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Social Capital, Sensemaking, and Recovery:

JAPANESE COMPANIES AND THE 2011 EARTHQUAKE

George Olcott
Nick Oliver

The earthquake that hit East Japan in March 2011 caused massive damage. While widespread disruption to global supply chains was predicted, production resumed with remarkable speed. This article describes how resources from the networks of damaged companies were rapidly mobilized and deployed, enabling rapid restoration of production. It uses the concepts of social capital and sensemaking to explain the speed of recovery. Social capital facilitated rapid mobilization, and strategies to build shared mental models permitted effective coordination under complex and rapidly evolving conditions. The ability to mobilize and focus resources is crucial to disaster recovery. (Keywords: Supply Chain, Japan, Risk Management, Automobile Industry, Operations Management)

Large-scale disasters, whether natural or man-made, result in world-wide disruptions to globally integrated supply chains. Disruptions have many causes, including industrial unrest, natural disaster, and terrorist action.¹ Japan has faced a disproportionate number of natural disasters due to its susceptibility to seismological events such as the 1995 Kobe and 2007 Chuetsu earthquakes and on March 11, 2011, a huge earthquake and tsunami. Such events bring serious consequences given the key position of Japanese manufacturers in global supply chains.

The March 2011 disaster consisted of three related events. The first was a powerful earthquake, the second the ensuing tsunami, which in turn caused the third event, a major catastrophe at the Daiichi (Fukushima) nuclear power station operated by Tokyo Electric Power. Nearly 20,000 persons were killed or are still

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missing and there was widespread structural damage in the Tohoku area, with an estimated 1.2 million buildings damaged (of which 125,000 were totally destroyed) and with many roads, bridges, and rail tracks rendered unusable.²

The Tohoku region is predominantly agricultural. Although the three prefectures hardest hit (Miyagi, Iwate, and Fukushima) account for only 6 to 7% of Japan's GDP and 2.5% of its industrial production,³ they contain a high concentration

of manufacturing facilities in the electronics, semiconductor, and auto components sectors. Tohoku, for example, is one of Toyota's three key production areas in Japan (along with Chubu and Kyushu) and many important suppliers to the Toyota Group (such as Aisin and Denso) have factories in the region. Some plants—such as the Renesas factory at Naka, which produces microcontrollers and other semiconductor products—account for a high proportion of critical automotive components and damage to these facilities threatened to halt auto production not only in Japan, but around the world.

The impact on automobile production in Japan was immediate and substantial, with production at the Japanese assembly plants of Toyota, Honda, and Nissan dropping to 62.7%, 62.9%, and 52.4% respectively in March 2011 compared to the previous month.⁴ All of Toyota's 18 domestic assembly plants stopped production immediately after the earthquake and it was not until March 28 that two of these restarted. Total industrial production in Japan in March 2011 fell to around 85% of February levels, with only a modest recovery in April. In the month following the disaster, auto assemblers struggled to ascertain the implications of damage to second- and third-tier suppliers, whose activities had previously been virtually invisible to them, concealed behind their first-tier suppliers. By the beginning of April, Toyota estimated that the supply of around 500 different components, from 200 locations, was disrupted.⁵

Major events such as earthquakes reveal the complex and interconnected nature of supply chains and highlight the significance of the *robustness and reliability of supply* as key dimensions of competitiveness. The problem is that manufacturers and their supply chains face many competing pressures. Demands for low cost and high quality encourage lean systems of manufacturing and supply, which mean minimal inventories and deep, long-term relationships between buyers and suppliers. Close relations enable the tight operational integration required by just-in-time (JIT) production and supply and they facilitate collaborative product development and problem solving.⁶ However, lean supply chains can also be "fragile"⁷ due to the high interdependencies that result from a combination of minimal inventories and single sourcing.⁸ Early analyses of lean systems, such as Toyota and its constellation of suppliers in and around Toyota City, recognized the importance of spatial concentration in supporting JIT delivery and intense information exchange between buyers and suppliers.⁹ Increased dispersion of production due to the greater globalization of supply chains¹⁰ represents a reversal of spatial concentration. The application of lean principles in complex global supply chains therefore creates tension

between the efficiencies and cost advantages that accrue under normal operating conditions and vulnerability to major shocks that may only occur infrequently and unpredictably.

We interviewed senior executives from five Japanese companies affected by the 2011 earthquake to establish the capabilities firms need to enable rapid recovery from rare and unpredictable events. In our analysis, we draw on two distinct, but related concepts—social capital and sensemaking.

Social Capital

The concept of social capital has been used to explain cooperative behavior within and between firms,¹¹ as has the idea of “embedded”¹² or “collateralized”¹³ social relations. These concepts lie at the heart of differences between neo-classical economic and sociological perspectives on human behavior. The former typically views impersonal, market-based relations between rational and self-interested economic agents as the basis of optimal efficiency in the allocation of resources. From this perspective, social relations between agents are unwelcome friction in the system.¹⁴ The sociological perspective, in contrast, emphasizes the benefits that accrue when parties enjoy social as well as purely economic relations—benefits which include higher trust, easier exchange of resources, reduced monitoring costs, and more intense exchange of information. These are especially valuable in contexts that require the combination and synthesis of diverse, often tacit, sources of knowledge, such as innovation and new product development.¹⁵ Social capital also facilitates the exchange of products and services whose precise nature is difficult to define and/or price. Of particular relevance to understanding disaster recovery is the role that social capital can play in cooperative behavior between firms, especially the very rapid, large-scale mobilization of resources necessary to rebuild a shattered system.

Comprehensive reviews of relations in inter-firm networks already exist.¹⁶ Here, we focus specifically on social capital, which we define as “the reservoir of goodwill within a community of individuals or firms that is characterized by a sense of obligation to assist other members of the community who are in difficulty; by trust that those giving or receiving assistance will not unreasonably exploit the situation to their advantage; and by a high degree of shared knowledge and understanding, accumulated over repeated interactions.” The term “generalized reciprocity”¹⁷ usefully captures the open-ended, non-specific sense of give-and-take found in situations of high social capital.

While much has been written about the significance of inter-firm relations in Japan,¹⁸ the focus is often on the impact of social capital (often subsumed under the phrase “close relations”) on the effectiveness of routine inter-firm processes and activities—for example, JIT deliveries, collaborative product development, and joint cost reduction projects.¹⁹ There is relatively little written on the role of social capital in recovery from disasters, although Nishiguchi and Beaudet’s vivid account of Toyota’s recovery from a fire at a key supplier is a notable exception.²⁰ However, the consequences of the 2011 earthquake were on an infinitely larger scale and demanded an unprecedented degree of co-operation and coordination

among companies—assisted by industry associations and government—in order to secure recovery.

Sensemaking and Situational Awareness

Mobilizing assistance is one thing, deploying it effectively is another. This is a challenge in any situation that requires the deployment of large numbers of people who have little knowledge or experience of the context in which they are working. This was exacerbated in the case of the earthquake because many of the damaged factories were very high-precision, knowledge-intensive operations. To examine the issue of *effective deployment*, the second set of ideas on which we draw are sensemaking, resilience, and high-reliability organizations (HROs). Weick and Sutcliffe provide a comprehensive overview of HROs²¹ and Weick and others have applied the concept of sensemaking to catastrophes, particularly those in which human error has played a part. A recurrent theme is how failures of collective sensemaking cause problems to escalate rapidly, often with disastrous consequences.²² Weick and colleagues emphasize the *avoidance* of failure rather than *recovery* from it (however, the literature on resilience also contains analyses of recovery, such as that of the investment firm Sandler-O’Neill following its decimation in the 9/11 attack).²³

That a breakdown in sensemaking portends catastrophic failure has been illustrated by studies of firefighters, flight crews, and other teams who have been overwhelmed by rapidly escalating problems. Overloaded and confused, team members lose shared mental models of the situation they are confronting.²⁴ Without these shared models, the underlying foundations for comprehension, co-operation, and teamwork are lost, precisely at the time when they are most needed. The collapse of individual mental models has been described as “losing the bubble,”²⁵ but the loss of the “bubble” can be a collective phenomenon as well, characterized by isolation along with unilateral and inappropriate action by team members who lack a shared view of roles, objectives, and context. In his analysis of the Mann Gulch fire, Weick describes how inexperience, unfamiliarity with co-workers, and a lack of trust (an absence of social capital) among a team of firefighters meant that panic-stricken team members ignored orders from the team leader to join him in a safe area created by means of an escape fire and instead simply ran for it, with fatal consequences.²⁶

Sensemaking is closely connected to the concept of “situational awareness.” Whereas sensemaking is the process by which we develop an appropriate mental model of a situation that allows us to process information and make intelligent choices, situational awareness describes the end state of the sensemaking process. High situational awareness represents a detailed understanding of one’s environment and of the consequences of actions. Where sensemaking has collapsed, as it often does in extreme and catastrophic circumstances, situational awareness will be low or non-existent and intelligent, appropriate, and co-ordinated action much less likely.

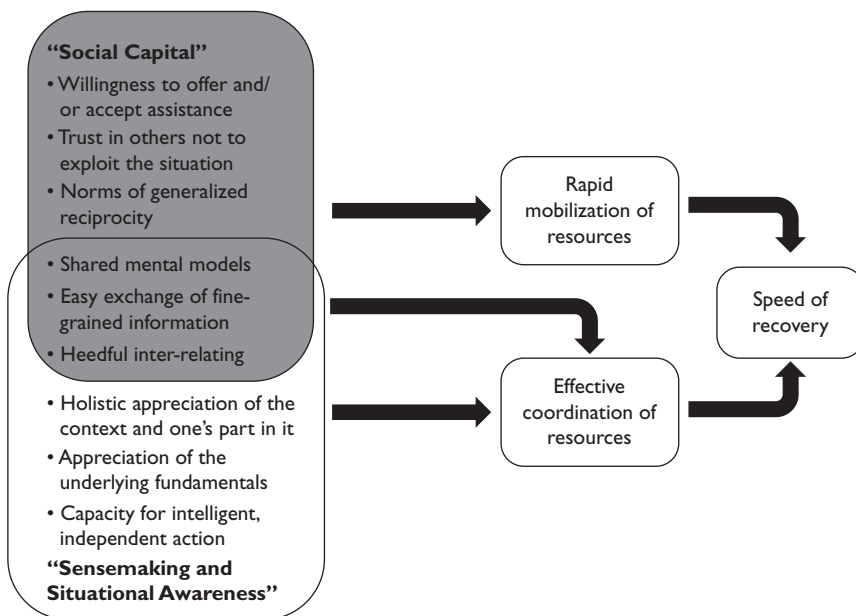
The concepts of sensemaking and situational awareness are useful in understanding the effectiveness of any form of collective action, but especially recovery from disaster, when those concerned are forced to act outside their normal frames

of reference. Weick describes sudden and large-scale disruptive events as “cosmology episodes,” to convey the idea of a stable and rational universe subject to sudden and pervasive disruption, resulting in a temporary inability to make sense of the situation.²⁷ Re-establishment of situational awareness and restoration of a sense of order are therefore logical precursors to recovery from catastrophe.

Social capital and sensemaking overlap most closely around the idea of shared mental models and heedfulness of the needs and roles of those with whom one is interacting. In the case of social capital, shared experience strengthens trust, goodwill, and obligation; for situational awareness, shared experience builds mutual understanding and a common knowledge base that makes coordination and information exchange easier. The pre-existence of (or the ability to rapidly create) shared interpretive schemes facilitates the high levels of co-operative, coordinated action necessary for swift recovery from disaster. As Weick puts it: “When meaning becomes problematic and decreases, this is a signal for people to pay more attention to their formal and informal ties and to reaffirm and/or reconstruct them.”²⁸ Just as the collapse of sensemaking and shared mental models precedes catastrophic failure, so the restoration of shared models is likely to be a precondition for rapid and effective recovery after catastrophe has occurred.

Intense, coordinated problem solving is needed in the aftermath of a disaster, in which large numbers of people, many previously unknown to each other, have to work toward common goals under chaotic conditions. Figure 1 summarizes the relationships between social capital, sensemaking, situational awareness, and the speed of recovery from disaster.

FIGURE 1. Social Capital, Sensemaking and Recovery



The arrows in the diagram represent primary flows of influence. Thus, we conceive of social capital as largely supporting *mobilization* of effort whereas sensemaking is particularly relevant to the effective *coordination* and *direction* of this effort. Social capital and sensemaking do have some commonality, represented by the area of overlap in Figure 1, in that social capital grows out of repeated interactions that, as well as developing trust, help to facilitate shared mental models and information exchange.

Data Collection

Our data collection focused on companies who were severely affected by the earthquake, either because they had key suppliers in the Tohoku area or because their own factories were damaged—or, in some cases, both. Five such companies were selected, and interviews were conducted with senior personnel between May and August 2011. There is a high concentration of automotive and electronics manufacturers in the Tohoku area and so these sectors are reflected in our choice of companies. Our aim was to obtain data while the recovery was still underway to get a picture of the recovery process before any post-hoc interpretation had taken place. A total of 16 individuals were interviewed across the five companies. We devoted particular attention to one company, Renesas, with which three of the other companies had a close relationship as major customers, and two as major shareholders. Renesas is significant because it had a semiconductor factory that suffered considerable damage as a result of the earthquake and was a major supplier to the automotive and electronics industry.

The interviews were semi-structured and used a schedule consisting of 12 broad questions. These served as a basis for general discussion but also permitted the exploration of more specific issues as these arose. The main areas covered in the interviews were:

- How each company had been directly affected by the earthquake (e.g., loss of its own manufacturing capacity) and/or indirectly affected (e.g., by suppliers not being able to supply).
- The business contingency planning (BCP) measures that were in place to deal with such an eventuality and whether these had served their purpose.
- Specific actions taken by each company to restore production and/or to help other companies do so.
- If a company had *received* assistance from others, the nature of that assistance, the process by which that assistance was offered and accepted, and how the assistance was delivered.
- The impact that each company's actions had had on the original timetable for recovery.
- What lessons had been learned from the disaster. For example, were companies considering a departure from lean operating principles in light of what had happened?

The five companies we analyzed were:

- Hitachi Ltd.—a multinational electronics company
- Mitsubishi Electric—a multinational electronics company
- Hitachi Chemical—a manufacturer of chemicals affiliated with Hitachi Ltd.
- Renesas—a manufacturer of semiconductors for automotive and industrial systems
- Denso—a major parts supplier to the automotive industry

All five had operations that were in the region directly affected by the earthquake and tsunami, or experienced disruption because they had suppliers who were in the affected areas. Hitachi Chemical completely abandoned a manufacturing plant due to the risk of radioactive contamination from the stricken Fukushima nuclear plant nearby. Hitachi Ltd., Mitsubishi Electric, and Denso were all significantly disrupted due to damage to Renesas's Naka factory.

The Recovery

By the end of August 2011, industrial production across Japan as a whole had reached 95.6% of pre-earthquake levels, and overall economic activity was at 98.8%.²⁹ The speed of recovery was particularly marked in the automotive sector. Having restarted production at two of their plants on March 28, by mid-April, 17 out of Toyota's 18 domestic assembly plants were operational.³⁰ The Miyagi plant, located in the area most seriously affected by the earthquake, re-opened on May 16.³¹ Nissan's Iwaki engine plant in Fukushima, which suffered considerable damage, reopened on May 17.³² In April 2011, Toyota estimated that normal production levels would not be reached until November 2011, but in May brought that date forward by 2 to 3 months.³³

Multiple resources were mobilized towards the recovery effort. These were provided by suppliers, customers, partners, and in some cases even *competitors* of the five companies. Central to this mobilization was a remarkable willingness for parties to pool resources, even in the absence of contractual protection over crucial matters of intellectual property and commercial advantage. A commitment to meeting obligations to customers and protecting them from the full consequences of the disaster appeared to be an important legitimating force in this process. We use the case of Renesas to show how resources offered by network partners were deployed and coordinated. Intermediate institutions, such as trade associations, also played a significant role in the recovery process.

Rapid Mobilization: Social Capital in Action

A striking feature of how resources were mobilized to support the recovery effort was the sense that it was an urgent national mission. There was recognition of the strategically important role of Japanese suppliers in many international supply chains (a role not fully visible prior to the earthquake), which meant that disruption in Japan would quickly have worldwide consequences.

“One thing the earthquake has reinforced in our thinking is our global supply responsibility. When our production stops, so does the rest of the world’s. It reminded us that we must be in a position to produce without interruption.” [Hitachi Ltd.]

Already under pressure from foreign competition, Japanese firms feared that an erosion of confidence in their ability to supply could lead to a loss of business and do substantial harm to Japan’s position in global manufacturing networks:

“Our biggest concern is that our Chinese customers say ‘Well, if Mitsubishi can’t supply we’ll have to go to Siemens or Rockwell.’ That could happen.” [Mitsubishi Electric]

The lean practices of the auto industry meant that they were severely affected, and interviewees were very aware of the risk that the lack of buffers posed to Japan’s lean supply chains:

“It’s an irony that the mass production manufacturers such as the automotive assemblers and electronics manufacturers are very thorough about JIT. This means that the slightest thing brings their factories to a halt.” [Mitsubishi Electric].

However, there was also awareness that an important reason for rapid recovery was the preservation of Japan’s position in global manufacturing networks, and the retention of manufacturing activity—and employment—in Japan:

“We are a Japanese company. We have around 50,000 employees here that we need to protect. We have to ensure that we preserve the *Monozukuri* [production] capability in Japan.” [Mitsubishi Electric]

Here we see social capital working via a sense of the community of firms. Industry associations played a critical role in energizing and coordinating the recovery process. Almost all interviewees referred to the role of industry associations, but the Japan Automobile Manufacturers Association (JAMA) played a particularly significant role. In the case of Renesas, the intervention of JAMA was of great importance:

“There were some companies from whom we requested assistance promptly, but there were also companies who unilaterally told us that they wanted to help out. [Most] offered assistance before it was requested. In that sense, the drawing power of JAMA was tremendous.” [Renesas]

Like Renesas, Denso stressed the significance of JAMA and its members to the recovery process and particularly emphasized the leadership of Toyota:

“And do you know why [the recovery of Renesas was so swift]? [It was due to] the help of the Automobile Manufacturers Association members, especially under the leadership of Toyota. Toyota has a lot experience from the Hanshin and Tohoku earthquakes. There is a particular Toyota group expression: ‘put the fire out quickly.’ There is no need to ask for authority. So masses of resources are committed. It doesn’t matter whether the company concerned has the resources to fix it or not. They come to do repairs, the electricians, whatever. Things get done quicker, and this means that restoration of production is quicker. This time, the impact was global and partly to avoid international criticism, JAMA under Shiga-san’s leadership [Shiga was the Head of JAMA at the time of the earthquake and COO of Nissan] sent huge resources to the company, including from parts suppliers.” [Denso]

Similarly, Hitachi Chemical referred to the role of the Carbon Association in providing a platform for the provision of alternative manufacturing resources:

“We made requests also to other members of the Carbon Association. Those that were able to make the material made it for us but where we also had to cooperate in production, our engineers went to their plants and used their machines to manufacture our products.” [Hitachi Chemical]

Two of the companies interviewed also referred to the role of the government, via the Ministry of the Economy, Trade and Industry (METI), working behind the scenes with industry associations to ensure that there was maximum inter-firm cooperation to facilitate recovery. (METI’s role in coordinating economic recovery is described on its website.)³⁴

Direct inter-firm cooperation—between customers, suppliers, and competitors—played a key role in the speed of recovery. Soon after the earthquake, the Japanese media were reporting many cases of companies sending employees to the plants of suppliers or customers in the wake of the earthquake. For example, Nissan’s suppliers sent 210 workers to the Iwaki engine plant.³⁵ Komatsu sent workers to help at the factories of their direct suppliers and to third-tier suppliers as well.³⁶ In perhaps the largest-scale mobilization of all, up to 2,500 outsiders were working at Renesas’s Naka semiconductor plant, which produced vital microcontrollers used in automobiles.³⁷

All the companies we interviewed reported a large-scale mobilization of resources to or from third parties. There were various triggers to this mobilization, with no single dominant model. Many companies were offered assistance before they even asked for it; others asked partners and competitors directly. This mobilization took various forms:

“One format is borrowing space and machinery and making it ourselves on their location, and the other is passing on the specs and the manufacturing system to them.” [Hitachi Chemical]

The earthquake was a freak event, demanding an extraordinary response, but it was clear that these responses were built on an underlying foundation of trust, goodwill, and obligation. The closest bonds were between *keiretsu* (or “group” companies), where such unconditional transfer of resources might be expected. As an interviewee at Denso, a member of the Toyota Group, put it:

“If we were seen as just living off the hard work of other firms in the Group, just asking for money and not doing the development, we would soon be cut out. But because we have this relationship, in emergencies, there will always be help at hand.” [Denso]

Given the scale of the disaster, stricken companies might reasonably have expected their clients to shoulder many of the consequences, and were in many cases protected legally by *force majeure* clauses in their contracts. However, the other side of the coin is a sense of obligation to partners that goes well beyond legal contracts:

“This kind of situation justified us declaring *force majeure* but if you do that and simply say we can’t meet our supply obligations, your business isn’t sustainable. Whether the client is Apple, Intel, or IBM, you need to figure out what it is that

they are going to need next and go in there at the R&D stage, that's one of the key success factors for our business. You can't do that by declaring *force majeure*." [Hitachi Chemical]

This community orientation stretched beyond the boundaries of formal industrial groupings. It allowed a re-definition of roles and boundaries in support of the recovery effort, perhaps the most dramatic of which was the preparedness of direct competitors to cooperate in order to restore supply.

Hitachi Chemical, a supplier of key components of rolling stock on Japan's high-speed rail system, described why they enlisted the help of others:

"[The rail network is] a vital element of the transport infrastructure but for this to stop because of a shortage of our part would have been very damaging to the public interest. So even though some important know-how might leak to our competitors, we had to make that tough decision." [Hitachi Chemical]

Hitachi Chemical described how they turned to a rival in order to restore production, despite the risk to proprietary knowledge:

"[We had products] processed by our competitors to the required specifications. It doesn't require the disclosure of such a lot of know-how but they will gain an understanding of certain elements of the processing procedures. But that's too bad." [Hitachi Chemical]

This does not mean that these companies relished handing over their know-how to competitors, rather that their sense of obligation to restore supply was so strong that it over-rode other considerations:

"We have had to disclose technology that was unique to us to competitors in certain cases. It's a bitter pill to swallow." [Hitachi Chemical]

The inter-firm mobilization was striking in terms of its sheer speed, something that would not have been possible had companies insisted on legal guarantees to protect their intellectual property and other commercial interests. Without exception, the exchange of sensitive information proceeded in the absence of a formal contract:

"It's based on a gentlemen's agreement and if manufacturing know-how leaks out in the process, well that's just too bad." [Hitachi Chemical].

"Contractual discussions? No, nothing. I doubt if any of the auto assemblers have either. From [the recipient's] point of view, they probably did not welcome the prospect of thousands of employees from other companies in their plant. But they were in an extremely difficult position. Without external help, they couldn't have recovered with their resources. There was of course no contract . . . it was a form of voluntary action" [Mitsubishi Electric]

"Our first priority is to cooperate with [Company X]. As far as cost is concerned we will negotiate with them from now about reimbursement of costs . . . We are committing a lot of resources, both people and technology but the first priority is to support the company, and worry about the costs later." [Hitachi Ltd.]

"It was agreed that costs incurred would be discussed after the recovery period was complete and we would clearly divide what costs would be borne by Renesas and what would be borne by the supporting company." [Renesas]

Companies were clearly very aware that in seeking and receiving help they were potentially helping competitors and risking leakage of company know-how. It was also accepted that there would need to be negotiations over reimbursement of costs once the recovery was further advanced. However, those involved put these considerations to one side to concentrate on achieving the fastest possible recovery, a priority that they seemed largely to take for granted.

Co-ordination: Sensemaking and Situational Awareness

The rapid mobilization of resources was a crucial first step in the recovery, but only a step. Once mobilized, such resources had to be focused, directed, and coordinated. Organizations that routinely operate under similar conditions, such as emergency services or the military, rely on repeated drills and practice to enable rapid, coordinated action. Achieving this with people working in an unfamiliar environment alongside others with whom they have not worked before represents a considerable challenge of coordination.

To explore this, we focus on Renesas's Naka factory, which suffered substantial damage due to the earthquake. Renesas produces microcontrollers for auto assemblers all over the world. Although an indirect supplier to the assemblers, the company was the sole worldwide supplier for many of its highly customized microprocessors.

Reenas's recovery fell into three main phases. The first involved the restoration of the factory building, which had suffered significant structural damage in the earthquake. In electronics manufacturing, many products must be produced under clean-room conditions, so restoration of the clean rooms was essential. The second stage involved repair and replacement of precision manufacturing equipment—this too had been severely damaged by the earthquake. The final phase involved re-starting and adjusting the production process until it was capable of producing at the required levels of quality. Different specialist skills and teams were required during each phase.

The first outside help arrived 17 days after the earthquake first struck, most of this delay being due to the absence of electric power at the site as a result of damage to the electricity grid. This period was used for planning and preparation ahead of the recovery effort itself. Initial estimates were that it would take six months for mass production to restart. However, as the recovery effort gathered momentum, this estimate was halved and production actually restarted in June 2011.

Offers of assistance were rapid and widespread. Renesas described how these were applied to the recovery effort:

“There were representatives from the various companies, we discussed with them the kind of skills required, and they went out and got them. We also discussed the schedule with them. This was a moving target, and while we might have a target date, we would always consider what resources might be required in order to secure an earlier start up.”

Up to 2,500 external people were on site at any one time. Renesas estimated that a total of approximately 80,000 man-days were contributed to the recovery

effort by external organizations. The total number of companies that helped was “somewhere between 200 and 400.”

Spurred on by the pressures and obligations, speed of recovery was paramount and this over-rode other considerations:

“The most important thing was the earliest possible recovery. The strategy was therefore to mobilize massive resources and work 24 hours a day. We couldn’t succeed without total information sharing.”

With so many organizations involved, the potential for confusion and wasted effort was considerable. Renesas emphasized widespread information sharing, parallel working, and coordination through constant mutual adjustment:

“[One of the biggest challenges was] that a mass of people who knew nothing about the situation would arrive all at once. How to make these people work most efficiently and move in the desired direction was the main point. The secret was the *oubeya* (or “large room”), which is one of the features of Toyota’s *kanban* system. Everyone was agreed on the main priority of getting the factory up and running as soon as possible. Part of that was mass mobilization and 24-hour operations. But the most difficult part was getting agreement on the tactics of how to execute this.”

The organization of the recovery effort was divided into “Upper” and “Lower” Groups. The Upper Group comprised representatives from the companies who sent people to assist with the recovery effort—in particular, companies affiliated with JAMA. It existed from the beginning to the end of the recovery effort, providing a great deal of continuity. It acted as a “control tower” that had a comprehensive overview of the evolving situation, and it also planned and supervised the deployment of resources. The Upper Group also provided an external, as well as an internal, boundary-spanning and coordinating function. A Renesas interviewee explained:

“I was a member of the Upper Group and we were located [in the Naka area]. We met, decided what needed to be done, and gave the orders to the Lower Group. One more important thing was that the representatives from each of the companies that participated also communicated with their companies and gained consensus on the strategy and direction.”

The Lower Group comprised those who were actually working on the ground, for example, repairing the buildings, clean rooms, and production machinery. Its composition changed depending on the phase of the recovery effort and according to the skills required.

“It was [a matter of] ‘for our current phase, we need electrical engineers’ and we discussed our requirements with the various companies, whether it was JAMA companies, Mitsubishi, NEC, Hitachi, or whatever, who then supplied them. We discussed with the representatives the kind of skills required, and they went out and got them.”

A key aspect of the process was frequent synchronization and stabilization similar to those seen in other contexts (such as rapid software development) that involve parallel processing with tight coordination.³⁸ The *oubeya* method supported this:

“Without a clear plan, there is only confusion. The most important point here is the sharing of information. The way to do this is for all the members, particularly the

members of the Upper Group, to be in the same room where all the information is written down, which team is doing what, what point they've got up to, who's in the group, the issues for today, written all over the wall. Discussion takes place on this basis."

The *oubeya* method performed several important functions. It provided a forum in which information from the various specialist teams was pooled and was key to developing and maintaining a shared representation of the situation. This is especially important in situations that are complex, rapidly evolving, and unfamiliar to participants, because there are no set "templates" for coordinated behavior (such as for planning, drills, and training).

The *oubeya* method also sustained a shared picture of progress, thereby allowing the Upper Organization to see where adjustments could be made to speed up progress. This was a key factor in reducing the initial estimate of recovery time from six months to three. Philosophically, this is similar to the visual control found in the Toyota Production System, which facilitates the identification and elimination of waste.³⁹

Another important feature of the recovery process was the early recognition that many of those providing assistance were not familiar with semiconductor manufacturing processes, especially the very high levels of cleanliness required. Renesas explained:

"We had our engineers give lessons on the basics at the beginning. What are particles? Why do we have to use clean rooms? . . . It wasn't a case of 'do that . . . don't do that.' It was explaining to everyone the importance of getting the cleanroom up and running before production could be started. It's because everyone understood clearly the need to get all impurities out of the cleanroom that the process went quickly and smoothly. With this clear understanding even if participants were not experts, they could contribute ideas that made a real difference . . . this is the factor that made the process work so well."

From a sensemaking perspective, this basic instruction in the manufacture of semiconductors represented a means to develop situational awareness, that is, the ability to contextualize and act on information appropriately. Imparting this awareness to the outsiders who flocked to the plant to assist with the recovery was the foundation for intelligent, parallel, co-ordinated action. The *oubeya* method therefore was a mechanism to build, maintain, and adjust each person's part in relation to the whole, encouraging the "heedful interrelating" central to situational awareness. This also demonstrates how the development of situational awareness is a social activity, and how order and purposeful behavior can be created and maintained under great pressure, despite a lack of shared experience among team members.

Lessons and Implications

Five major lessons and implications follow from the story of the recovery.

Mitigation of Supply Chain Vulnerability

The earthquake revealed supply chain vulnerabilities that had been largely hidden under normal conditions. Indeed, this was the single most important issue

that our interviewees felt required urgent attention. These vulnerabilities can be partly addressed by greater visibility of the end-to-end supply chain so that risks can actually be seen. However, once the risks are visible, there are still difficult trade-offs to resolve, such as between the routine cost advantages of concentrated sourcing with limited buffering and the exposure to risk from rare, “black swan” events.⁴⁰ Competitive pressures push companies and their suppliers towards limited buffering and close relations with one or two suppliers. On the other hand, pressures to source globally pull in a completely different direction, as firms seek to exploit the advantages of low-cost locations. Together, these forces create complex global supply chains with vulnerabilities that may be difficult to discern until they are revealed by catastrophes such as the earthquake.

The risks of single sourcing were glaringly revealed by the earthquake. However, in assessing the consequences of the disaster, the companies in our study also recognized that if this risk was addressed through the most obvious means—such as greater buffering or splitting of production across multiple sites—then day-to-day operational costs and performance would be compromised, with the consequent erosion of cost-competiveness and risk of loss of business. Mitsubishi Electric accurately expressed this dilemma:

“The greatest damage on this occasion was that some of our purchasing was done from one source. In the case of microprocessors, because they can be so customized, there is a strong tendency to rely on one supplier. And in the case of Renesas, it wasn’t just one supplier, it was one factory. So the answer is to have these products made in various factories. But if that affects efficiency too much, then as a minimum we have to have a situation where the product can be made quickly at an alternative location. We could ask an alternative supplier to be ready with the software to produce the microprocessor at short notice.” [Mitsubishi Electric]

This statement implies that there is an intermediate position between pure single sourcing and pure multi-sourcing. Such a position is based on single sourcing under normal conditions, but backed up by a readiness to quickly switch sources in the event of a disaster. This will not of course be costless—time and resources must be ploughed into preparations for alternative suppliers to receive designs, and possibly rehearse production, for a situation that may never arise. Where production equipment is expensive and highly specialized, the costs of establishing and maintaining this switching capability may be prohibitive. However, the alternative—to assume that disaster will happen and to multi-source routinely—will incur higher operating costs day in and day out, and hence is not necessarily a better option.

“We may have to alter our design specifications or our production line design so that we have an alternative place to produce if one of our lines goes down . . . rather than having suddenly to produce at B, we have to have a situation where we can produce at either A or B at any time [through] compatible machinery or production design.” [Hitachi Ltd.]

Social Capital and Business Continuity Planning (BCP)

During the recovery, the fact that offers of assistance were spontaneous and made in the absence of prior agreement on price or other conditions reveals another facet of high social capital environments. Some readers may conclude

that the co-operative behavior we have described is a consequence of cultural and institutional patterns found only in Japan and is not replicable in other environments. Admittedly, there are patterns in Japanese inter- and intra-organizational relationships that may make co-operative behavior more likely. However, there are examples of social capital at work in the U.S., such as the rebuilding of the brokerage firm Sandler-O'Neill following the devastation of 9/11, and the role of the Mary Queen of Vietnam Church in New Orleans in assisting its immediate community in the aftermath of Hurricane Katrina.⁴¹

Thus, although the levels of spontaneous co-operation seen in the aftermath of the earthquake may be more likely in relatively communitarian, high social capital societies such as Japan, similar behavior clearly occurs in contexts that are sufficiently severe and threatening to serve as powerful uniting forces or to incite a sense of moral purpose.⁴² The interesting question is whether such co-operative behavior can emerge under less-extreme conditions, and how co-operative tendencies can be created and maintained. The recovery revealed how suppliers, customers, and competitors were able to re-conceptualize themselves as *partners* in the recovery process, working towards the common goals of maintaining supply to customers and protecting Japan's position in global supply chains. This reconceptualization allowed resources that were distributed throughout the system to flow to where they were needed. Given the scale of destruction, it is clear that the resumption of production would have taken many months more without such a massive mobilization of resources. The implication of this for firms in complex supply chains is that the creation and maintenance of social capital with other players could, under the right conditions, form an integral part of their contingency planning processes.

This means re-thinking traditional inter-firm boundaries when planning for disaster recovery by identifying other enterprises, including competitors, who would also suffer if there were a major supply chain disruption. Recovery plans could therefore incorporate mobilization of resources that exist within other supply chain partners, not just those within a single enterprise.

Preparing for Co-operation in a Crisis

It may not be realistic in low social capital environments to expect other firms to commit resources in the way that these Japanese firms did without some form of formal agreement and contractual protection. However, it may be possible to establish in advance an understanding of a few basic principles, such as how costs would be ascribed to various parties. It might even be worthwhile to formalize such agreements into broader "disaster recovery strategic alliances." Companies form strategic alliances for many reasons—market entry, technology development, resource sharing, and so on. Why should alliances not extend to business continuity planning?

The Role of Industry Associations

Mobilization and coordination following the earthquake were achieved not only by goodwill, but also by industry associations who played important brokering and bridging roles. Competitive dynamics naturally create obstacles to inter-firm

cooperation, but industry associations can, as champions of their industry's well-being and with a sector-wide perspective, play an important part in supporting inter-firm cooperative efforts. However, the role and influence of such associations, and the resources that they have at their disposal, differ considerably from country to country.

Rapid Sensemaking and Development of Situational Awareness

In Renesas there were sensemaking strategies at work that enabled shared mental models to develop in a complex and rapidly evolving situation, via the Upper and Lower Groups and the *oubeya* method. Steps were also taken to develop situational awareness of the conditions of semiconductor manufacture, so that incoming labor, despite being unfamiliar with the context of semiconductor manufacture, was able to contribute effectively. When a system is shattered, shared mental models are crucial to effectively coordinating the resources and effort that social capital may unlock—without this there is likely to be little more than well-intentioned confusion. Inter-firm coordination in a crisis will often require a detailed understanding between partners, so the more interaction there is between these partners (including opportunities for recovery “rehearsals”), the more likely it is that shared frames of reference will develop. The *oubeya* method illustrates very clearly how shared mental models, critical to the development of situational awareness, can be generated in a short time to support the recovery process.

Conclusions

By drawing on resources from across their networks, these five Japanese companies were able to bounce back from a major trauma with surprising speed. Is this a pattern that can be replicated elsewhere? Thirty years ago, many commentators were of the opinion that lean manufacturing methods were so rooted in Japan's cultural and institutional context that they could not be replicated elsewhere—a position that few commentators would hold today. Similarly, although the highly co-operative inter-firm behavior seen after the 2011 earthquake may emerge more quickly, easily, and spontaneously in some contexts than in others, there is no reason to suppose that the core principles cannot be applied more widely. These principles are based on: thinking beyond the boundaries of the individual firm in order to identify resources that can help recovery; mobilizing these resources, via social capital if it exists, or by safeguards against opportunism if it does not; and applying strategies to build and maintain a shared, holistic picture of the recovery process.

In recent years, many areas of the world have experienced destruction and disruption of cataclysmic proportions—terrorist attacks, earthquakes, tsunamis, extreme weather, and climate-related events. The severity and unpredictability of these events render many traditional countermeasures ineffective, or too costly to be feasible. Under these circumstances, understanding and developing the capability for rapid recovery is not optional, but essential.

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