Measuring Collaboration in Globally Distributed Software Development Teams

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ABSTRACT
At ABB, we seek to empirically evaluate the effectiveness of new collaboration tools and methods for globally distributed software development (GSD) teams. We found it challenging to identify key metrics that would serve to associate improved collaboration with improved team performance. We used the Goal-Question-Metric (GQM) method to define a set of metrics for collaboration in GSD projects. Experiments will be conducted applying these metrics to a diverse set of development projects at ABB. Future publications will describe the outcomes of our studies at ABB.

Categories and Subject Descriptors
K.6.1 [MANAGEMENT OF COMPUTING AND INFORMATION SYSTEMS]: **Project and People Management** – *Staffing, systems development.*

General Terms
Management, Measurement.

Keywords
global, distributed, software, development, project management, metrics, collaboration, tools, productivity, quality, innovation, communication, trust, coordination

1. INTRODUCTION
Software development, whether co-located or distributed, is widely acknowledged to be fundamentally a human activity, one whose challenges are amplified by ever-increasing pressures on delivery speed. Effective collaboration is a key concern that, while recognized as critical, can be difficult to manage well, and is complicated by the difficulty of measuring and improving 'soft' teamwork characteristics. Performance of distributed teams is especially dependent upon Trust, Communication, and Coordination over Distance [4]. In globally distributed software development (GSD) teams, Culture, Language, and Temporal (time-zone) barriers [6] can magnify issues with trust, communication, and coordination. The increasing prevalence of global development and the greater visibility of these team performance gaps make GSD projects useful study targets.

Collaboration technologies can potentially offset the effects of distributing a project. However, introducing new technologies and tools also poses team effectiveness risks that require careful evaluation. In the Industrial Software Systems program of ABB Corporate Research, we are currently executing a study to examine these six GSD factors and the effects on team performance (efficiency, delivered quality, and innovation) from deploying collaboration tools.

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2. RELATED WORK
Measurements for team productivity and delivered quality are common, and empirical studies have assessed communication and coordination [4] [7]. A number of industrial studies, e.g. [6], have measured cross-site relationships and delays on distributed projects. However, metrics and data on how tools impact trust, culture, language, temporal distance, and innovation are scarce. A study leveraging XP-EF to measure communications on a GSD team using XP included geographic, temporal, and linguistic factors as well as characterizing the tool environment [2]. Several works describe results from creating and applying better SCM-based tools to improve collaboration on distributed teams, e.g. [3].

Despite tremendous recent advances in collaboration tools, studies that quantify specific benefits from using these tools on GSD teams are still very much needed [5].

3. COLLABORATION METRICS
The goal of current studies of GSD collaboration at ABB is to understand and measure the impacts of improving tools and methods for specific development activities. Additional characteristics we will assess include whether enhanced collaboration tools and methods make communications more effective, increase collaboration among co-located or remote team members, change frequency of coordination communications, or change frequencies of use for existing methods of communication.

Existing research has discussed factors, but not specific metrics, for the GSD characteristics of interest for our study. To define metrics for our research, we have applied the well-accepted Goal Question Metric (GQM) methodology [1].

3.1 Goal

Following GQM, we first defined the primary business goal for our research:

> To improve globally distributed project productivity in order to deliver measurable improvement in quality, innovation, productivity, and/or efficiency (cost, schedule) by fulfilling the globally distributed software project team's needs by providing the most appropriate collaboration tools paradigm.

To focus the measurements in our experiments, we defined three sub-goals relating to project productivity/efficiency, product quality, and innovation.

3.2 Key Questions

Next, we generated questions to describe these sub-goals and to explore the impact of the six GSD factors. Some of the twenty (20) questions in our study are:

- How does temporal separation affect the project efficiency?
- How does the level of transparency (trust) among teams affect project efficiency?
- What is the impact of different communication methods on project quality?
- How do cultural differences among different teams affect project efficiency?
- What is the impact on innovation with each collaboration method?

3.3 Key Metrics

Finally, we generated metrics to measure the questions/attributes that define our sub-goals. The following list of key metrics shows examples selected from our entire set of twenty-five (25) metrics.

- The degree of temporal separation (time zone), measured in absolute number of time zone hours between team-member pairs. *(If multiple sites are involved, a measure for team pairs across each site is recorded.)*
- Change in average team trust rating over multiple sessions. *(Trust ratings are collected with questionnaires after formal meetings conducted between sites.)*
- The number of issues due to communication failures that are caused by process differences, process gaps, misunderstanding, culture, personal interfaces, or misrepresentation of data. *(This metric looks at project action-item records to categorize issues by causes related to miscommunication.)*
- The number of ideas generated by distributed teams over a period of time (ideas generated with multi-site involvement).
- The team's rating of communication efficiency by method (asynchronous, conference call, shared desktop conference, video conference, face to face). *(This rating is collected via survey after formal meetings.)*
- The time spent communicating by method (informal discussion, asynchronous (email), conference call, shared desktop conference, video conference, face to face). *(This is an aggregate for the project and will be based on surveys and team member diaries kept during the experiment.)*
- The change in project efficiency over time, compared before and after enhanced collaboration. *(Measured in work product size unit per staff time unit in aggregate for the project.)*
- The change in project quality over time compared before and after enhanced collaboration. *(Quality is measured by delivered defects categorized by type and phase detected; number of defects by phase, number of defects remaining to be fixed at the end of each phase, and number of defects not fixed are considered as candidate measures for this metric.)*

4. CONCLUSIONS/FUTURE WORK

To 'benchmark' the GSD collaboration issues experienced in real ABB projects, we have begun gathering data from various teams across the globe working on different projects; some of the data for these metrics is being collected by a questionnaire-guided interview. Experiments are being defined in which enhanced collaboration tools or methods will be applied by a GSD team. Based upon our questionnaire findings and these tool experiment proposals, we will select metrics for each experiment, based on their applicability in the experiment. Team data will be collected before, during, and after the application of enhanced collaboration tools and methods. These experiments will help us assess whether use of enhanced collaboration tools achieves the goal of improving quality, innovation, and/or efficiency of development activities by GSD teams.

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