

Integrating Team Contracts in Interdisciplinary Project-Based Learning

Elena Vasquez, Maria Rodriguez

Elena Vasquez, Department of Engineering Education, University of Geneva, Switzerland; Maria Rodriguez, Institute of Educational Research, ETH Zurich, Switzerland

ABSTRACT

The paper discusses the use of team contracts as a reflexive tool in the framework of a 9-month interdisciplinary program run across 3 institutions – the China Hardware Innovation Camp (CHIC). The program has the particularity of having teams composed of engineering students (3), design students (2) and business students (1) affiliated with one of the 3 institutions and working together to develop a connected device.

Given the limited number of students participating in the program each year (10-12 engineers and 10-12 non-engineers), emphasis is put on a qualitative assessment of the learning outcomes. This takes the form of several reflective notes due throughout the program covering teamwork, project management and intercultural management.

The paper focuses on the dimension of teamwork. It presents the underlying pedagogical scenario and the protocol related to the use of team contracts as a reflexive tool. It compares the proposed template with the contracts drawn up by 4 teams and analyses the evolution of the contracts during the program. It discusses the reflexive notes of students within a team and across/within teams and disciplines. Finally, it compares the evaluation by the students with the use of team contracts in another setting.

1 PROGRAMME OVERVIEW

1.1 Brief description of the programme

The CHIC program proposes to go “from idea to functional prototype in 30 working days”. Teams receive a blank sheet of A3 paper at the beginning of the program and have 3 semesters to conceive, develop and prototype an IoT device.

The high-level learning outcomes of the program have been divided into:

- Disciplinary: define functional requirements of a connected device, apply a structured approach to product development and realize a functional prototype;
- Transversal: communicate effectively with professionals from other disciplines, write a scientific or technical report, identify the different roles that are involved in well-functioning teams and assume different roles, including leadership roles, apply fast prototyping techniques and technologies, pitch a product in front of different audiences, communicate effectively across different languages and cultures.

The nature of the program implies that students are exposed to various management issues, including project management, teamwork and meeting management. In short, the program is project-based, interdisciplinary, inter-institutional and student-driven. It can be assimilated to new product development project-based programs [1]. As such it builds on a growing trend of product development programs in multi-disciplinary settings [2].

1.2 Motivation of the use of team contracts

Whereas the program tends to be highly appreciated by the students, they often point out the challenges related to working in interdisciplinary teams. As put forward recently by one participant: *"I was told it would be difficult but I never imagined it would be that hard"*. Such issues with cross-boundary collaboration are not surprising. Edmondson and Harley show that teaming across knowledge boundaries can be difficult in practice, and innovation is not always realized [3]. Heikkinen and Isomöttönen show that learning experiences are not fixed, as team spirit and student attitude play an important role in how students react to challenging situations arising from introduction of the multidisciplinary [4]. At the same time, Borrego and Newswander identify a number of characteristics of successful cross-disciplinary engineering education collaborations [5]. Reflexivity—the extent to which teams reflect upon and modify their functioning—has been identified as a possible key factor in the effectiveness of teamwork [6].

A number of reasons motivated the use of team contracts:

- In previous editions of the program, students were asked to write reflexive notes on project management and meeting management. The quality of the notes varied significantly between the students. Individual differences aside, one hypothesis was that they were lacking a common reference point to reflect upon;
- While team contracts have been used in the economics literature with the aim to optimize efficiency [7, 8], other authors have proposed the adoption of team contracts to initiate team learning [9]. The latter approach seemed more suitable to the learning environment;
- As noted above, previous assessment of transversal skills related to teamwork consisted of individual reflexive notes due by the engineers (and only the engineers) as part of their assessment of transversal skills [x]. Decision was made to extend the reflexivity related to teamwork to all the participants on two grounds: 1) all participants tended to agree that some of the key learnings from the program laid in teamwork and 2) limiting reflexivity to engineers sent the implicit message that it was (simply) an exercise rather than a tool to improve collaboration. A team contract seemed an ideal vehicle to gather all participants, give rise to discussion and collaboration around a common document.

2 PEDAGOGICAL SCENARIO¹

The team contracts were introduced as part of a broader workshop on teamwork that all participants followed at the beginning of the program. As a final activity of the workshop, teams were tasked with drafting a draft version of the contract. To do so, students were given a template² and time to work individually and then in their team to identify some of the questions deemed important. The elements of the contract referred to 4 dimensions: 1) goals 2) work norms, 3) meeting norms and 4) decisionmaking. Students were then mixed outside of their team to compare the important questions with students from other teams. Additional time was given for the students to bring back their discussions into their team and draft an initial version of the contract. If an agreement could not be found rapidly on one item, the different views would be noted, the discussion suspended and teams would have to move to the next item. Teams were encouraged to use their upcoming meetings to revisit, complete and/or amend the draft team contract. It was also made clear that the team contract would accompany them during the whole program and that it could be amended at any point in time. To ensure that students treated the contracts seriously, they became part of the deliverables.

The overall scenario included both group work and individual on the team contracts over the first 30 weeks of the program (see Table 1).

Table 1. Timeline of deliverables (group and individual)

	Week 2	Week 6	Week 11	Week 15	Week 30
Group	Draft version	1 st version		2 nd version	3 rd version
Individual			1 st reflexive note		2 nd reflexive note

Source: Compiled by author

3 COMPARISON OF CONTRACTS

3.1 Comparison of template with teams' contracts

Whereas the high-level elements of the 4 contracts are more or less identical – by and large they follow the template at their disposal – one can identify initial differences within the items (see Table 2). For instance, workload features in each contract but estimation vary from 16 to 20 hours per week. Akin, expected meeting lengths vary between 60 and 120 minutes. Regarding decision-making (including on contract amendments), certain teams opted for a majority system while others favoured consensus, followed by 2/3 majority in case of no consensus being reached.

¹ The use of team contracts and of reflexive notes has been shaped by discussions with Dr. Emmanuel Sylvestre from the University of Lausanne's Centre de Soutien pour l'Enseignement (CSE) and Dr. Roland Tormey from EPFL's Centre d'Appui pour l'Enseignement. The workshop on team work was conducted by Dr. Jean-Philippe Maître (UNIL, CSE). I am very grateful for their ideas and guidance in developing the pedagogical scenario and accompanying material.

² These categories and questions have been taken and modified from an outline found online in a resource for a course of software construction given at the MIT :

http://web.mit.edu/6.005/www/fa15/projects/abcplayer/team-contract/#team_contract

Table 2. Comparison of contracts across teams

	Goals and obstacles	Work norms 11 items	Meeting norms 6 items	Decision-making 3 items
Team 1	Goals: device and program-related Obstacles: mistakes, time management, values, MVP	(11) workload, division of work, deadlines, failure to comply, team contract revision, quality of work, communication, data storage	(6) frequency, location, length, note-taking and absence	(3) contract amendment, approval and nonagreement
Team 2	Goals: quality of work and agreement	(11) workload, division of work, failure to comply, deadlines, contract revision, disagreements, diversity, communication, data storage	(3) frequency, length, absence	(3) contract amendment, approval mechanism and rate
Team 3	Goals: device-related and individual objectives	(11) work load, division of work, deadlines, contract revision, disagreements, communication, data storage	(5) frequency, location, day, length and absence	(2) contract amendment, approval mechanism
Team 4	Goals: teamwork-related, learning Obstacles: schedule conflicts, disagreements	(11) workload, division of work, deadlines, absences, documentation, disagreement, communication, data storage	(5) frequency, location, length, note taking and absence	(2) contract amendment

Note: Numbers in parenthesis indicate how many of items are covered by the contract for each dimension.

Source: Author's data.

3.2 Evolution of contracts during the program

At the time of writing, the program is not over. One can nonetheless note that relatively few amendments were made between the draft, 1st and 2nd versions. A number of reasons can explain this: 1) the team contract covers all the situations and needs no amendment, 2) there are few frictions and disagreement in the team requiring to go back to the contract, 3) the contract is not considered as useful to ensure cross-boundary collaboration or to solve the existing frictions or 4) the team contract is (once again) seen as an exercise and not a tool for collaboration.

Some of the amendments made to date relate to meetings. For instance, no longer having a fixed meeting day/time or to take meeting minutes, a better equilibrium of meeting location, attribution of individual responsibilities. In one case, the amendment consists in the addition of a section regarding what takes place once team members no longer all work together on the project. More specifically, it addresses questions related to fairness and representativeness between team members as well as eventual financial compensation on the basis of working hours if there is money involved. The

latter is particularly interesting since no project in the past ever resulted in a financial transaction (as this is not the objective of the programme). However, it shows that the team envisages such an eventuality and deems it sufficiently important to amend the contract.

4 REFLEXIVE NOTES

Reflexive notes have been chosen as the *de facto* mechanism to assess the learning outcomes pertaining to transversal skills. They are due at the end of each semester (on week 11 and 30 of the program) and shall not exceed 500 words. Students have the choice to write their reflexive notes on 7 topics: 1) creative thinking, 2) communication in meetings, 3) meeting management, 4) project documentation, 5) management of convergence and divergence, 6) user-driven and solution-driven approaches, 7) team contract. They are asked to collect evidence specific to that process and conduct an individual analysis. The analysis is then discussed within the team before the drafting of the reflexive note. In other words, it follows an individualgroup-individual cycle. Each note must include a summary of the initial individual analysis, a summary of the team input and discussion, a link with the team contract, learnings pertaining to team and project management and (eventual) individual behavior change.

4.1 Comparison of reflexive notes within and across teams and disciplines³

6 reflexive notes (out of 23) pertained directly to “team contract”. As a reminder, students are free to choose which of the 7 types of reflexive notes they want to work on. Only “project documentation” totalled a similar number of reflective notes. One team had no reflexive note covering team contracts while the 3 others teams had 2 such reflexive notes each.

Table 3. Comparison of reflexive notes

	Communication in meetings	Convergence/divergence	Creative thinking	Meeting management	Project documentation	Team contract	User/solution driven	Total
B	0	1	0	0	2	1	0	4
D	0	0	1	2	1	2	1	7
E	1	2	1	2	3	3	0	12
Σ	1	3	2	4	6	6	1	23

Note: B=Business, D=Designer and E=Engineer; one student did not submit a reflexive note Source: Author's data

As part of the note, students were asked to link their comments to the team contract. Not all notes made such an explicit reference. Those who did covered elements such as responsibilities added to the contract, organization of documents, or decision-

³ At the time of writing, one (of two) reflexive note per person has been handed in.

making. It goes without saying that the 6 notes relative to team contracts made explicit references. In one case, the student questioned to what extent the contract was to be taken literally (i.e., as a legally binding contract) or as a guideline.

Table 4. Selected quotes from reflexive notes on team contracts

Team ₂	Team ₃	Team ₄
(E ₁) When we first wrote the team contract we kind of anticipated a lot of issues and norms but few of them were respected. We faced some issues that are written in the team contract, but we never needed to go back to it to resolve those problems. However, we also faced some issues that could maybe have been avoided if there were clearly written in the team contract. In the beginning, the team contract was not important for what was written on it but for the process of discussing the main points of group dynamics and be sure that everyone was on the same page. I learned that for a project as big, a good team dynamic is necessary and a team contract really helps in this aspect. In my opinion is not an immutable text but more a tool that helps the group to organize itself and guide us through all the steps of the project. Even if we don't use it very often, it is always in our mind.	(E ₁): Go through initial contract and compare. One aspect to revise pertained to allocating more time to decision-making. Two aspects to add pertain to collegiality and ownership in case of incorporation. On the basis of a group discussion, some students propose to update the contract; one student sees the contract as useful when future problems will arise. (D ₂): Team contract as important piece in team dynamics in particular when things become tough. On the basis of the group discussion, a change is proposed regarding meeting length (upwards) and an addition regarding managing deliverables.	(B ₁): The contract was a good start to understand how the members are willing to work on the project. Some additional details have been added since we wrote the contract but nobody thought of updating it. (E ₃): We interpret the contract more as a guideline and not word by word as a legally binding document. Another proposition was to regularly check the contract and adapt/revise it.

Note: B=Business, D=Designer and E=Engineer

Source: Author's data

As a general rule, students seem to have followed the process to discuss their note within their team. This resulted in some form of congruence (at times overlap) between the notes in teams. At the same time, in only one team did half of all the students work on the same note (3 out of 6).

4.2 Comparison with US study

Smith provides an interesting comparison point when it comes to how student perceive team contracts [10]. A similar questionnaire was given to the participants of the CHIC program after Week 20. One can see that except for individual performance, the CHIC participants fall within the undergraduate and graduate students sampled in Smith's study (see Table 5). Likewise, the question on which there is the most disagreement relates to their own performance. That said, on average, the participants tend to agree with the fact that the contract improves/enhances elements pertaining to collaboration (accountability, commitment and expectations).

Table 5. Comparison of team contracts studies (means)

Questions	Undergraduate (n=15)	Graduate (n=32)	CHIC program (n=17)
The use of team contracts increased my sense of responsibility to the team	4.13	3.16	3.59
The use of team contracts increased team members' overall sense of responsibility to the team	4.13	3.13	3.29
My performance was improved because of the team contract	3.73	2.44	2.35
My team's performance was improved because of the team contract	4.07	2.75	3.00
My satisfaction with the team project was improved because of the team contract	3.87	2.75	3.18
The team contract increased my sense of accountability to the team	4.13	3.03	3.29
Fairness of team process was enhanced by using the team contract	4.40	3.16	3.76
Fairness of team results was enhanced by using the team contract	4.20	3.09	3.47
Sense of overall commitment was enhanced by using the team contract	4.27	3.31	3.35
Task-specific commitment was enhanced by using the team contract	4.33	3.28	3.29
Clarity of expectations was enhanced by using the team contract	4.47	3.41	3.59
Overall effectiveness was enhanced by using the team contract	4.53	3.09	3.24

Note: the questions followed a Lickert scale 1-5 with 1=Strongly disagree and 5=Strongly agree
Source: Adapted from [10] and author's data

5 DISCUSSION AND CONCLUSION

5.1 Lessons learnt

A number of lessons can be derived from the team contracts and first reflexive notes:

- The understanding of "contract" may need to be clarified so as to avoid being misunderstood
- The frequency and quantity of amendments remains low; Many teams see their contract as something "in the background" that does not really need regular revisiting
- The contract is considered as a vehicle to discuss and get group dynamics kickstarted rather than a tool that accompanies the team along its journey
- It remains difficult for the teams to project themselves in the long-run (*"We did this contract without thinking of the long-term"*)

- When compared to previous editions, one notices less variation in the quality of the reflexive notes – this may also be due to a much more structured of the deliverable
- When looking at the statistical comparison, the program participants do not significantly differ from the sample of graduate students which is not surprising since 2/3 of the participants are graduate students

5.2 Levers for improvement and final thoughts Among

the ideas for improvement, one could:

- Make explicit from the beginning that the contract is in no means “legally binding” and it should be seen as a set of guiding principles
- Formally require the contract to be amended at each milestone (i.e., once per month during the academic calendar)
- Draw attention on the “tricky” items of the contract – this will be much easier during the next edition of the program

While slightly more than halfway through the edition, the use of team contracts appears to provide a good reference points for the reflexive notes and, more generally, the assessment of transversal skills in the program.

REFERENCES

- [1] Hey, J., Pelt, A. V., Agogino, A., and Beckman, S., (2007), Self-Reflection: Lessons Learned in a New Product Development Class, *Journal of Mechanical Design*, Vol. 129, No. 7, pp. 668-676.
- [2] Pun, K. F., Yam, R. C. M., and Sun, H., (2003), Teaching new product development in universities: an action learning approach, *European Journal of Engineering Education*, Vol. 28, No. 3, pp. 339-352.
- [3] Edmondson, A. C., and Harvey, J.-F., (2018), Cross-boundary teaming for innovation: Integrating research on teams and knowledge in organizations, *Human Resource Management Review*, Vol. 28, No. 4, pp. 347-360.
- [4] Heikkinen, J., and Isomöttönen, V., (2015), Learning mechanisms in multidisciplinary teamwork with real customers and open-ended problems, *European Journal of Engineering Education*, Vol. 40, No. 6, pp. 653-670.
- [5] Borrego, M., and Newswander, L. K., (2008), Characteristics of Successful Cross-disciplinary Engineering Education Collaborations, *Journal of Engineering Education*, Vol. 97, No. 2, pp. 123-134.
- [6] Schippers, M. C., Den Hartog, D. N., Koopman, P. L., and Wienk, J. A., (2003), Diversity and team outcomes: the moderating effects of outcome interdependence and group longevity and the mediating effect of reflexivity, *Journal of Organizational Behavior*, Vol. 24, No. 6, pp. 779-802.

- [7] Bartling, B., (2011), Relative performance or team evaluation? Optimal contracts for other-regarding agents, *Journal of Economic Behavior & Organization*, Vol. 79, No. 3, pp. 183-193.
- [8] McAfee, R. P., and McMillan, J., (1991), Optimal Contracts for Teams, *International Economic Review*, Vol. 32, No. 3, pp. 561-577.
- [9] Marcellino, P. A., (2008), Adopting Team Contracts to Initiate Team Learning, *AASA Journal of Scholarship and Practice*, Vol. 5, No. 1, pp. 15-20.
- [10] Smith, P. A., and Clinton, B. D., (2009), Instilling student responsibility with team contracts and peer evaluations, *Advances in Accounting Education*, pp. 81-101.