Resilience in Collaboration:
Technology as a Resource for New Patterns of Action

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ABSTRACT
In CSCW, there has been little or no attention given to how people use technology to restore collaborations when there is a major environmental disruption. We are especially interested in studying resilience in collaboration–the extent to which people continue to collaborate with work groups or to socialize despite prolonged disruption. We conducted an empirical study of people living in two countries that experienced prolonged disruption through war in their work and personal lives. We describe how technology played a major role in providing people with alternative resources to reconstruct, modify, and develop new routines, or patterns of action, for work and socializing. People created new assemblages of technological and physical resources. We discuss how the use of new resources in creating new routines led to more of a reliance on virtual work and in some cases to deeper structural changes.

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Collaboration, disrupted environments, resilience, routines

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K.4.3 [Computers and Society]: Organizational Impacts – Computer-supported cooperative work.

INTRODUCTION
In recent years, we have experienced major events that have disrupted environments all over the world: 9/11, Hurricane Katrina, the tsunami in the Bay of Bengal, the earthquake in Pakistan, terrorist attacks in London and Madrid, and numerous wars. These events have resulted in the unfortunate loss of human life and also have involved substantial economic costs. When the disruption affects the

environment for a prolonged period of time, people must find ways to adapt to carry on in their lives.

Environmental disruptions are not new. What is new is that we are now living in an age where video and audio sharing, podcasts, blogs, wikis, Internet fora, Internet telephony, IM, cell phones, and other communication and data-sharing technologies are nearly ubiquitous for many people in many parts of the world. Whereas just over a decade ago most people still relied primarily on telephone, radio or television broadcasts to get real time information about disasters, now anyone with an Internet connection and a modest amount of software or anyone with a cell phone can contact others, disseminate information, connect to others and self-organize. We believe that this real time ubiquitious control of information critically affects how people carry on with their work lives and maintain relationships when the environment is disrupted.

As CSCW researchers, we are interested in understanding how collaboration and technology use is impacted when the environment is continually disrupted. When the environment is severely disrupted then people may need to leave their home for a safe environment, sometimes continually changing residences. They may change workplaces, not be aware of where colleagues are, revise work schedules, or need to find new means for traveling to work if the route is dangerous. Our intent in this study was to understand the role of information technologies (IT) in enabling people to continue in their collaborations and interactions when the environment is disrupted.

ADAPTATION IN DISRUPTED ENVIRONMENTS
To date CSCW research has not given much attention to collaborative work and interaction in environments that are unpredictable, volatile, and risky. When faced with such environments people might leave, stop work, or be resilient and stay and continue to work. Resilience has been defined as the ability to cope with an unexpected situation, to "bounce back" [9]. Discussions of resilience have centered around properties related to human action in responding to unexpected events: redundancy, resourcefulness, communication ability, self-organization, improvisation, role-switching, and information-seeking [9, 15]. Yet, the

role of resources, and especially IT resources, have not received much attention in acts of resilience.

Research in CSCW has started to address how citizens and groups coordinate in the direct aftermath of disasters [12, 10]. Adaptation after a residential move has also been studied [13]. We are interested in studying resilience at the level of groups: not just in terms of how groups coordinate after a disaster but how groups can continue to collaborate when the environment is continually disrupted, e.g. in war.

We are interested in how people accomplish action when their environment is disrupted. To understand how people develop new ways to act when the environment hinders them, we focused on identifying typical routines used in work and social interaction. Routines are defined as repeated patterns of actions, performed by multiple actors in a context [5]. Empirical evidence has challenged the notion that routines are stable, instead showing that they are dynamic, adaptable, and in fact can function outside of structural rules or norms [5]. This view includes the idea of agency in forming new, and modifying existing, routines.

When changes to any social system occur, e.g. from some outside event or force, in what Barley [2] terms "slippages", then such events can trigger new ways to act. Thus, a disrupted environment which affects people's normal routines can be a trigger for people to develop new routines, or new *patterns of action*, to adapt to the changed environment. A focus on routines enables us to understand how people take action (if at all) to restore these routines or develop new ones when the environment disrupts them.

People draw on resources to mediate their action [7]. Though the notion of resources is wide-ranging, having encompassed intangible things such as information or skills [4], we focus on the use of IT as a resource that mediates action. When people enact typical behavioral routines, they draw on familiar resources, such as using their car to drive to work, or to meet face-to-face with colleagues or friends. However, when typical routines cannot be performed (in the case when a disrupted environment prevents them), and if people are intent on continuing their work and relationships, then they need to find new resources or new ways to use familiar resources to create new ways to act.

Feldman [4] showed how when organizational practices change, in turn this changes the meanings of resources for people and how they are used. Resources are thus malleable; their function and meaning is situational. For technology, this situational aspect is described by Orlikowski [11] as "technology-in-practice": through use in practice it becomes evident how technologies structure human action. Habitual use of a technology reinforces that mode of usage. Yet when changes in the environment lead people to alter their habitual ways, in turn this changes the meaning, and types, of resources that people use. New structures emerge through instantiation in practice.

In this study we explore resource choices and how they were used by people to be resilient in disrupted environments. As the field changed we discovered that different attributes of resources become important as enablers of action. From our data we discovered many cases that show when familiar routines were not possible or too risky to do, then through bricolage [cf 9], people drew on new resources, combined resources or used familiar resources in new ways to act. An overriding pattern that we found was that people switched from relying on physical resources (e.g. cars, workplaces) to using IT as a primary resource to carry out action. In doing so, people modified existing routines or developed new routines. Thus, when the physical environment constrained people, IT provided people with alternatives to continue to act in both their physical (and virtual) environments. Following Orlikowski's notion of "technology-in-practice", new ways of using resources to be resilient led to the emergence of new structures with consequences for work and social lives.

RESEARCH SETTING AND METHODOLOGY

We chose to conduct our study with participants in two countries: Israel and Iraq. These two field sites were diverse in many aspects such as culture and economy, but were comparable in two major ways: 1) the residents of both countries were experiencing wars and severe disruption to their environment and their familiar activities, and 2) IT was widely available. We stress that we are not interested in evaluating the events from any political perspective but rather are interested in understanding how people use technology to act when the environment is disrupted.

Israel

We chose Israel as a field site because during the 2006 Israeli-Lebanon war it provided us with an opportunity to understand technology choices due to its high-technology infrastructure. At the time of the war, the country had a 100% digital network, a penetration rate of 125% for cell phones, and broadband connections for about 70% of households (ranking fourth in the world). There were a number of technology choices available for people: e.g. Internet, cell phones, laptops, mobile devices, as well as a variety of Internet applications: audio and video sharing, IM, email, SMS, blogs, wikis, games, etc. Second, Israel had recently experienced a major environmental disruption so that it was still fresh in people's memories [6]. Third, the environment remained disruptive for a prolonged period of time such that people had to develop new routines or adapt old ones. We could thus study the routines that people formed. Fourth, many potential informants are English speakers unlike many other disrupted environments.

Iraq

We chose Iraq as a field site to be able to compare and contrast experiences with Israel and to generalize our research results more broadly. As with Israel, the war in Iraq disrupted the lives of its residents. The war has also been prolonged (over five years at the time of this writing)

and many Iraqis are English speakers. However, there were also some notable differences between the countries. Whereas in Israel the technical infrastructure remained largely intact during the length of the war, in Iraq, there were continual breakdowns and problems with the physical infrastructure. There is also an interesting story to be told about technology adoption and use in Iraq. Unlike Israel, where IT has been widely available for years, in Iraq, prior to the war in March 2003, the technological infrastructure was virtually non-existent. Contacting friends and family abroad was nearly impossible; interactions were restricted to within Iraq's borders, as one informant described:

Seriously, we felt like we were so much left behind, and we were different than the world, and the rest of the world was an alien to us. Besides phones, cars, and computers, there was no other technology…

Before the war the Internet was available, but was monitored, restricted mostly to e-mail use, and limited (in government operated Internet centers) Most Iraqis had never seen a cell phone, and satellite television receivers were banned. Also, before the war, electricity and gasoline was available and people could freely socialize in person.

The technological landscape changed drastically following the war; information technologies were introduced practically overnight. While the penetration rates of the Internet (.1%)[1] and cell phones (39.6%) still remain low in Iraq, technology adoption began to occur. Computers were used in Iraq before the war but the use of unrestricted Internet, cellular phones, and satellites came after the war. Before the war only three of our Iraqi informants used limited Internet, one had satellite access and none used a cell phone. After the war, our informants had access to IT and adopted various technologies: e.g. Internet, cell phones, laptops, mobile devices, and applications such as IM, email, SMS, social networking sites, YouTube, and online forums.

Methodology
We conducted 59 interviews. 40 semi-structured telephone interviews (17 males, 23 females) were done from Oct. 2006-July 2007 with participants living in Israel during the conflict in August 2006. Each interview lasted about one hour. Starting in September 2007 we conducted 19 semi-structured phone interviews with Iraqis (15 males, 4 females) who lived in Iraq during the war: 12 currently live in Iraq and 7 now live outside of Iraq (UK, U.S., Jordan). The interviews averaged about two hours as often we experienced their environmental disruption during the interviews. Sometimes we had to switch among communication tools (e.g. phone, Skype, IM or email) until something worked consistently.

We sought informants who fit the following criteria: 1) they lived in the war zones, 2) they used at least basic IT, and 3)

[1] 2007: http://www.internetworldstats.com/list4.htm

they were English speakers. As our goal was to find people with access to technology, and given the limitations of access to larger populations for sampling, we used snowball sampling [3] to recruit participants. Our initial "seeds" were people we had known in Israel from the research community and in Iraq from a U.S. contact. Documents and written diaries were important sources of information about events and people's perspectives at the time they were in the disrupted environment. We had extensive archival data from 16 Israeli informants in the form of blogs, email, bulletin board postings, and forum messages written during the war. We used this to triangulate with the interview data. Guided by grounded theory [14] applied on the electronic archives and interviews, we identified the important issues related to technology use and developing routines.

We asked informants to identify routine behaviors (following [5]) used for work and socializing, before and during the war. In our interview and archival data we coded for patterns of behavior used for work and socializing before the war, and changes during the war. We focused on IT use before and during the war and whether it impacted people's work and interactions. We consider new routines to be patterns of behavior not done previously. We consider modified routines as changes in pre-war existing routines.

Our informants in both field sites were educated. The work roles of our informants were quite diverse: e.g. control systems engineer, professor, doctor, administrator, technical writer, CTO of a startup, teacher, research scientist, marketing consultant, translator, medical student, farmer. Their age range was wide. The technical experience of our informants ranged from basic experience using technology—email and Internet--to the more technically savvy use of, e.g., wikis, IM, Internet telephony, and SMS.

THE DISRUPTED ENVIRONMENT
We begin by describing the extent to which the environments in both countries had changed. The informants had difficulty enacting familiar patterns of action in work and interaction. Simple actions that in a normal environment we take for granted such as taking a walk or taking a shower or driving in a car entailed risk. In the event that a siren warning went off (in Israel) then people needed to seek shelter immediately. The threat of bombs in both countries was very real. Most of our informants described that they had experienced either seeing the effects of recent bombs, hearing the "whizzing" sound or seeing bombs explode. The Iraqi informants referred to bombs as "flashes". In Israel, informants reported running in and out of shelters from 8-20 times per day. One informant described the lack of familiar routines:

I don't know, there was no normal routine of waking up, going to work, and doing work and getting back home… things like that. So that was different, sleeping at various hours of the day, of the night, waking up and checking the news, and being scared of what was going on, what was

happening to friends, and things of that nature. That was... I guess that was different than the normal routine.

Driving to work, to school, or to cafes had previously been taken for granted before the disruptions; they were now considered highly risky. People did not travel unless they really needed to, as described here:

I live 35 minutes south of the factory, traveling was a major safety concern. Rockets could land anywhere. Traveling to and from work was a major decision, to leave the house or stay home.

[on driving]: Now you're in a potential rolling bomb. If you're bombarded by shrapnel, it hits your gas tank, then you're gone.

Even if Iraqis were able to obtain gas, travel became increasingly dangerous as these informants relate:

Last year, security was so disturbed, but we had to go to school. So on my way back home I was with my uncle in a car, and a bombed car exploded only a few meters ahead of us. Only seconds separated me from being dead in that explosion, or even being handicapped.

...I mean if you drive your car to the university maybe it's gonna happen... bombs in the street, sometimes we will see people shooting other people. We were expecting everything...

First of all many of the roads are blocked for security issues. It's either blocked by government offices or by people themselves. Some of the roads [have] terrorists or security personnel passing through, so they don't want regular people to go through these roads...

TECHNOLOGY AS A RESOURCE FOR RESILIENCE

We found many cases where the environmental disruption prevented people from using familiar resources for work and socializing (e.g. using cars for travel or meeting friends at homes or social clubs). We found that our informants drew on new IT resources or used familiar IT resources to create new patterns of action for work and interaction. This led in some cases to the emergence of new work and social structures.

For all but one of our 40 Israeli informants, we found an increased usage and new uses invented for familiar technologies, and the adoption of new applications and technologies. In Iraq, because technology was introduced when the war came, it is not possible to compare as we could with Israelis whether technology use *changed* with the advent of the war. However, we did find that all our Iraqi informants adopted technology for use fairly extensively in their daily lives. We therefore cannot discuss change in technology use but only *how* Iraqis used technology resources to create patterns of action in the war.

During the war, familiar routines were disrupted, such as when or how people worked or socialized. Nearly all our informants described how they were intent on creating routines to restore "normalcy" in their lives. Many informants could not travel to their workplace, or meet regularly with colleagues or friends. In the next sections we will describe the ways that technology was used in changing work and social patterns during this disruption.

Technology Supporting Patterns of Action in Work

Nearly all of our informants continued collaborative work and social interactions during the war, demonstrating resilience. In Israel, many of our informants who normally would have met in the workplace were not able to. They could not travel or did not want to take the risk to travel to work. Others described how they changed their residences frequently, e.g. from relatives' homes to hotel rooms, back to their own homes. For others, the infrastructure of schools and daycare was not available and people had to stay home with their kids. Familiar routines in work and home life were disrupted. We first discuss new routines for work.

We describe first the case of five Israeli authors who showed resilience in meeting a paper deadline despite the fact that some were continually moving residences throughout the war. Whereas before the war the group met face-to-face synchronously to discuss the paper, during the war their work became mostly asynchronous and distributed. They changed the resources they used, now meeting over email, Skype, and IM, and used a wiki. Changing their resources supported their ability to act and to continue to be "authors". The group structure radically changed. The authors gradually formed new routines of having multiple two-way distributed conversations, in contrast to their previous typical synchronous face-to-face conversations. Because the authors were continually moving it was difficult to schedule more than two people at a time. Yet the use of this new routine and resources had consequences for their communication. One colleague described that they "shouted" more over email than in their face-to-face meetings. Another consequence was that the manager of this group then changed his work routine and began to travel by car throughout the war visiting each member of the workgroup to "restore" collegiality of the group's pre-war face-to-face communication. He also began to use new resources to support this new travel routine, relying much more heavily on IT, cell phone and SMS, to communicate while on the potentially dangerous roads.

Another case of resilience is that of a psychotherapist, who explained how due to the risk of travel, she and her clients could not meet face-to-face, their usual practice of interacting. This informant developed a new routine of conducting sessions with her clients by telephone. Whereas before the war, clients would seek her out, in this new routine the roles were reversed and she took the initiative in contacting the clients over the phone, showing resilience to continue her interactions with her clients. In this way she could continue to act as a psychotherapist. The use of this new routine and new use of a familiar resource (telephone) had consequences as it changed the nature of interactions

with her clients. She explained that interactions became far more personal using the phone:

It wasn't official at all. There was absolutely nothing official about it. We were closed down, we were told not to go to work, and I was not told really to do anything. It was just something that I need… that I felt needed to be done, and it was the right thing to do. But I wasn't required to.

An interesting case of how technology use changed patterns of action in work was reported by two different Israeli informants who were in the military reserves and were called up during the war. These reservists brought their existing routines using IT in civilian life to their new environment in the military. These familiar routines using IT enabled them to bypass the hierarchy and contact others, e.g. when they needed help. Traditionally the Israeli military uses radio communication in a one-to-many broadcast along hierarchical lines. However, as reservists entered the military they brought with them learned habits of technologies that they used in civilian life, e.g. SMS and the cell phone. One case of using such previously learned habits in the military occurred when a soldier, whose tank entered Lebanon and became under siege, used SMS to summon help from a person of high rank in division headquarters. Traditionally, soldiers use radio to contact their commanding officer one step up in rank, but this person bypassed the chain of command to contact a high ranking person directly through SMS with his cell phone. Help was sent. People who were friends and colleagues in civilian life were of different ranks in the hierarchy when they entered military life. The use (and civilian habits) of cell phones and SMS in the military provided soldiers with a new kind of agency to contact others irrespective of rank (which bypassed the military hierarchy).

The resources and routines thus changed from formal communication across the hierarchy to a combination of formal and informal communication. Again, the new use of familiar resources had consequences: not only in bypassing the hierarchy but also in weakening the structure of checks and balances that exist with radio communication. Because of the one-to-many broadcast nature of radio commands, multiple people can overhear the commands and serve as checks. With cell phones, these checks and balances are lost, as one lieutenant colonel described:

So what happened is that you know, you take the habits from their day-to-day regular life, and apply them to the same encrypted phone, but what the problem is that you start [...] initiating army decisions with the cellular phones. And even sometimes commanders are sending commands using the cellular phone, and then there is no… and then you are basically putting aside the checks and balances you have in the regular communication channels you have in the army.

Travel was very risky. We found that informants used familiar resources of cell phones in new ways to develop new routines to be resilient to continue to drive on the roads. Here are just two examples. One informant described a new collaboration routine for travel that she formed calling it a "cell phone battle plan":

… we would basically call when we were very, very close, we got the timing down so that we would know, 'ok I'm about 30 seconds from her house' and that's how long it's going to take her to run down the stairs and run into the car, because you didn't want to be out in the car, and you didn't want to be sitting and parked and waiting anywhere… it was like running a mission for enemy lines or something, it was incredible.

Another new routine with IT to support travel was developed by an engineer who worked in a small startup company. He recently moved to the country from Germany. He described how he lay in bed for two hours every morning worried about the 45-minute risky drive to work. He described a new routine that he developed for travel to work using the cell phone, calling his family in Germany, and which helped him make his daily drive:

Of course, the cell phone is always there. If something happens in the street you can call someone. It is very important for me to have a cellular….It was...my family, my relatives, they call me in the morning [from Germany] *and ask what I'm doing and if I'm going to work. They call me, because it's 7:30 and they know I leave then. 45 minutes later they call me again to see if I got to work. And the same for the way back.*

In the first case, the use of cell phone helped the informant coordinate driving; in the second case, the use of the phone gave psychological support. For both, the new use of familiar resource and new routine enabled them to act.

The Israeli informants who were able to most closely follow their existing pre-war routines in work were those who relied heavily on technology for "virtual" work before the war. Working in a "virtual" environment with others enabled them to be independent of the disruption in the physical environment. One engineer, who was responsible for integrating remote access in a large global company, took his computer and cell phone with him when he was called up into the army. He continued to collaborate with his colleagues in the company while he was involved in intensive training the first 72 hours and also for about a week after. One woman, a CEO of a small company, left her home in the north and began to live a nomadic existence, moving from hotel rooms to friends' homes. She used a new technological resource: a prototype device that enabled her to have Internet access wherever she was. She continued to run the company from wherever she happened to be. An informant who worked in a global distributed team was able to continue work as he moved between his brother's home and his own. Since most of his online meetings were with team members in the U.S., he met with them in the evenings (when bombing ceased), a less disruptive time. Another informant, a technical trainer and writer, who collaborated with others throughout the country

and in other countries, switched from working at the office to working at home. Since his primary contact with clients was on the phone and Internet, his change in location was not noticeable to his clients. His personal life though was constantly disrupted as a new routine became moving in and out of bomb shelters 8-10 times per day. Thus, for these informants, their work in "virtual" environments enabled them to be independent of the physical environment and thus relatively unaffected by disruption.

In Iraq, similar to Israel, the physical disruption in the environment prevented our informants from enacting their former pre-war routines of traveling to work and attending the university. Our Iraqi informants used technology to develop new ways to continue to work and collaborate.

Missing university became a regular occurrence (one informant missed school for nine days due to a curfew). We discovered the creation of new online collaboration fora so that students could still interact without traveling. One medical student informant who was "very keen on computers and the Internet" started a dialogue using email with a couple of friends. It did not take him long to realize that they had created an ad hoc e-mail based forum. After this realization he started a forum which now has over 450 members who discuss university related topics, coursework, and other issues. Students can now meet other students online without physically traveling to school. He explains:

Friends sent an e-mail asking about the college and they included many names and another one replied to all, and gradually we started to have this very long chain of e-mail discussing lectures and attendance. Then I noticed, well, people are willing to engage in dialogue and they are willing to interact with each other…

Seven medical student informants reported a new pattern of collaboration that emerged as so many missed lectures: colleagues began to use technology to capture and disseminate information to those who could not physically attend school. Some students began to record course materials on paper and make photocopies for others. One informant learned how to create flash animations, created animations to help illustrate course materials, and distributed these to his peers on CDs or on flash ROMs. One informant created a web forum, and after uploading course materials to a server, would then distribute a hyperlink to his peers using the forum or via e-mail. In other cases, people would send him an SMS to ask for the hyperlinks when it was time to take exams. Another informant began taking photos of microscope slides using a digital camera, and would then distribute them on CDs to his classmates. This new pattern of action caught on and was adopted by his peers, professors, and soon the university as a whole, as he explained:

Especially when digital cameras got cheap and more popular and lots of people had them. When I was in 6th year, people in their 4th year who were in pathology, they convinced the department to give students the CDs. The

doctors were taking those photos, making sure they show you what they want to show you. It started from a simple idea and the college itself embraced it.

Another case of resilience involved Iraqi informants who were translators for the American army. Initially they started physically traveling to their workplace. They developed a new work routine of receiving assignments at home, translating them and sending the assignment to their managers using the Internet, e-mail and cell phones. The use of new resources enabled them to continue being translators without traveling to the workplace.

However, as the technological infrastructure was often disrupted, our Iraqi informants used an assemblage of physical and informational resources that were continually being reformed and reorganized. A journalist described that his news organization had established two reporting groups, in southern and northern Iraq. People within each group coordinated among themselves and with external reporters using the Internet and cellular phones. When a technology did not work people switched to other communication media or went to an Internet cafe. Resilience for these journalists involved flexibility in switching between technological and physical resources, as one describes:

So when the Internet went down it was all of us. So it was out of our control. And for the reporters they were just calling and saying sorry we don't have Internet. Many times reporters were threatened so they couldn't go out and use the Internet. There were also curfews. You have to be really flexible when you work in places like Iraq, because it's basically a war zone. The kind of rules you have in other places, in Iraq you cannot…

Technology Supporting Patterns of Action in Socializing
When the physical environment prevented people from enacting their familiar routines of socializing face-to-face then many developed new communication routines using new resources. In some cases this changed the structure of relationships, e.g. with who our informants interacted and the norms of communication. We will discuss the experiences in each of the countries.

Though nearly all Israeli informants reported an increased use of email and cell phone, and for many also IM and SMS, we discovered a common new pattern of action that emerged. Sixteen of our 40 Israeli informants (40%) started completely new practices of communication. During the war they began regularly to write blogs, long emails, post to Internet forums or bulletin boards in messages distributed to large numbers of people. For all these informants, this was a completely new use of these communication technologies.

One case is of an Israeli professor who began what she called a virtual support group where she sent out daily emails describing her feelings and day-to-day experiences. She sent these first to her students, and then to a wider list, eventually reaching about 50 people. This became a new daily routine for her and she would spend about 5-6 hours a

day composing this email. Another informant, an avocado grower, developed a daily routine where he wrote a story about his life each day during the war in long emails, first to friends and family. The list then grew to the expatriate community of his town. He included photos taken with his cell phone, as he described:

It was important to maintain a routine, even if it included an abbreviated work schedule. That routine included my daily correspondence, which I considered a personal obligation to myself. My observations at work were critical to the writing, as I barely ventured beyond the confines of the community or the orchard.

One informant began a new routine of writing a blog which soon included a cartoon in it. She described that her new daily routine started when she woke in the morning and spent time thinking of the cartoon to post in her blog:

I used it as a therapeutic means for me, in between work or when I wasn't working. And just to know I was communicating with a lot of people.

A personal trainer, whose hobby was using a virtual Internet flight simulation program, switched during the war to using the collaborative forum feature of the program. There he regularly posted what he called "Letters from the War Zone". He said that when the war started he stopped playing the game as it seemed silly. He thought constantly about composing writing for this forum. A technical trainer, who began to post regularly in her blog, sometimes 2-3 posts per day, once received a frantic call from a client in Spain when she didn't post. Another informant described the value of her new email routine during the disruption:

It started out as an e-mail that went out to all our friends and relatives overseas, and it just grew and grew and grew because they kept sending it to all their friends and relatives, so by the end I think my e-mail was reaching over 1,000… I would sit at my computer every second day, for a couple of hours, and try and create a story based on the news and our personal experiences as a family. And that was a very important part of my life during the war…. No doubt about it, it definitely empowered me. And it made me feel stronger and braver than I would have felt otherwise.

We found similar new communication routines that developed in different types of groups. A graduate student group sent out regular emails, first among 11 students and then more joined. A workgroup at a large corporation set up a blog for the group to talk about the war. People posted in it regularly. One professor turned an e-learning system into a message system when she started a new routine of sending personal messages out to her students.

These new communication practices with new uses of resources not only showed resilience in continuing communication among existing groups but they also had consequences in expanding the reach of these Israeli informants beyond their physically disrupted environment. Many informants described that having a routine where they could communicate online became a coping mechanism during the war, and some explained that it empowered them. Others described that by communicating to people outside of their war environment, in environments that were "normal", it was a way for them to make sense of their "abnormal" environment, such as when they enacted "siren" routines.

In Iraq, communication practices also changed, with a new reliance on IT, and with changes in social structure far more radical than in Israeli society. A societal change arose with the war: in addition to the physical dangers of traveling to meet friends and family, people also began to not trust people who they met face-to-face, e.g. on the streets or at school. Students found it nearly impossible to make friends at the university because other students could be potential "spies," tied to the insurgency, or a part of terrorist groups. Professors were wary of forming friendships with students because other colleagues who did so had suffered dire consequences. One Iraqi informant describes:

… the best thing we had before the war was being able to go out a lot. You know, stay out late at night… but we would visit relatives [before the war], you know, come back home when it's real dark and we wouldn't care about it because it was pretty safe. … The streets were safer, there were no traffic jams, and no roadside bombings, so we didn't have to worry about going out at any time. Our relatives were still in Iraq but now most of them are gone. We used to have so many places to go to and people to hang out with…

Thus, before the war in Iraq, people's routine patterns of interaction were to socialize in person. The inability to socialize in person due to risky travel and the lack of trust of meeting new people face-to-face led our Iraqi informants to start and maintain relationships with others online in a virtual setting. All 19 of our Iraqi informants developed new patterns in their social lives that incorporated email, IM, social networking sites, and chat rooms to socialize.

As many people left the country due to the war, people who remained adopted IT to maintain contact with friends and family. Thus, technology allowed our informants to "cross borders" and socialize with friends and family in different parts of Iraq and the world, as one informant described:

…I'm giving them updates as to what I'm facing in Baghdad. Right now I'm talking to my family in Baghdad, and they're sharing everything with me. It makes me feel like I'm living in a small world. Everyone can give everyone news. And that we are crossing the borders through the Internet, talking to my sisters, brothers, father, mother, even if they are in different countries. Gives you a feeling of comfort that you are in touch with them. And you can simply contact with them and check on them. Can send e-mail to see if you are well.

The development of these new communication routines led to a radical structural change for the Iraqi informants.

Before the war Iraqis routinely attended social clubs. Now technology was not just being used to maintain relationships, but was also starting to provide entertainment and socialization – as the social clubs did before the war. The norms of communication changed: the use of IT enabled people to talk about topics that they could not ordinarily do face-to-face. In Iraqi society today, for example, openly discussing certain topics face-to-face such as women's rights can have negative consequences. However, our informants described that they could discuss such topics online. Two of our male informants who regularly used chat rooms discussed how the anonymity allowed people to express what they were feeling. He said that people could speak their minds and even be "*very rude.*" People discussed their opinions online on the current Iraqi situation citing there was a "*clear division between people supporting Saddam and those not supporting him.*" While the current regime is "secular", the general mistrust and violence in Iraqi society, coupled with increased social conservatism have "pushed women into the background" and restricted Iraqi women in speaking freely [1]. A female informant described that the Internet supported their "freedom" to discuss their opinions openly:

...people expressed themselves more freely there. They even had bold opinions that they wouldn't dare to say when they're in school... it was mostly about social things that discuss the relationships between men and women, and also women's rights and how unfair the Iraqi and Muslim society in general was to women.

Another radical change in social structure occurred with overcoming societal traditions. In Iraqi culture, tribal ties have lasted for centuries and most Iraqis are members of, or have kinship to, tribes. Much socialization and marriage still occurs through tribal connections [8]. Tribal networks refer to the long-standing relationships of Iraqis centered around the extended family and friends of family [8]. For example, people tend to turn to their tribal network to find a suitable spouse, as the families are already well acquainted. Of course people still met others at the University or at social clubs, but in Iraq it was typical for people to meet others who were friends of friends or friends of family.

However, in an uprooting of societal traditions, by using the Internet, Iraqis now meet new people who are outside of their tribal network. One of our informants even described that her new Internet relationships were stronger than previous face-to-face relationships before the war. Three of our informants began to use YouTube to show videos of what they described as the "*real Iraq*". One informant described how viewers of his YouTube videos contacted him and ultimately visited him. Another informant explained that he met a woman online who was living in Southern Iraq (and outside of his tribal network). By chance he later met her when visiting Baghdad as he explains:

It was very strange. I met… you know, if you meet the person you are talking to on the net without any, you know,

appointment, it was something really new to me. I'm sure it happened outside Iraq because they had been practicing, or they have been, you know, having Internet long time ago and sometimes this stuff is happening. But in Iraq it was very new to me, to meet people who I know from the net. That was one of the things that, you know, activities that changed in Iraq. Everything actually changed in Iraq, it's [a] different Iraq.

Whereas in Iraqi society people usually marry within their tribal network [8], one informant described how she met her fiancé using Myspace.

I told you that I used Myspace, and that's where I actually met my fiancé right now….we started talking about the situation and it went from that to… you know, other stuff, and other stuff, and we kept talking for about a whole year, and…you know, until we met each other…He is American, he's a civilian, working in Iraq.

DISCUSSION AND CONCLUSIONS
Our goal in this paper was to understand how people adapt in work and social life when hindered by a continual disruption in the physical environment. The war prevented our informants from enacting many familiar routines such as meeting at the workplace or socializing face-to-face.

In the cases that we reported, we found that our informants enacted resilient behaviors by adopting new media or by using familiar media in new ways to reconstruct, modify, and develop new patterns of action for work and socializing. The informants whose routines changed the least were the ones who already were working with others virtually. They were able to be independent of their physical environment. These informants reported to us that often their distributed colleagues did not know their environment was disrupted (or that they might be speaking from a bomb shelter). In other cases when our informants used new media and changed their practices, we found that their practices moved in a direction of working and communicating more "virtually". The Israeli authors used new technologies to interact at a distance, the psychotherapist used the telephone to interact with her clients, the Iraqi medical students used technology so that students could get access to coursework without traveling, and the Iraqi translators and journalists used new media to work at a distance (when technology did not work in Iraq then they switched to physical resources). Informants in both cultures adopted more online interaction practices, replacing face-to-face interaction.

CSCW has long described the implications of technology use in virtual work. In our study we found that the environment hindered people from enacting familiar routines. Technology became a resource that, through enabling virtual work, people could be independent of their physical environment, and thus resilient to continual disruption. The environment was thus an actor that played a role in leading people towards more virtual interaction.

Our study shows how being resilient in group work and interaction involves the flexible reorganization of resources. The informants created new *assemblages* of technological and physical resources, at times switching solely to IT to develop new or modify pre-war routines, and at other times using IT to modify existing routines where they had previously solely relied on physical resources, such as cars for mobility. In many cases our informants adopted these new assemblages of resources and developed new routines in a collective manner such as the Israeli authors or the Iraqi journalists and medical students.

Our study illustrated how resources are malleable as the context changes. Typical uses in normal environments for cell phones in car travel might be to inform others when an unexpected event occurs (e.g. if one is stuck in traffic), or to simply chat. Affordances of technology resources changed as the environment changed, so that they were used in ways that enabled people to modify or restore routines. Cell phones became devices to coordinate travel in real-time, as with the "cell-phone battle plan". In considering the role of resources in resilience we might extend the notion of "technology-in practice" [11] to *resources-in-practice*: only through using technology in context does its utility emerge as a resource for resilient behavior. Our study has shown how the use of technology in conjunction with the adaptation of routines led to a different conceptualization of technology as a resource. This also builds on Feldman's idea that resources are created through action [4].

Resilience has been discussed as people "bouncing back" or holding on to an existing practice after a disruption [9]. Our study showed that acting to be resilient not only led to modifications, or even the creation of new routines, but also to emergent structures that had systemic effects. Being resilient does not just involve achieving short-term aims such as interacting with clients, or attending class, but we found that resilient actions often have more expansive social consequences. Following Orlikowski [11] we found that through the actions of using technologies differently, new structures emerged. Recursively, many smaller structural changes served to create more resilient environments for our informants' work and social lives. The Iraqi medical students were resourceful in using IT to form new collaborative patterns of disseminating course materials online and this changed educational routines, soon becoming regular university practice. There was a practice in place for future events: students could get course material if they could not travel to the university. Internet forums led to discussions about courses which became a new collaborative aspect of education for the Iraqi students. The Iraqi translators and journalists created virtual work practices for future work so that they did not need to depend on travel if disruptions continued to occur. New daily online communication routines for both cultures soon expanded beyond the borders of their countries so that people interacted with others in nonwar environments. Getting feedback from people in "normal" environments

helped our informants cope with events in their own environment. These changes created routines and environments that were more resilient to disruption.

But some systemic changes created challenges. For the Israeli authors, structural changes in their group communication, which enabled the group to continue working on its paper, led to some discord. The manager changed his work practice to drive to meet with group members to restore and maintain good relations. Civilian habits of cell phone use in the Israeli military benefited individuals but created a rift in the checks and balances of the formal radio communication system. Thus, not all actions to be resilient benefited the group or organization.

Some structural changes affected societal norms. The use of online communication for socializing for Iraqis led to new norms of interaction where taboo topics could now be discussed. In a strong irony, the Iraqis turned to the Internet to maintain tribal relationships with friends and families and ended up forming relationships outside their tribal networks, changing a long-standing cultural practice.

Thus, resilient actions can have effects that extend beyond a change of practices and use of new resources to accomplish immediate goals. Such systemic changes have not received much attention in the literature discussing resilience. Past studies of resilience have focused on properties of human action that enable people to adapt to adverse situations [9, 15]. Our study adds to the discussion of resilience by showing the role of technology resources in creating new routines for work, travel, and socializing so that people have more choices of how to act during the disruption. When physical resources or means to take action were not available (e.g. travel, workplaces), then technology provided people with alternative means to enact agency, to continue to work and socialize during disruptions.

This study allows us to compare and contrast the differences across two very different countries and cultures. The two cultures of Israel and Iraq are markedly different and the informants used technology in different ways. At the time of its war Israel had already been a highly technical society, with one of the world's highest Internet and cell phone penetration rates. In contrast, at the time the war in Iraq started, Iraq had limited and controlled Internet; after the war began our informants adopted IT fairly rapidly. But what is common to both cultures is that when the physical environment prevented people from enacting familiar patterns of action, both changed their use of IT, flexibly combining IT with physical resources, to create new (or to modify existing) patterns of work and social life.

In terms of practical recommendations, our study shows that in times of disruption people need to have increased situational awareness of others in their social network. This awareness information on the one hand could consist of simple status information letting others know that they are safe. We can envision a system that would automatically notify members of a group which technology is currently

available for all or most people to use to communicate. This system might recommend, for example, that members meet with Internet telephony if all have Internet access at the time, or by cell phone if the network is available to all.

Our data also points to the potential of utilizing collective intelligence in providing online information about a disrupted area. For example, people could collectively update a satellite map online with up-to-the minute information on local disruptions in their area. Of course this practice introduces potential issues of information integrity.

We discovered that the willingness to adopt IT was important for resilience. Working virtually enables people to be independent of their physical environment. A recommendation would be for organizations to train groups in virtual work practices so that group members could seamlessly and quickly switch to virtual work when needed. There is a long history in CSCW describing social and technical challenges of virtual work such as adopting interoperable technologies and establishing common conventions. Environmental disruptions underscore the need more than ever for organizations to be adept at virtual work. Disruptions are, for the most part, unexpected. By training people to be flexible in assembling, combining, and switching resources, organizations can increase their resilience to disruptions. Flexibility in switching resources can be a benefit to organizations even for minor disruptions.

Limitations
We have several limitations to our study. First, as our goal was to study how people used IT to adapt to disruptions, we used a snowball sampling approach to provide us with a group who used IT (a limited group in Iraq). As most of our 59 informants were educated we can only generalize these results to people who are similar and who have access to a range of technologies. Our sample though consisted of a wide range of professions, personalities, ages and experience so we can say they are good indicators of how similar people might act with access to IT. However, we note that our snowball sampling approach could have led people to recommend others like them. Another potential limitation is that the memory of our Israeli informants might be distorted due to the time that elapsed since the war and interviews (from 2-10 months). However, we triangulated archival data written during the war with interviews and found consistency. Also, research shows that memory is very reliable over time for typical events which fits our focus on routine behaviors [6]. Last, we cannot discern whether the structural changes found in Iraq are due to technology or other changes, e.g. the regime. We can only report how IT helped people act, but further research is needed to understand the basis of these changes. We hope that our study can spark more research in this area.

ACKNOWLEGEMENTS

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