A Follow Up Study into the Effect of Disruptions on the Performance of Software Engineering Teams

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Abstract

This paper describes follow up research carried out on software engineering teams composed of students who were engaged in the Maxi project, one of the group projects in operation at the University of Sheffield. Once again an online version of the Myers-Briggs Type Indicator (MBTI) was used to ascertain the personality type of the students and the teams were observed in meetings throughout the project. The previous study had shown that teams who failed to discuss pertinent issues to a satisfactory level ran the greatest risk of encountering serious project problems. In the follow up study lack of debate was not such a serious problem, with more problems caused by what one might term interpersonal issues, i.e. inter-team squabbles, sarcasm, and lack of cohesion

Keywords
Empirical Software Engineering, Personality Theory, Myers-Briggs Type Indicator, Group Work in Software Engineering

1 Introduction

The research described in this paper is a follow up study aiming to build on earlier work dealing with the interplay of different personality types in software engineering (SE) teams, and the effect of disruptions on the working practices of the team [1]. The expectations before the previous study were that a team dogged by a large amount of disruption would experience more serious problems over the course of a project, but this proved to be only partly true. The initial expectation was that more disruption would be more damaging; this expectation was based on the results of previous research [2], [3]. The opposite proved to be true, teams without disruption but who lacked debate and suffered from communication problems proved to be the most dangerous in terms of encountering serious problems and failing to meet project milestones. Negative outcomes for observed teams without sufficient debate included limiting discussion to only a few alternatives, initial solutions were never reconsidered, alternatives were either not proposed or they were ruled out by the majority of the team resulting in lack of debate on future issues, this lack of debate led to a false confidence in some instances or a fools’ paradise whereby the team refused to make sensible contingency plans.

Due to the results from the previous study, the authors expected that lack of debate would again prove to be a significant problem. However, theory cannot always
predict reality, and one must take this into account whilst carrying out research on humans. The aims of this research are consistent with previous work in this area, to observe and measure SE development teams from the initial embryonic stage of team formation right through to the final implementation of a new software system. The end goal was to attempt to uncover whether certain personalities contribute more in terms of ideas, speaking in public, being a foil for ideas, or working hard behind the scenes. This paper is part of a larger project that aims to discover how important the effects of personality type are on the performance of SE teams, and the extent that disruptions have on the internal workings of the team and the quality of the work they produce.

Section 2 describes the research methods used, section 3 describes how the behaviour was observed and analysed, section 4 summarises the main results, and section 5 lists the conclusions and possible future directions.

2 Research Methodology

2.1 Ethnographic Methods

Ethnographic methods were employed to observe selected student teams. These methods were originally founded by social anthropologists to aid them in their understanding of different cultures and environments. They are now used in many disciplines in which research involving humans is important including sociology, psychology, criminology, human computer interaction (HCI) and ESE. Ethnography is synonymous with living in and immersing oneself in the culture of the group to be researched for an extended time period. It can also be described as the observation of people in their cultural context.

2.2 Personality Typology Used

The work of Jung and its close relationship to the MBTI (Myers-Briggs Type Indicator) are the areas of interest for this research. More information is available in the key books by Jung [4] and Myers [5], as well as previous papers by the authors [2], [3].

The test used in this research is not the official version of the MBTI, it is an online test based on the MBTI developed by Human Metrics a consortium of Israeli psychologists who have over 30 years experience in the field of personality research. Israeli statisticians and psychologists have found no significant statistical differences between this test and the official paper version of the MBTI [6].

2.3 Teams Observed

A whole range of SE group projects take place each year in the Department of Computer Science. These include the Crossover Project, Software Hut, Genesys, Darwin and Maxi Projects. These projects vary from first year undergraduate courses right up to MSc projects.

The work described in this thesis was carried out on Maxi and students. The Maxi project is an MSc project that runs for the academic year and the main aim of this
module is to ensure that students understand the nature of team-work and to equip them with the knowledge needed to become a valued team member in the SE industry.

The Maxi project was designed to give students experience of working in teams, in dealing with industrial clients and in dealing with the whole plethora of problems that are present in group projects working to a tight time-scale. Throughout the project the students are given advice on generic team working concepts such as team management, conduct of meetings and action minutes. All of the 2005-2006 Maxi teams agreed to participate in the research.

3 Classifications

There were several phases involved in going from the field notes stage into quantifiable data. These phases are described in detail in [3]. Issues rated 1, 4, 5 and 6 on the ordinal scale were deemed to be potentially problematic for a variety of reasons. The evolution of the scales to measure the impact of no debate and/or disruptions on the workings of SE teams is described in [1]. As this is a follow up study there is no need for further discussion in this paper as the classification schemes have been adequately described in earlier reports. For purposes of clarification the scales will be included in this paper:

<table>
<thead>
<tr>
<th>Level</th>
<th>Kind of Disruption</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Premise uncritically accepted with no interaction between team members</td>
</tr>
<tr>
<td>2</td>
<td>Dealt with smoothly and harmoniously after a brief discussion</td>
</tr>
<tr>
<td>3</td>
<td>Lengthy period of constructive debate discussing the virtues of an issue</td>
</tr>
<tr>
<td>4</td>
<td>Caused slight disruption by forcing people off relevant issues</td>
</tr>
<tr>
<td>5</td>
<td>Lengthy period of destructive debate, lengthy disruption</td>
</tr>
<tr>
<td>6</td>
<td>Caused complete disruption to the work of the team</td>
</tr>
</tbody>
</table>

Table 1: Level of Disruption

Issues where the level of disruption was rated as 2 or 3 were assumed to be handled ‘normally’ i.e. without disruption, whereas others were expected to have some impact on the quality of the work produced. To measure this two ordinal scales were created. It was observed that there were two kinds of effects: an internal impact where the relevant issues were resolved without management intervention and an external impact when management was forced to intervene. To measure the extent of these
effects two ordinal scales were created, one each for internal and external impacts as shown in tables 2 and 3.

<table>
<thead>
<tr>
<th>Level</th>
<th>Internal Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No Impact</td>
</tr>
<tr>
<td>1</td>
<td>Small changes made to document</td>
</tr>
<tr>
<td>2</td>
<td>Large scale restructuring to one document</td>
</tr>
<tr>
<td>3</td>
<td>Major restructuring to more than one document</td>
</tr>
<tr>
<td>4</td>
<td>Complete re-write of documentation</td>
</tr>
<tr>
<td>5</td>
<td>No working system at end of project</td>
</tr>
</tbody>
</table>

Table 2: Internal Impact of Issue

<table>
<thead>
<tr>
<th>Level</th>
<th>Managerial Involvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No Impact</td>
</tr>
<tr>
<td>1</td>
<td>Management intervention led to small changes</td>
</tr>
<tr>
<td>2</td>
<td>Major large scale restructuring due to management criticism</td>
</tr>
<tr>
<td>3</td>
<td>Large scale restructuring to several documents</td>
</tr>
<tr>
<td>4</td>
<td>Marks lost for area of project</td>
</tr>
<tr>
<td>5</td>
<td>Deadlines missed, marks lost for late work</td>
</tr>
</tbody>
</table>

Table 3: External Impact of Issue

4 Results

Three Maxi teams were observed over the academic year 2004-2005. Once more interesting results were obtained. A striking feature of these teams was that they were very ethnically diverse; one team did not have a single native English speaker. Obviously such factors must be taken into account when analyzing the results. There was also an overwhelming bias in favour of the functions of NT, to the extent that not a single subject returned sensing as a preference over intuition, 73 % of the subjects had a preference for thinking over feeling, 60 % had a preference for judging over perceiving, and 53 % preferred extraversion over introversion. In comparison to the NT functions scale, the preferences on the E-I, J-P attitudes scale were much more diverse, without such a striking contrast in the results.
4.1 New Maxi Team 1

<table>
<thead>
<tr>
<th>ID</th>
<th>Type</th>
<th>E-I %</th>
<th>S-N %</th>
<th>T-F %</th>
<th>J-P %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A</td>
<td>INFP</td>
<td>I 44</td>
<td>N 33</td>
<td>F 44</td>
<td>P 22</td>
</tr>
<tr>
<td>1B</td>
<td>INTP</td>
<td>I 44</td>
<td>N 22</td>
<td>T 11</td>
<td>P 33</td>
</tr>
<tr>
<td>1C</td>
<td>ENTJ</td>
<td>E 44</td>
<td>N 33</td>
<td>T 44</td>
<td>J 11</td>
</tr>
<tr>
<td>1D</td>
<td>ENFJ</td>
<td>E 11</td>
<td>N 22</td>
<td>F 11</td>
<td>J 22</td>
</tr>
<tr>
<td>1E</td>
<td>INTJ</td>
<td>I 33</td>
<td>N 67</td>
<td>T 56</td>
<td>J 1</td>
</tr>
</tbody>
</table>

Table 1: MBTI Types New Maxi Team 1

Average Clarity of Preference:

- E: 28
- I: 40
- N: 35
- S: 0
- F: 28
- T: 37
- J: 11
- P: 28

This team managed to work remarkably well over the entire project, despite great differences in both personality and ethnicity. They produced work of a consistently high quality and were a team in the true sense of the word, in that the collective whole was much greater than the sum of its parts. This team wasn’t dominated by one or two individuals, and communication between the members was excellent throughout. This communication was a feature of team meetings as almost all issues were discussed thoroughly and the atmosphere encouraged constructive debate.

![Figure 1: Level of Disruption all Issues New Maxi Team 1](image)

Figure 1 shows that this team were remarkably consistent when it came to debating issues; they also avoided the major problems of disruption or lack of debate. The overwhelming majority of issues debated by this team were grouped under ordinal rating 3. They also had a fairly well balanced look when it came to informing and ideas/questions as illustrated by figures 2 and 3:
1A (an INFP) and 1C (an ENTJ) were the main spokesmen for this team, although they were ably assisted by other team members. 1A in accordance with type theory was a sensitive individual, who promoted positive growth amongst team-mates. 1A was very polite, a good listener and had the ability to put team-mates at ease, 1A was genuinely interested in understanding points from team-mates, and was keen to avoid any conflict. Even if 1A strongly disagreed with someone there was no animosity, instead the focus was on intuitively understanding the other person’s perspective and feelings. As an INFP, 1A focused on feelings and human conditions and attempted to avoid rushing to any impersonal judgements. This preference for perceiving was a crucial factor to take into consideration when looking at how many issues were rated three on the ordinal scale. 1A genuinely wanted to help and encourage others to enunciate their opinions.

1C worked very well with 1A. 1C as an ENTJ with clear preferences had a natural tendency to organize and direct the team. 1C was decisive, knowing what needed to be done, and was confident when assigning roles to team-mates. Although 1C was very strong in debate, there were no instances of this character becoming confrontational, despite not being tuned in to people’s feelings; a lot of this was down to the personality types of team-mates. 1C was determined not to repeat any mistakes, and if the manager or client commented on a particular piece of work, 1C ensured that these comments were taken into account whilst either amending a previous piece of work or starting a new piece. 1C had a lot of presence and was able to use this as a force towards achieving team goals. 1C was very assertive without appearing to be arrogant or domineering, but was also innovative and had a flare for ideas.

The other key member of this team was 1E whose knowledge of technical issues proved to be invaluable. 1E’s type is INTJ. Although 1A and 1C were the main spokesmen in this team, 1E was the person most likely to answer any technical query or deal with any problem in this area, 1E was aided and abetted in this by a hardworking though subservient sidekick in 1B (INTP). 1E was very insightful and was quickly able to understand and then apply a concept. This came to the fore when technical issues such as XML, Java, Object-Oriented Design, and Software Testing were discussed. 1B’s role was to primarily act as a foil for 1E when discussing such issues. 1B had a great ability to analyze difficult problems, and come up with logical explanations. 1B sought clarity from many of 1E’s statements and helped to turn many ideas into realities. 1B was gregarious around team-mates, but because of
underdeveloped feeling had difficulty in giving warmth and support to team-mates in certain scenarios, when THF issues were discussed.

Figure 4: Issue Type New Maxi Team 1

Figure 4 shows the kind of issues that were discussed by this team. One THF issue caused slight concern, but was still discussed in a rational manner. This was the matter of 1A checking work for grammatical errors, this was a large extra burden but was deemed necessary after client and managerial criticism over the layout of stage plans, feasibility reports and requirements documents. Due to 1A’s diligence and willingness to help those who were not so proficient in terms of written English these initial problems were overcome.

The final member of this team 1D is an ENFJ. 1D had very good people skills and sought to bring out the best in team mates. 1D focused on understanding, supporting and encouraging team mates, especially when working on documentation. Although at the same time 1D was always honest when assessing others’ work, this honesty was appreciated by team mates. 1D’s intuitive awareness of peoples needs coupled with the preference for feeling helped to create a positive human centred environment that was conducive to good team work. As all issues concerning this team were rated as a 2 or 3 on the level of impact scale they did not produce any data for impacts of disruptions.

4.2 New Maxi Team 2

<table>
<thead>
<tr>
<th>ID</th>
<th>Type</th>
<th>E-I %</th>
<th>S-N %</th>
<th>T-F %</th>
<th>J-P %</th>
</tr>
</thead>
<tbody>
<tr>
<td>2A</td>
<td>INTP</td>
<td>178</td>
<td>N 78</td>
<td>T 44</td>
<td>P 33</td>
</tr>
<tr>
<td>2B</td>
<td>INTJ</td>
<td>I 11</td>
<td>N 11</td>
<td>T 78</td>
<td>J 44</td>
</tr>
<tr>
<td>2C</td>
<td>INTJ</td>
<td>I 56</td>
<td>N 33</td>
<td>T 33</td>
<td>J 44</td>
</tr>
<tr>
<td>2D</td>
<td>INTJ</td>
<td>I 11</td>
<td>N 33</td>
<td>T 33</td>
<td>J 56</td>
</tr>
<tr>
<td>2E</td>
<td>ENTJ</td>
<td>E 1</td>
<td>N 33</td>
<td>T 11</td>
<td>J 11</td>
</tr>
</tbody>
</table>

Table 2: MBTI Types New Maxi Team 2

Average Clarity of Preference

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>E:</td>
<td>1</td>
</tr>
<tr>
<td>N:</td>
<td>38</td>
</tr>
<tr>
<td>F:</td>
<td>0</td>
</tr>
<tr>
<td>J:</td>
<td>39</td>
</tr>
</tbody>
</table>

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>I:</td>
<td>39</td>
</tr>
<tr>
<td>S:</td>
<td>0</td>
</tr>
<tr>
<td>T:</td>
<td>40</td>
</tr>
<tr>
<td>P:</td>
<td>7</td>
</tr>
</tbody>
</table>
This team experienced a lot of disruptions, due almost entirely to sharp retorts and sarcasm. 2A was the driving force behind the team, yet paradoxically was also the cause of many disruptions.

Figure 5: Level of Disruption all Issues New Maxi Team 2

This team did not suffer from any problems relating to lack of debate, as Figure 5 illustrates. The large number of issues rated as 2 or 3 highlight the fact that the team members were happy to discuss certain points. On the minus side the large number of issues rated 4 and one that rated 6 shows that there was a lot of disruption. These disruptions caused serious long term problems, and resulted in failure to complete the project. Figure 6 lists the type of issues that were responsible for causing disruptions.

Figure 6: Disruptive Issue Type

Many of these disruptions were caused by sarcasm, witty responses or pedantry. 2A is an INTP (the only team member with a preference for P over J) with very clear preferences for functions and attitudes. 2A was very analytical and often caused annoyance by correcting others in a sharp manner. Pedantry was also a problem as 2A often displayed open-endedness when discussing solutions due to the preference for perceiving coupled with the NT characteristics, so we are left with a character who has an open-mind, but is also driven by a need to be precise and competent, this served the team well on several occasions when writing documentation, as 2A insisted that the team address every point mentioned by the manager, and with stage plans as 2A stressed that all work should be recorded including hours spent working on a particular part of the documentation, and suggesting that the team meet the client twice in quick succession just incase there were any last minute changes. 2A was also careful to warn the team about overkill, putting in too much information with regards to design documents, especially relating to people and procedures, he said be precise and to the point, mention something if necessary, this contradicted the views of other team members and the manager, and earlier views expressed by 2A, for 2A it was extremely important that ideas and facts were expressed correctly and succinctly. 2A
was typical of an INTP in the sense that they spend considerable time second-guessing themselves; this could be confusing for team-mates. 2A occasionally accused people of stating the obvious or offered a sharp retort to a suggestion, and often seemed to be haunted by a sense of failure in the project. This was not done with any malice or intent to offend as 2A was a generally laid back character and came across as having a good relationship with team-mates, none the less disruptions were caused and discussion was sometimes killed. Another team member 2D admitted that “2A was good with ideas, and proved to be very useful to the team”. 2C also stated that “at times the team seemed to be like a one man band, and said 2A’s contribution was “crucial”.

Examples of 2A’s responses include “we will have a database, so don’t worry”, was the response to a legitimate point about how to organize the DB tables. When discussng the nature of the software to be produced one team member (2E) stated “the most obvious thing is that we are dealing with a change management system”, to which 2A responded “tell us something we don’t know”. In another discussion with 2D, 2D asked whether a revision would be entered manually or automatically for a specific artefact, 2A responded with “automatically, that is the whole point of the system”, to which 2D said “so a command object”, at this point a clearly frustrated 2A simply said “bingo”, another discussion was concerned with risk analysis, 2A used the same word when 2B stated “that there was no need to add spell-checkers and tables as this is already available in WinWord”, 2A’s reply to this was “bingo, there is no need to reinvent the wheel”, 2A stated that a lot of risk analysis was pointless but needed to be done and added that it was vital in systems “that could kill people”, and when 2D said an artefact can have many revisions, 2A responded by saying “that’s obvious”. There were other similar exchanges but it is not necessary to describe each occurrence here as the point has been made. 2A’s team-mates did not respond in any provocative manner as they were not put off by any sharp comments, albeit apart from some awkward periods of silence after a retort.

Figures 7 and 8 show that disruptions had a serious detrimental impact on the performance of this team. This was the case for internal and external impact. What this means is that if a disruption did occur, it was likely to be troublesome and would have far reaching consequences.

Some members of this team expressed concern early on, stating that they were not comfortable doing certain types of work. 2B uttered what turned out to be prophetic words “at the end of the project the solution will not work”. 2B also said that many problems would not go away; some team members expressed concern about writing
certain types of documentation and programming. These problems were never adequately addressed. 2C was worried about internal mental problems, such as changing focus when they had already decided to go down one particular route. 2C also noted that other team members had to play a more active role and not allow 2A to do most of the talking, having such a clear preference for introversion meant that 2A was not a natural spokesman, and wasn’t totally confident when discussing with his team-mates, clients and managers, INTP’s do not like to lead or control people as it goes against their nature. 2C also realized early on that the team were not getting enough specific information from the client, this had dire consequences as the project reached its climax, 2C was keen to stress that the team started to plan their work better, break work down for individuals and work out some pertinent questions for the client, and they must stress continuity and keep each other informed of developments. Later on in the project 2C mentioned that the team were putting things off, that they should have done the database before the Easter break, 2B also mentioned that they should have had a meaningful discussion with the demonstrator before the Easter break. Despite being clearly aware of impending problems the team did not act. This inaction did not pass without consequence: the team were late handing in the Stage 1 statistics, which had to be posted to the manager, this resulted in loss of marks; they were well over budget at the end of Stage 2; and 2A attempted unsuccessfully to shift the blame to the manager for the team being over budget; there was a bug in the final system that prevented users from entering a new artefact; 2A’s admission that one person was responsible for the lion’s share of the code; the login wasn’t working, which was directly related to earlier concerns from team mates about being uncomfortable with certain tasks; there were also obscene messages in the system when it was demonstrated, this was wholly unprofessional, and the final documentation was incomplete. The end result of all of this was that there was no working system at the end of the project, and this was made worse by the fact that important documentation was incomplete (i.e. requirements and testing), an absolute worse case scenario for a Maxi team.

Figures 9 and 10 show who was responsible for informing, generating ideas and asking questions.

![Informing New Maxi T2](image1)

![Idea/Question New Maxi T3](image2)

Figure 9: Informing New Maxi T2 Figure 10: Idea/Question New Maxi T3

Figures 9 and 10 show that 2A was the dominant member and that concerns about his heavy workload were justified. These concerns came from 2A, other members of the team and the manager who felt that 2A was sometimes carrying an intolerable burden. Not surprisingly the sheer pressure of this situation took its toll on 2A’s health, as the project went on 2A started to complain about feeling weak and tired and was
susceptible to viruses, on a couple of occasions 2A was absent due to a heavy cold. Other team members complained about tiredness and burn out, but they did not suffer to the same extent as 2A who at times appeared to be visibly afflicted by illness. Another telling factor was that 2A was the only native English speaker in the team, so perhaps other members were not so confident when informing or coming out with ideas, although they were happy to discuss points once they had been raised.

Because 2A was such a dominant member of this team the remaining members can only be mentioned in passing. All of these members were INTJ’s, with three INTJ’s (2B, 2C, and 2D) and one ENTJ (2E). 2C in particular had a very clear preference for introversion and seemed very reserved in meetings, Figures 9 and 10 shows that this person did not initiate a single discussion. A noteworthy incident involving 2C related to getting the client to sign the requirements document. 2A initially suggested forging the signature, and 2C responded by arguing that they should force the client to sign it, at sword point if necessary. This threat of violence caused this particular issue to be rated as a 6 on the original ordinal scale.

The contributions of the other members were neither intrinsically good or evil, 2D engaged in several useful debates with 2A and apart from 2A was the most active team member, 2D enjoyed asking questions and was keen to gain an understanding of different areas of the project, this was apparent during discussions with 2A. 2D also admitted to suffering from depression due to the project and other factors and also expressed deep dissatisfaction at the end of the project. 2D was also at the forefront of mentioning concerns relating to work that needed to be carried out and whether the team were ready to undertake certain tasks. 2B and 2E did not cause any disruptions, nor were they at the forefront of discussions. They were generally diligent when called upon to do a certain task, but seemed to lack initiative and would often wait to be told what to do as opposed to volunteering or suggesting a certain path.

This team provided a classic example of what can happen when there is too much reliance on one member. The fact that both the documentation and the system were incomplete at the end of the project speaks for itself. The disruptions that took place were often damaging to the overall performance and severely hindered the team. Whilst having many issues that rated 4 on the ordinal scale, this team did not have any serious screaming matches or confrontations, the disruptions were more related to sardonic responses and idiosyncratic drollery. Nor was lack of debate a problem for this team, they were often aware of problems yet instead of acting on them preferred to leave things to 2A. This tactic could only work on a short-term basis, relying on it over the entire project proved to be a very costly error.

### 4.3 New Maxi Team 3

<table>
<thead>
<tr>
<th>ID</th>
<th>Type</th>
<th>E-I %</th>
<th>S-N %</th>
<th>T-F %</th>
<th>J-P %</th>
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<tbody>
<tr>
<td>3A</td>
<td>ENFJ</td>
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<td>N 11</td>
<td>F 11</td>
<td>J 1</td>
</tr>
<tr>
<td>3B</td>
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<td>I 56</td>
<td>N 44</td>
<td>T 44</td>
<td>P 22</td>
</tr>
<tr>
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<td>N 33</td>
<td>T 22</td>
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<td>N 33</td>
<td>T 1</td>
<td>J 22</td>
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<td>3E</td>
<td>INTJ</td>
<td>I 78</td>
<td>N 56</td>
<td>T 11</td>
<td>J 11</td>
</tr>
</tbody>
</table>

Table 3: MBTI Types New Maxi Team 3
Average Clarity of Preference:

E: 20   I: 48
N: 35   S: 0
F: 2    T: 20
J: 17   P: 4

Observing this team throughout the project was very interesting, for the first half of the project they were dominated by two individuals (3D and 3E), and for the second half dominated by 3B. The other two members had minimal influence. Another aspect of this team was that for a while they were fractured along both ethnic and gender lines. Figure 11 shows the level of disruption for all issues involving this team.

Figure 11: Level of Disruption for all Issues New Maxi T3

A cursory glance at Figure 11 shows that lack of debate was not a serious problem, and that 3 was the most commonly occurring ordinal rating. On the negative side 4 was the second most commonly occurring ordinal rating with only one less issue than 3. The kinds of issues resulting in disruptions are shown in Figure 12. Figure 12 shows that the disruptions were almost evenly spread between PSI, THF and C. The PSI problems affected areas such as budgets and stage plans, feasibility report, and design document, so they were not minor concerns. An example is that the feasibility report was said to be ‘disastrous’. The mission statement was incorrect, they failed to address feasibility and justification, and the manager was marking against those headings. This was a rude awakening for the team and 3E stressed that they needed to communicate with each other in a more coherent fashion.

Figure 12: Disruptive Issue Type
Figures 13 and 14 show the internal and external impact of disruptive issues.

![Internal Impact Chart](image1)

![External Impact Chart](image2)

The THF problems had a greater effect on the team, as they persisted for the entire project. As mentioned earlier there was an ethnic division in this team, at times it was 3D and 3E almost working as a separate team. Both of these characters were the same nationality. 3E remarked that together with 3D they could form a sub-group. 3D and 3E both complained on several occasions about having to do most of the work. 3D said that there was a danger that the team could be seen to be dominated by 3D and 3E. 3E admitted that they were running the show. 3D argued that one or two members were being overloaded with work and putting in a lot more hours, according to 3D only two people were working on project reports and documentation. 3E added that the DB and class designs were also done by the same people and that only two people were working hard in the team. 3B admitted that 3D and 3E had worked very hard during the first half of the project, to which 3E responded that there were serious communication problems and problems relating to submitting things at the last minute and not having the chance to check documents prior to submission.

3B said that 3A had the statistics for Stage 3, to which 3A responded that the budget was incomplete. This prompted 3D and 3E to throw their hands in the air in frustration! 3B did not agree entirely with the argument that 3E and 3E were doing most of the work and others were deliberately avoiding work, 3B claimed that there were many factors influencing why the team was being dominated by two people, the main reason was that there was a team within a team including having conversations in a foreign language. This was also apparent by 3D’s admission that work was going on with 3E on 3D’s own personal machine at home. 3E said that everyone seemed to be working on their own machine. 3C also said that 3D and 3E should try to involved others more, 3D responded by stating that the others should show more initiative. After this, 3B started to play a prominent role. 3D stressed that they should be wary of team problems.
Figures 15 and 16 show that the duo of 3D/3E, and 3B were dominant. 3B felt compelled to act in light of complaints from 3D/3E. 3D and 3E made it clear that they were not interested in socializing with the rest of the team, and said they should be too busy working to worry about going out. Another side issue was that 3A had managed to insult 3B by using foul and abusive language in response to a legitimate question about the design document. 3A tried to claim that it was done in humour but could barely conceal the simmering anger. 3B said such insults and language were bad for team morale; this followed a threat by 3D to walk out due to dissatisfaction with the way things were progressing. 3E also remarked that they were running over budget.

What happened during the second half of the project was very interesting, because it was almost as if the first half of the project had been turned on its head. This time it was 3B doing most of the work and dominating meetings. 3B said three members of the team had bailed out for the Easter holidays. 3B almost single handedly designed the interface, managed to do most of the DB connectivity work, wrote most of the SQL queries for the DB, tested the interface and the DB, and worked hard on the user manual. This hard work came at a large personal cost to 3B in terms of health and lifestyle. At one point 3B complained about sleep deprivation, and mentioned only having 4hrs sleep over a period of 3 days, 3B was also dogged by burn-out during the last few weeks and admitted to suffering from burn-out in one meeting. 3B also confessed to having spent 60-70 hrs working on the user interface, and said the team seems to be a one man band and had gone full circle since the first half of the project. In the first half of the project 3D and 3E were the dominant members, in the second half 3B was dominant, a remarkable turn around.

This team was essentially dominated by three individuals, but not in a conventional sense, as the duo of 3D/3E led the way in the first half of the project and 3B became the prominent member in the second half. The other two members 3C and 3A were largely in the background for the duration of the project. They did seek solace in each other and kept out of internal team politics apart from on the occasion when 3A insulted 3B with foul language, this was puzzling as both 3C and 3A had a preference for extraversion over introversion; it would have been interesting to have seen their interactions in an all female team. Interestingly there was a sharp gender division in this team, with 3A and 3C being the only females, and they were largely frozen out of the discussions.

3D and 3E were ENTJ and INTJ respectively. 3D had moderately clear preferences for functions and attitudes and 3E had very clear preferences for introversion and
intuition. 3D disliked seeing mistakes repeated, and had no patience with inefficiency. 3D was not naturally tuned in to other people’s feelings, hence the harsh complaints about others not pulling their weight, and leaving work to 3D and 3E. At times 3D could be harsh, and often had difficulty seeing things from outside of a personal perspective and could often lack patience with those who saw things from a different perspective. 3D needed to work on recognizing the value of other opinions, and to take other people’s feelings into account. This could be one of the main reasons why the two female members of the team were reluctant to express opinions. 3D could have appeared to have been an overbearing individual with a forceful, abrasive nature. This is similar to an ENTJ from a previous study [1], a member of Genesys Team 4 who intimidated several team mates due to being perceived as overbearing and arrogant, yet the individual in this Genesys team had a grudging respect for the prominent members of the team. This is fitting in with type theory, as 3D certainly respected 3B when the latter expressed contrary opinions and stood by them. Yet very few people do stand up to such individuals, as both members 3D and 4F from the Genesys team were very forceful and excelled in verbal duels. 3D did enjoy interacting with 3E and ENTJ’s enjoy interacting with people generally.

3E as an INTJ was drawn to 3D primarily because of shared language and culture, but personality also played a role. INTJ’s value intelligence and competence, and 3D had the presence of an intelligent and confident person. Introverted intuition dominated 3E’s personality; a lot of energy was focused on generating ideas and possibilities. In the presence of 3D, 3E was encouraged to share ideas and ask questions, particularly as many of the early meetings resembled a private conversation between these two individuals and sometimes involved flitting between different languages. 3E was happy to let 3D take the lead role, due to 3D’s greater communication skills, yet was effective at objectively looking at specific situations and often realised that the team were heading towards problems, particularly due to communication barriers. 3E was also realistic with the realisation that unless the individuals started to work as a team and end the practice of having splinter groups within the team, there was a good chance that they would sink together. Despite this 3E seemed to lack interested in other people’s feelings when discussing human issues, with the exception of 3D. With such a clear preference for intuition, 3E had a tendency to ignore the details and realities of the current situation. This came to the fore when 3E started to discuss different approaches to designing the system whilst the team were still in the feasibility stage, and when querying the database was discussed before it had been designed, this long range thinking was useful as it forced others to consider the next step, but was little use when faced with clear and present dangers and deadlines. 3E came across as being an aloof and reserved character to team mates, and rarely expressed positive opinions (or any opinion) about other peoples’ work or plans. This wasn’t down to rigidity or ignorance, people with such a clear preference for INT often have difficulty expressing themselves, particularly when discussing emotional or human centred points. In the absence of adequate communication abilities, 3E ran the danger of appearing blunt to team mates.

3B was in many ways a similar character to 2A in the previous Maxi team both are INTPs. By a strange sequence of events 3B became the dominant member and spokesman of the team. This was remarkable given that 3B played a strictly supporting role in early meetings, and was happy to let 3D and 3E drive the team. This changed when 3D and 3E started complaining about the lack of effort and
initiative from the others. 3B certainly responded to this criticism and carried out a lot of research relating to the project, such as reading extensively on user interface design, and SQL. This was in addition to carrying out work as described earlier. As an INTP, with a clear preference for thinking 3B was concerned with truth, and justice. This proved to be a catalyst for 3B’s remarkable response in the second half of the project. 3B did not want to be penalised unfairly, and made the decision to lead from the front. Because of this introverted thinking, 3B was inwardly decisive, there was no loud proclamation, and 3B simply decided that a change in course was necessary. Under stress an INTP can become very sensitive to criticism, and it could be argued that 3B overreacted to the threats and criticism emanating from 3D and 3E. As 3B remained in the shadows for most of the first part of the project, and worked almost single-handedly during the second half it is very difficult to assess interactions with team-mates. 3B certainly focused on the central issues, viewed information objectively, and used analytical skills and sheer hard work to solve problems. It is unlikely that the team could have completed the project without 3B’s great efforts towards the end, this differed from the previous Maxi team as 2A carried that team for the duration of the project as opposed to the one half from 3B, nonetheless these efforts had a detrimental effect on the physical and psychological health of both students. A legitimate criticism that could be levelled at 3B was that there was not enough consultation with other team members, and better relationships could have been established with 3A and 3C, although the relationship with 3A was strained due to an angry verbal assault from 3A. This verbal assault coupled with the criticism from 3D and 3E led to 3B having a very negative emotional state of mind, this led to 3B interpreting project issues in a very subjective way, such as diving right into the user interface design on the back of personal research without discussing with others. In many ways the behaviour of 3B was typical of that of an INTP with clear preferences acting under pressure, or in the face of what they perceive to be an injustice.

There was another problem facing this team in addition to the fascinating interactions and politics going on. This was the issue of having more than one client. 3A remarked that the initial client they were seeing was not the final user, yet they had to meet this person in order to gain access to the actual client. 3D was angry about this and said that “extended lines of communication could be a problem; it could end up like Chinese questions”. 3A said this could be a problem as the final client may have very different requirements. 3D also noted that the initial client was changing requirements and messing the team around, 3D’s impatience and anger towards the client increased as the project went on. 3D felt the client was wasting the teams’ time with pointless meetings and by changing the requirements. 3E event went as far to suggest that the team forget their own internal differences and see the client as some kind of common enemy. 3D agreed with this and added that the client had created a separate list of non-functional requirements which went against what the project manager suggested. 3B later said that “having two clients is a nightmare, they make changes and are not synchronised”. 3B was forced to concede late on in the project that any new changes could not be accommodated and the system would have to be frozen. Although all of the team had faith in the project manager, in that he would not allow any unfair changes from the client that deviated from the original requirements document so close to the end of the project.
Despite all of these setbacks a working system complete with documentation was produced at the end of the project. In the final project meeting only 3B and 3A were present. 3B admitted that the project was a real learning experience. The 3 issues which rated 1 on the level of disruption ordinal scale had no negative impact for this team. Further analysis reveals that one issue was a short exchange between 3D and 3E relating to Fagin’s inspections, the next was a general comment by 3D about programming languages, and the third was a comment made by 3B with regard to the user manual. Given the nature of both the issues and the team is it possible to ascertain why no disruption occurred as a result of these issues rated 1 on the level of impact scale.

5 Aggregation of Results

![Figure 17: Overall Impact Rating/Internal Impact](image1)

![Figure 18 Overall Impact Rating/External Impact](image2)

Figures 17 and 18 show that lack of debate was unlikely to have a serious impact on any of the Maxi teams from the 04/05 project. Instead it was issues that were actually classified as disruptions (i.e. rated 4, 5 or 6 on the level of disruption ordinal scale) that tended to have a serious internal and external impact. What is interesting about this set of results is that lack of debate did not seem to be a problem in any sense, one reason for this is that very few issues did pass without adequate debate, this can be
seen by the very high numbers of twos and threes on the level of disruption ordinal scale for all of the teams involved.

As was seen in the descriptions of the teams these disruptive issues had an adverse, in some cases fatal impact on both internal interpersonal communication and on the actual work produced. One team narrowly avoided complete disaster due to the heroic efforts of one member in the final weeks; another team were not so lucky and failed to produce the required work by the end of the project time-scale. This shows just how serious the impact of disruptions can be on the workings of SE teams.

6 Conclusions

It appears that the personality composition of members is very important, and can affect team leadership, and intra-team communication and coordination. Other research has argued that these human aspects are just as, if not more important than technical aspects for better performance [7], [8], [9].

Group interaction styles affect communication and thus team performance by facilitating or hindering the exchange of information among group members. An issue requiring further study was how constellations of personality types manifest into team interaction styles. This PhD project helped to fill this knowledge gap. A practical implication of this research is that it may be possible to predict team performance and interaction style from an assessment of the personalities of its individual members. If an interaction style can be predicted then it may be possible to predict the effectiveness of the teams’ performance on certain tasks. Detailed descriptions of these aspects can be found in the results section of this and other relevant papers [2], [1], [3]. SE managers should consider selecting personnel so there is personality heterogeneity between the team leader and other team members in the social-interaction and information gathering dimensions.

The Maxi project teams described in this paper contained several interesting characters, New Maxi Team 1 passed by without incident, and the other two teams had certain individuals who were responsible for the majority of disruptions. 2A from New Maxi Team 2 and 3B from New Maxi Team 3 were both INTPs. 2A in particular was a very clear and quick thinker, and was able to focus with great intensity on different areas of the project. 2A sometimes worked alone through the night, according to type theory INTPs exhibit the greatest precision in thought and language of all the types, a problem for people with such clear preferences is that they run the risk of becoming impatient with those who are not so quick to appreciate their opinion or insight. This may cause others to become defensive and view the INTP as arrogant. This came to the fore in 2A’s critical analysis of other peoples’ ideas and comments, and to a lesser extent with 3B who worked alone for long periods. An INTP enjoys work that allows them to use logical and structured thinking, to be abstract and build models, 3B certainly enjoyed designing the interface; intuition was given full play as the design process got under way. 3D from New Maxi Team 3 had many of the same characteristics as 4F from Genesys Team 4, a loud, opinionated, boisterous character, who enjoyed making decisions and developing ideas, but at the same time could be said to be dominating the team and failing to take other peoples’ feelings into account, this was obvious when 3D criticised others and ignored their take on the situation.
This research has demonstrated that psychological type can be used as a means of understanding different, and sometimes, opposing views towards problems in team based SE projects. Results of this work help to explain the conceptual orientation of software engineers toward working through the stages of a project.

7 References