The Role of Visualization in the Naturalization of Remote Software Immigrants

Azam Khan[1,2], Justin Matejka[1], Steve Easterbrook[2]

Autodesk Research[1] & University of Toronto[2]
210 King Street East
Toronto, Ontario
M5A 1J7 Canada
azam.khan@autodesk.com
justin.matejka@autodesk.com
sme@cs.toronto.edu

Abstract: Software development is commonly becoming a globally distributed task, often due to mergers and acquisitions, globalization, cross-divisional efforts, outsourcing, or even telecommuting. Individuals -and entire teams- are suddenly faced with new challenges when they must move from the traditional synchronous co-located paradigm to the newer asynchronous distributed paradigm. While previous work has examined collocated software immigrants, we investigate remote immigrants who may be working synchronously or asynchronously, and report on the naturalization process. Specifically, we focus on the role of visualization in helping with this process. The case study presented is exploratory in nature with data collected via pilot interviews. We found a number of issues impeding normal workflow, as perceived by participants who recently became remote software immigrants, and we discuss how visualization tools were developed to help them to understand the process.

1 Introduction

While Global Software Development (GSD) has recently been established as a new and compelling research area, the transition from Local Software Development (LSD) to GSD has not been examined in detail. We believe this transition [CR06] is an important part of GSD and these early experiences may have a significant effect, lasting for several years, while teams move toward –and acclimatize to– viable GSD practices.

Inspired by the software immigrant metaphor introduced by Sim and Holt [SH98], we extend the exploration of this transition, from individuals joining new development teams in a collocated setting, to teams joining established larger remote teams in a distributed setting. In keeping with the immigrant metaphor, we also call this process *naturalization*. Primarily, the team being integrated could be considered as going from a physical team to a hybrid physical-virtual team.

Virtual team [GC03, LS97] and GSD research often further include dimensions of space, time, culture, and technology, often combined as a general concept of *distance* in a networked world [GHP99]. Casey and Richardson [CR06] propose factors significant during the establishment of virtual teams focussing on the management issues. However, our work more closely follows the work of Herbsleb and Grinter [HG99] who examined a GSD code integration project at a large corporation. We track a small team based in Toronto working in a large software development corporation with 6451 employees and over 30 development centers around the world. The six member team was part of a company with 400 people acquired by the corporation and this paper reports on the experiences of the team for an 18 month period beginning from the acquisition.

Two integration projects were executed by the team during this period. The first project begins the naturalization process of the team into a larger distributed remote team with the task of integrating a component created by the team into a single product. Based on management's perceived success of this effort, the second project carries the component integration task into many of the company's products.

2 Orientation

The culture of the corporation was quite different from that of the team. Due to the highly distributed nature of the corporation, meetings were primarily conducted by phone conference. Moreover, a notable number of employees worked from their homes. When initially phoning into meetings, the team members were fairly disoriented, not recognizing the voices of the participants, nor understanding their roles on the project. Another difficulty was understanding the management structure for the project and how members of different divisions cross-reported. No physical meetings took place to facilitate the integration project. Meeting participants typically used Windows NetMeeting to share documents or to record meeting notes. The six members of the team would often be speaking with ten people on the phone, several of whom would dial into the meeting individually. The team found the process to be quite challenging and stated that, even after dozens of meetings over a period of four weeks, it was still difficult to identify individual voices and roles. To address the team's disorientation within the company and within the project, visualization was used

2.1 TeamViz

The company had an organization tree intranet tool that would graphically show a manager and the employees directly reporting to them, but navigating up or down the structure would reload the page, eliminating context, and only a single level was shown at a time. To overcome this limitation, one of the developers on the team (on his own initiative) created a visualization program called *TeamViz* to better understand the roles and relationships of the phone meeting participants. The tool was built using the Processing language built on top of Java (www.processing.org). As input, TeamViz took a Microsoft Excel employee list spreadsheet and email lists extracted from Microsoft Outlook, with a small custom-made plug-in.

The basic data for each employee (Name, Location, Title, and Manager) was accessed from a spreadsheet from the Human Resources (HR) department intranet. That data was then loaded and analyzed to count the number of direct and total reports for each manager. TeamViz was highly interactive. Clicking on a manager node would open it up to display all of the manager's direct reports. Middle clicking on a node would open up the employee's HR webpage. Hovering over a node would display a tooltip including the employee's HR photo dynamically downloaded from the company website. Finally, dragging an email onto the window would add all recipients of the email to the graph. Using the email list for the sixteen people on the team resulted in the visualization shown in Figure 1. The layout is achieved through an energy minimization algorithm treating the edges as springs holding the nodes together, and having each of the nodes repel from every other node.

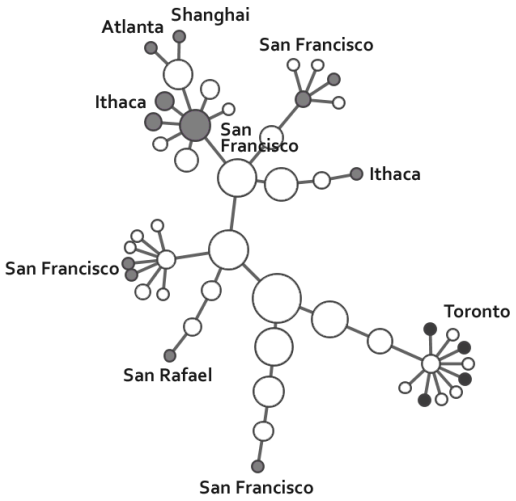

Figure 1: Project team structure visualization generated from email list, showing both physical distribution and hierachical organization.

The diagram in Figure 1 shows individual employees as circles. All people who are on the email list have their circle filled with solid grey. Members of the Toronto team who were part of the project under discussion are shown as circles filled with solid black. Circles are joined by lines drawn between each manager-employee pair and so, the reporting chain can be seen between team members. Circle size is based on number of total reports so that the company president will be shown as the largest circle. As can be seen, the complete project team is highly distributed, both in space, time, and structure. This hybrid physical-virtual team has at most three or four people in a single office/city but they may be in significantly different parts of the corporation in terms of the reporting structure. At least four vice presidents connect the team together.

2.2 Process Conflict

Virtual-team research characterizes conflicts as: Relationship, Task, or Process [GC03].

While the team did not report any significant task or relationship conflict, many conflicting situations occurred relating to the process used, especially the decision-making process in a multi-headed structure. For example, after approximately ten weeks, a situation arose with the Quality Assurance (QA) team. The Toronto team had discovered the need to add a significant amount of functionality and had determined that the changes were critical. However, QA rejected them for scheduling reasons, despite that they were already fully implemented and working. In negotiations with QA, the team conceded one of their primary components for the testing, and therefore inclusion, of the critical new design changes. The team was surprised to find that QA, in effect, announced and controlled which features would make it into the release based on their own throughput limitations. This was very different from their previous experiences. In general the team reported being disoriented when the head of the project would completely defer major decisions to various groups.They felt that they did not have „local“ representation of their needs within the established larger team.

3 Multi-team Orientation

Despite any naturalization problems encountered in the first component integration project, the result was considered by management to be a success. This lead to the decision to integrate the component into at least four more products and, from the perspective of the team, began a new naturalization process with a completely new set of people. The new larger team was explicitly cross-divisional and contained 49 people, with 45 managers appearing in the tree connecting the team members, as shown in Figure 2.

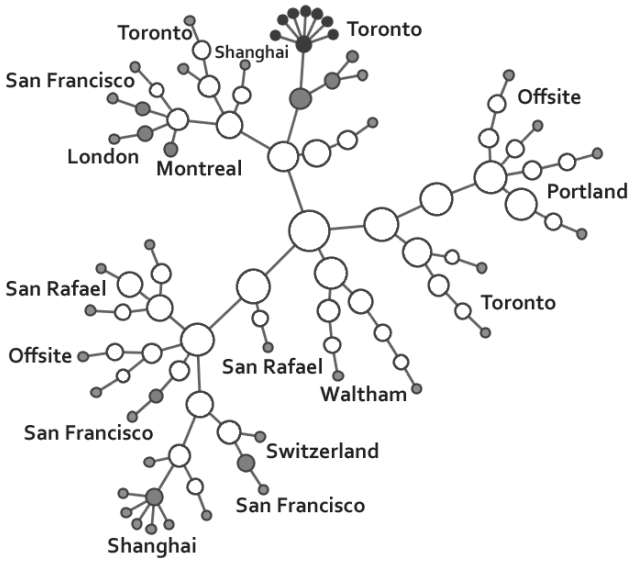

Figure 2: Larger cross-divisional team of 49 people, shown as shaded nodes, with 94 employees shown in total, leaving 45 managers to connect all team members.

To avoid some of the problems encountered in the previous project, the Toronto team physically visited three of the key sites in North America to get to know the people involved more directly, before having ongoing telephone meetings during the project. As is well documented in virtual team literature, all of the benefits of meeting face-to-face were had. They reported that this experience definitely positively affected their perception of team members on the phone meetings for the rest of the project.

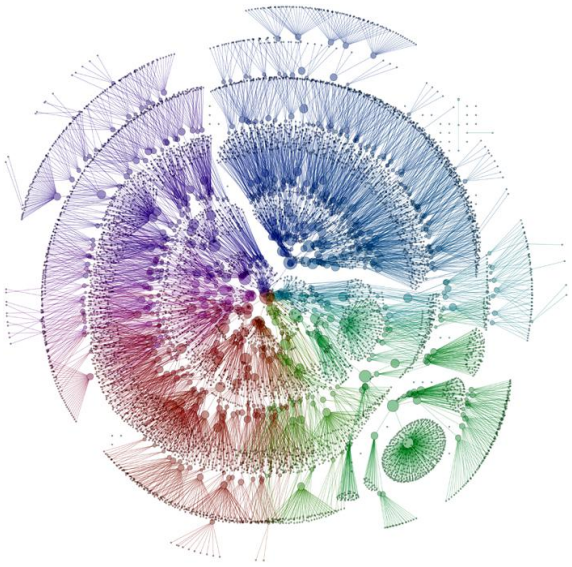

Figure 3. Employee tree for entire company.

Again,the TeamViz program was used on almost a daily basis to help the Toronto team understand the who the people involved were and where they fit into the larger corporation. As this larger project was started on an annual company cycle, many of the people from the smaller team from the previous project had been reassigned to other tasks, and this further reinforced the Toronto team's feeling of „starting over" with a naturalization process. With 49 people on the primary team, and over a hundred people on secondary teams, the TeamViz developer created another visualization of the company structure, this time including all employees, as seen in Figure 3. In this figure, the graph nodes again represent individual employees and are drawn as points or small circles. The circle size reflects the number of people whom that employee has reporting to them, so, for example, the president (at the center of the graph) has the largest circle. The lines between the nodes connect employees to their managers. The figure shows that there are about five major levels (rings) in the tree indicating a fairly shallow organization. Other notable features are the cluster to the lower right which shows the large Shanghai development office with a single manager and the upper right quadrant clearly separated, indicating the separation of the sales structure in the company, all reporting to a single vice president of worldwide sales. The TeamViz energy minimization algorithm was used for this visualization as well. Finally, this tree was animated revealing large temporal structure changes caused by internal reorganizations.

While this visualization did help in the understanding of the overall corporate structure, it was not interactive as the minimization process took a significant amount of time to resolve all constraints. As such, its usage was not as common as TeamViz.

4 Conclusion

The naturalization process proved to be difficult for the team under review. The established team they were working with seemed satisfied with a shared leadership approach but a hierarchical system was preferred [CDB03] by the software immigrants. Mismatched roles and a lack of face-to-face meetings seemed to contribute to conflicts and the resolution of problems was ad hoc. The distribution in space, time, and structure of the team also seemed to contribute to process conflict. The immigrant team developed a software tool to help visualize their company structure to better understand the roles and relationships of the people they were working with. They reported using the tool regularly throughout the duration of both integration projects. While previous work has discussed teams distributed in space and time, we have presented the distribution in structure as a compounding factor in the naturalization process.

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