, task force, group of residents, professional body, departments, skills, or it may purposely be multi-disciplined. A node may also be anything that has a relationship with another node. It may be a person, a web page, cities, power-stations or ideas. The clusters identified depend on the problem definer's overall problem. If I was interested in university research then I would see different clusters compared to someone interested in designing a web site.

The Small Worlds phenomenon was exposed by Milgram in his letter experiments (1992), and later popularised in a play and film "Six Degrees Of Separation" (Watts 1999). The phenomenon means that any two people picked at random usually turn out to be connected via a chain of not more than six intermediate acquaintances. This seems counter intuitive given that, for most of us, frequent direct two-way conversation only occurs with less than 20 people; our Small Worlds cluster. However, each node in that cluster is part of a slightly different cluster or has been in the past. These different acquaintances clusters are linked, albeit not as strongly as the links within our everyday cluster. This suggests we have adopted an overall population network which is neither 'everyone knows everyone else,' nor one where local clusters of socially interactive persons (cliques) have no means of contacting other clusters. Rather what seems to naturally occur is a mix of the two; clusters that are weak-tied.

There is now a reasonable amount of empirical evidence supporting the Small Worlds phenomenon from a range of natural situations (Killworth 1979; Watts 1999; Matsuo 2001; Richardson 2001; Buchanan 2002). Much of it extends the social network research (eg. Mizruchi 1994; Scott 1996; Durrington 2000; Cross 2002).

That we should arrange ourselves socially into clusters can also be explained by knowledge sharing theory (Hare 1976). This highlights that we can only have direct two-way knowledge sharing with a limited number of people due to the exponential growth of knowledge sharing channels given an increase in people. With 3 people wishing to communicate with each other freely, there are only three knowledge sharing channels that have to be kept open (A to/from B, A to/from C, and B to/from C). For 4 people there are 6, and for 5 there are 10 channels that have to be serviced. The number of channels grows exponentially. For people that means sharing pleasantries, as well as being able to physically get to and from them (same time, same place). Having to service a lot of channels becomes very time consuming. But channels once opened can be left inactive for considerable time and only used as the occasional need arises.

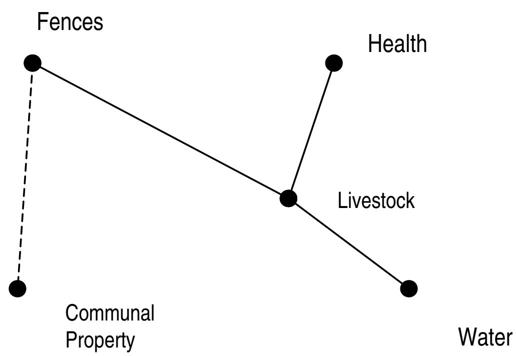
As mentioned, the Small Worlds phenomenon has been found to apply not only to human relationships but also to food chains, ant nests and biological cell structures. This paper uses the assumption that it will also apply to ideas. But first, Alexander's argument that ideas can be thought of as being networked needs to be introduced.

Alexander's synthesis

Alexander (1964), in the context of being interested in designing a new village for people being relocated in a developing nation, suggested that it is useful to think about ideas as being networked. This is a simple concept but powerful in that it allows us to analyse ideas, using what had been learnt in social network theory. For example, the idea of 'we need our livestock to be well protected' may be seen to be connected to the idea of 'we need good quality water,' 'the cows must be fenced from the bulls,' 'our health and the health of our livestock are woven together' and so on. As a network this may be drawn as Fig. 2, an ideas network which shows that the idea of fences may also be connected to the idea of communal property.

The ideas expressed as statements are nodes on the network. If the synthesis sees two idea statement nodes as being connected then a line is drawn between them. Seeing idea statements as being in a network enables many to be connected together in a network ever

Fig. 2 An ideas network



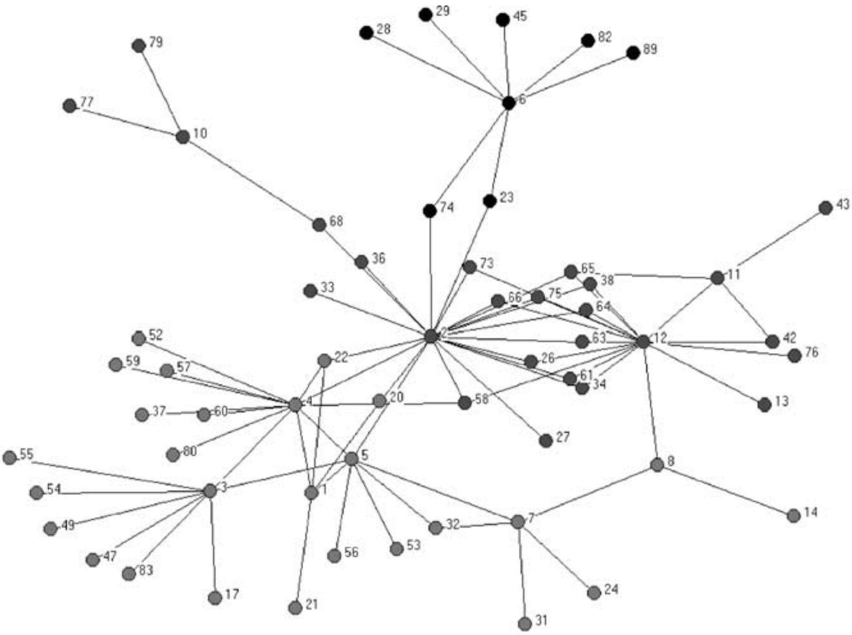


Fig. 3 The network diagram

increasing in size, and then allows analysts to set to work looking at some emerging patterns of characteristics of the network. For an example of a larger network, see Fig. 3 below.

Clearly, the source from which the idea statements are extracted can be anything deemed relevant to a particular problem situation. It may be the transcript of an interview, a community meeting, remembered comment from a conversation or statements in corporate documents. The statements are about anything thought important or interesting, they be factual points, knowledge claims, recommendations, summations or ideas. It is better they be conditional statements[1] because the condition can be used to provide a richer set of links between the statements.

So, the statements can be seen as nodes in a network, with the connections between them represented by the lines between the nodes. The Small Worlds phenomenon predicts that if this is done the resulting network will display a clustered pattern (this will be illustrated next). After this, *how* the clusters are useful for conceptualising problems will be explained.

An illustration

Moving away from Alexander's village example, and returning to the wildfire example used earlier. Assume you have been asked to suggest how a community structure their thinking about the problem of the wildfires that threaten to sweep through their region each summer. They need help in conceptualising the problem to enable them to start thinking in more detail about the myriad of different issues involved.

[1] A statement containing words like if, where, when, while, or because.

Table 1 The interaction matrix

	1	2	3	4	5	6	7	...	20	21	...	30	...	...	74	...	89	90	91
1																			
2					**1**										**1**				
3																			
4																			
5		**1**																	
6																			
...																			
20																			
21																			
...																			
30																			
...																			
74		**1**																	
...																			

Assuming you also decide to use Alexander's suggestions and want to draw a network of stakeholders' idea statements, then the first task would be to collect a large number of conditional statements. One of these may be "The community's ability to self-organise depends on the services offered by the local radio station." If considered a useful idea, then it can be numbered and recorded; e.g. conditional statement No. 29. Through a series of meetings and from the documents of other affected communities, numerous other conditional statements can be identified, recorded and numbered.

Next, these statements need to be linked. This is a synthesis, which will use the implicit conceptual frame of those doing the linking. This suggests a group of stakeholders should debate these connections. This has the added advantage of encouraging them to become involved in the problem conceptualisation. While labour intensive, this connecting debate is also thought important to surface assumptions and to force some intense consideration of the statements. It may also generate further statements. This provides thought about the statements in a rich context with shared understanding.

So the statement: "The town has not experienced a wildfire but the risks seem to be increasing" might be seen to be linked to the statement: "The establishment of new parklands to the north increases fire risk because of increased density of vegetation." While many statements might be thought to be linked remotely, only the strong links need to be recorded. The author's experience is that for this exercise there only needs to be about 10–15% of connections compared to nodes, else the resulting network becomes too cluttered.

Moving back to analysis, the statements as numbered nodes and the connections (links) between these nodes can now be diagrammed in a network. The mechanics of doing this using modern computer software is first to draft an interaction matrix (see Table 1: The Interaction Matrix). This is the required input format for the software to draft the network diagram. The numbered statement nodes make up the top and side headings of the matrix. The connections between the nodes decided upon (eg. that statement 2 is connected to statement 5 and 74) make up the contents of the matrix. See Table 1.

The matrix can be used to calculate the network diagram using one of a number of computer algorithms as reported in the network analysis literature (Scott 1996). Such programs help draft a diagram (graph) of the statements networked, by first calculating for all the connections together and then locating the nodes in the diagram as if the line connections were 'elastic.' Clearly, this would be rather hard to do by hand.

Returning in more detail to the illustration of a community wanting to conceptualise the problem of wildfires, assume that 91 conditional statements have been identified, recorded and numbered. Two examples of these statements (Nos. 2 and 5) are:

(Statement 2) Presentations of new ideas for protecting the town will always include some language games to persuade an audience, who in turn will appreciate that the presenter's choice of language will not be completely neutral.

(Statement 5) Good ideas to protect the community cannot speak for themself; rather they have to be passionately argued for.

I have chosen these two because, to me, the two statements are about persuasion or advocacy. So, I think statement 2 is connected to statement 5. The task is to find other statements thought to be connected to either 2 or 5, again either in terms of advocacy or some other basis. For example:

(74) There needs to be recognition that discontinuous innovations of town management are hard to justify compared to incremental improvements.

The three statements may be recorded as connected because they are all about advocacy. However if the person linking the statements had the issue of 'protection' foremost on their mind, they might say statement 74 is not connected to 2 or 5. Deciding what is connected is intended to be very subjective. This may allow the problem definer's deep underlying assumptions or conceptual frame to make the connections. This is especially so when only a low number of connections are sought. The connections can be drafted into a matrix (spreadsheet) which has the numbers of the statements (1 to 91) as both the left hand labels and along the top.

Table 1, the interaction matrix, therefore shows the statement numbers as column and row headings and the decision that certain statements are connected as 1's in the body of the matrix. For convenience, the Interaction Matrix presented here is a very cut-down version of the overall 91 $\times$ 91. It shows only that statement 2 was considered to be connected to 5 and to 74, but 5 was not thought connected to 74. If only 10–15% of the statements are deemed connected then the matrix is going to be sparse. No connection is recorded as a blank cells (or zero) meaning there is no connection (line) between the row number statement and the column number statement.

This matrix can then be used as input for network analysis software to draft the network diagram. Figure 2 shows the network diagram that resulted from the complete illustration interaction matrix. It was drawn by entering the matrix in to a piece of standard Network Analysis software called UCINET6 written by Analytic Technologies. The software has an advantage over a manual drafting of the network, because it has all the connections before calculating the layout of the network. The number of connections, and which connections, determines where nodes (statements) appear in the network diagram. The software allows for later manipulations of the network diagram, such as 3D rotation, identification of cliques and changes in the appearance. In the network diagram presented below, the numbers are the statement numbers and the lines show which statements were said in the matrix to be connected. For example, from 'top centre' in Diagram1: The Network Diagram below you can see that statements 6 and 22, 6 and 74 and 6 and 89 were recorded as being connected.

As predicted by the Small Worlds phenomenon, the network turns out to have 'clusters'; it is not evenly distributed. My interpretation is that there are three main clusters of statement numbers. One might be called 'top centre' and has statement numbers 28, 29, 45, 82, 89, 6, 74, 23. There is another which might be called 'bottom left' which includes 52, 55, 21, 4 and

5. The third might be called 'centre right' which includes statements 65, 43, 13, 34, and 26. You will remember that these three clusters are made up of argument statements drawn from the literature, so, these three clusters can be thought of as emerging issues. For example, consider the 'top centre' cluster made up of statements 74, 23, 28, 29, 45, 82, 89, 6.

It is hoped that these emergent clusters are not as expected from the connections debated by the stakeholders. The original example used was that 2 and 5 are connected, and that 2 and 74 were connected. In the resulting network, due to many other connections suggested, statement 5 has appeared in the 'bottom left' cluster, statement 2 is rather central to the 'centre right' cluster and statement 74 is in the 'top centre' cluster. Moreover, the 'top centre' cluster is suggesting that 28, 29, 45 etc are connected to 74 through 6 even though this connection was not explicitly entered into the Interaction Matrix.

Naming conceptual frames

Once the clusters have been identified from the network diagram, and it may not need to be too exact a process, they need to be named. This stage moves back again to synthesis. It requires creative thinking about what statements make up the cluster. It can be seen as synthesis because of the need to struggle to understand why the diagramming algorithm resulted in the particular clusters that emerged. Importantly, although the process can be seen as creative, it occurs in an informed way, reducing a complex task to a handful of issues that emerged as clusters. By trying to envision what is suggested by the statements that make up each cluster, you are forced to think synthetically about the cluster. What does it remind you of?

In the wildfire illustration, the statements in the 'top centre' cluster included (in no particular order) the following:

(6) Have I got it right, self-organisation means each of the community sub-groups has to think up its own reaction being aware of what other sub-groups are doing?

(23) Why did it go wrong last time? Because we were all waiting for each other to act. Water needed electricity who were waiting for vets to clear the lines and the vet needed water and electricity to do their stuff. The town management were overwhelmed.

(74) There needs to recognition that discontinuous innovations are hard for the town management to justify, compared to incremental improvements.

(28) The town administration will be a special sub-group responsible for the communications between all the other community sub-groups not the radio stations as a sub-group.

(29) The communities ability to self-organise depends on the services offered by the local radio station.

(45) Self-organisation does allow for the input of suggested changes by the appropriate people after the appropriate processes have been followed, it is a complex process.

(82) The sub-groups say what it will do not what needs to happen by others.

(89) We are the only ones with the skill to repair high tension cables and we are not going to do that unless we have clear contracts with the town management.

Reading this passage over a few times, not paying too much attention to particulars and inevitably drawing on my own past experiences, I start to think about the power struggle between the community sub-groups, or at least the radio stations, and the town administration. This suggests to me that the whole wildfire planning problem situation may need to be thought about, brought into existence and conceptualised, using the conceptual frame of 'power tensions.'

The same sort of synthetic thinking is also needed for the 'bottom left' cluster and the 'centre right' cluster. Let us assume for brevity these are interpreted as being something about 'legal' issues and something about the 'empowerment' of specialists. This suggests that the overall wildfire problem also needs to be conceptualised using the three conceptual frames of power, legalities and empowerment. Doing this will conceptualise the problem in a particular way; one recognisable to the stakeholders involved in this whole process. Sense is being made from the original maze of often conflicting statements. Hopefully, it is a conceptualisation that was unexpected and one that decentres those involved a little, so they are forced to see the problem somewhat anew.

In summary

This paper has attempted to introduce briefly a method for conceptualising problems. Conceptualisation is seen as a process of thinking about a problem situation through particular 'concepts.' The sources of 'concepts' that are appropriate to the specific context of the problem is problematic and important. The intent of this paper was to demonstrate a rational method for emerging appropriate concepts from discussions with stakeholders. These discussions often result in an extensive array of disjointed statements be they the result of interview transcripts, organisational documents or the wider literature. This task of creatively conceptualising problems is thought important because the author agree with Rittel and Webber's description of social problems as wicked. How the problem is conceptualised is thought to have significant impact on what is seen as a satisfactory solution.

The creativity in the method outlines comes from mixing the analysis needed to draft a network from the creative selection of conditional ideas statements and deciding which are connected. The Small Worlds phenomenon predicts that this network will display clusters that would not have been easy to predict without the use of the statements being entered into network graphing software. This creation of an unexpected cluster provides the opportunity to make another creative leap by naming these clusters. These names provide the 'concepts' to be used to then conceptualise the whole problem domain. The method therefore uses a combination of analysis and synthesis to provide a way forward for determining some sort of structure for conceptualising wicked problems.

References

Ackoff R (1994) From mechanisitic to social systemic thinking, *http://ackoffcenter.blogs.com/*. Sighted 6/6/05

Alexander C (1964) Notes on the synthesis of form. Mass., Harvard University Press

Bailin S (2003) Is argument for conservatives? or where so sparkling new ideas come from? Informal Logic 23(1):3–17

Buchanan M (2002) Nexus: Small worlds. W.W. Norton, NY

Carley KM (1997) Extracting team mental models through textual analysis. J Organ Behav 18:533–558

Cross R, Borgatti SP et al (2002) Making invisible work visible: Using social network analysis to support strategic collaboration. Calif Manage Rev 44(2):25–46

Dennett DC (1989) The intentional stance. MIT Press, Cambridge

Dewey J (1910) How we think. Dover, NY

Durrington VA, Repman J et al (2000) Using social network analysis to examine the time of adoption of computer-related services among university faculty. J Res Comp Educ 33(1):16–27

Hare AP (1976) Handbook of small group research. Free Press, New York

Killworth PD, Bernard HR (1979) A pseudomodel of the small world problem. Soc Forces 58(2):477–505

Matsuo Y, Ohsawa Y et al (2001) A document as a small world, www.miv.t.u-tokyo.ac.jp/∼matsuo/homepageeng.html. 2003

Milgram S (ed) (1992) The individual in a social world: Essays and experiments. McGraw-Hill, New York

Mizruchi MS (1994) Social network analysis: Recent achievements and current controversies. Acta Sociol 37:329–343

Richardson KA, Lissack MR (2001) On the status of boundaries both natural and organizational: A complex systems perspective. Emergence 3(4):32–49

Rittel HWJ, Webber MM (1973) Dilemmas in a general theory of planning. Policy Sci 4:155–169

Scott J (1996) Software review: A toolkit for social network analysis. Acta Sociol 39:211–216

Watts DJ (1999) Networds, dynamcs and the small world phenomenon. Am J Sociol 105(2):493–527

Weick KE (1995). Sensemaking in organizations. Sage, Thousand Oaks, CA