

6. Ivanov V.G., Zhurakovski V.M., Barabanova S.V., Galikhanov M.F., Suntsova M.S. New trends in training engineers in Russia [Electronic resource]. 2015 ASEE Int. Forum, Seattle, WA, 14 June 2015. S. I, s. n., cop. Amer. Soc. Eng. Education, 2015, pp. 19.24.1–19.24.6. URL: <https://peer.asee.org/new-trends-in-training-engineers-in-russia> (Accessed 17.05.2016).
7. Vedomstvennaya tselevaya programma "Povyshenie kvalifikatsii inzhenerno-tekhnicheskikh kadrov na 2015–2016 gody" [Elektronnyi resurs]: utv. prikazom Minobrnauki Ros. Federatsii ot 12 maya 2015 g. № 490 [Department targeted program "Continuing professional development for engineering and technical staff for 2015–2016", approved by the order of the Ministry of Education and Science of the RF dated May 2015, № 490 [Electronic Resource]]. Moscow, 2015. 20 p. URL: <http://минобрнауки.рф/%D0%B4%D0%BE%D0%BA%D1%83%D0%BC%D0%B5%D0%BD%D1%82%D1%8B/7301/%D1%84%D0%B0%D0%B9%D0%BB/6160/%D0%9F%D1%80%D0%B8%D0%BA%D0%B0%D0%B7%20%E2%84%96%20490%20%D0%BE%D1%82%2012.05.2015.pdf> (Accessed: 17.05.2016).
8. Programma povysheniya kvalifikatsii inzhenerno-tekhnicheskikh kadrov [Elektronnyi resurs] [Continuing professional development program for engineering and technical staff] [Electronic resource]. Moscow: the Ministry of Education and Science of the RF, 2012. URL: <http://engineer-cadry.ru> (Accessed: 17.05.2016).
9. Galikhanov M.F., Guzhova A.A. Complex approach for preparation and implementation of continuous professional education programs in technological university [Electronic resource]. ICL 2013: Proc. of 2013 Int. conf. on Interactive Collaborative Learning, Kazan, 25–27 Sept. 2013. S. 1.: IEEE, 2013, pp. 54–55. URL: <http://dx.doi.org/10.1109/ICL.2013.6644535>
10. Ivanov V.G., Barabanova S.V., Galikhanov M.F., Guzhova A.A. The role of the presidential program of training engineers in improvement of the research university educational activities [Electronic resource]. ICL 2014: Proc. of 2014 Int. conf. on Interactive Collaborative Learning, Dubai, UAE, 3–6 Dec. 2014. S. 1.: IEEE, 2014, pp. 420–423. URL: <http://dx.doi.org/10.1109/ICL.2014.7017809>
11. Ilyasova A., Galikhanov M., Ivanov V., Shageeva F., Gorodetskaya I. Concept of implementing the programs of additional professional education within the cluster system [Electronic resource] /// Proc. 122nd ASEE Annu. Conf. & Exposition, June 14–17, 2014, Seattle, WA, USA. S. I.: cop. Amer. Soc. Eng. Education, 2015, 10 p. URL: <https://www.asee.org/public/conferences/56/papers/14065/download> (Accessed: 17.05.2016).

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## Global Interdisciplinary Teams in Engineering Education

Instituto Superior de Engenharia do Porto (ISEP)

**J.C. Quadrado**

National Research Tomsk Polytechnic University

Association for Engineering Education of Russia

**K.K. Tolkacheva**

**Multiple disciplines approach, which includes global enhanced interdisciplinarity, has been discussed in the engineering education context from the early 21st Century. There is very little disagreement about its importance for the engineers, the key question has been how to implement theory into practice both in the curriculum and in the actual learning enhancement phase. Both Problem-based learning and CDIO framework are constructivist learning approaches that emphasize these issues. In this paper, we discuss how to mitigate the social distance in these global education teams and therefore how it becomes the primary management challenge for the global interdisciplinary team leader. The management of the social distance is then paramount to identify and successfully improve the social distance. This approach reflects several components, namely, the structure, the process, the language, the identity, and the technology used.**

**A successful interdisciplinary and multidisciplinary teacher/learning depends on the general team dynamics. Several strategies to enhance interdisciplinary teams in engineering education are presented.**

**Key words:** interdisciplinary teams, engineering education, management, team leader, social distance.

### 1. Context on global interdisciplinary teams

To succeed in the global economy today, more and more engineering companies are relying on a geographically dispersed workforce. They build teams that offer the best functional expertise from around the world, combined with deep, local knowledge of the most promising markets. They draw on the benefits of international diversity, bringing together people from many cultures with varied work experiences and different perspectives on strategic and organizational challenges. All this helps multinational companies compete in the current business environment [1].

But university managers who actually lead engineering faculties are usually not so focused in building global teams for

engineering education unlike the existing focus to building global research teams [2]. Creating successful work groups is hard enough when everyone is local and people share the same office space. But when team members come from different countries and functional backgrounds and are working in different locations, communication can rapidly deteriorate, misunderstanding can ensue, and cooperation can degenerate into distrust. This is even more evident in the academic environment where the interdisciplinary team work is already very challenging.

One basic difference between global interdisciplinary teams that work and those that don't lies in the level of social distance – the degree of emotional connection among team members. When people on a team all work in the same place



J.C. Quadrado



K.K. Tolkacheva

the level of social distance is usually low. Even if they come from different fields or backgrounds, people can interact formally and informally, align, and build trust [3]. They arrive at a common understanding of what certain behaviors mean, and they feel close and congenial, which fosters good teamwork. Coworkers who are geographically separated, however, can't easily connect and align, so they experience high levels of social distance and struggle to develop effective interactions. Mitigating social distance therefore becomes the primary management challenge for the global interdisciplinary team leader. The management of this social distance is then paramount to identify and successfully change the social distance. This approach should reflect several components, namely, the structure, the process, the language, the identity, and the technology – each of which can be a source of social distance (Fig.1.). In this paper we will describe some of the global enhanced teams' possible dysfunctions and describe how smart leaders can fix problems that occur – or prevent them from happening in the first place.

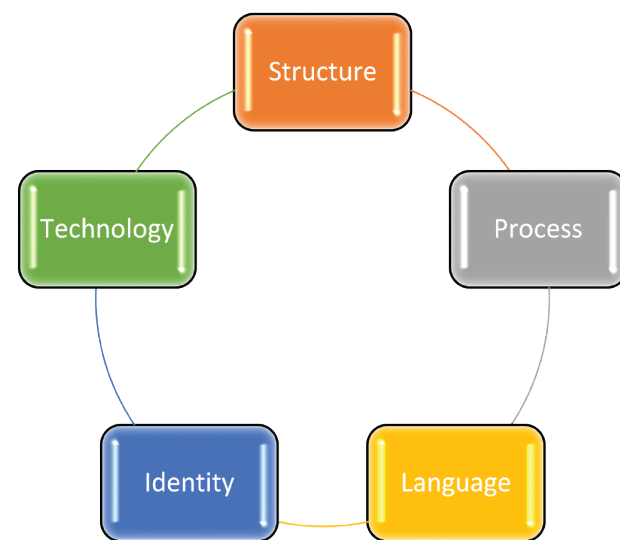
## 2. Structure and the Perception of Power

In the context of global interdisciplinary teams in engineering education, the structural factors determining social distance are the location and number of sites where team members are based and the number of educators who work at each site.

The fundamental issue here is the perception of power. If most team members are located in United States (US), for instance, with two or three in Russia and in Portugal, there may be a sense that the US members have more power. This imbalance sets up a negative dynamic. People in the larger (majority) group may feel resentment toward the minority group, believing that the latter will try to get away with contributing less than its fair share. Meanwhile, those in the minority group may believe that the majority is usurping what little power and voice they have.

To correct perceived power imbalances between different groups, a leader of a global enhanced interdisciplinary team needs to get three key messages across:

Fig. 1. Management of the social distance



who we are; what we do; and that I'm there for you (Fig. 2).

It is important that the answer to the who we are question is, that the the team is a single entity, even though individual members may be very different from one another. The leader should encourage sensitivity to differences but look for ways to bridge them and build unity. To bring people back together a leader for a global interdisciplinary team should create opportunities for employees to talk about their cultures, and instituted a zero-tolerance policy for displays of cultural insensitivity.

About the question of what we do, it is important to remind team members that they share a common purpose and to direct their energy toward team unit or the academic goals. The leader should periodically highlight how everyone's work fits into the course's overall strategy and advances its knowledge. For instance, during a weekly coordination conference call, a global team leader might review the group's performance relative to the academic objectives. The leader might also discuss the level of collective focus and sharpness the team needs in order to keep innovating.

About the question on if I'm there for you, team members located far from the leader require frequent contact with him or

her. A brief phone call or e-mail can make all the difference in conveying that their contributions matter. The team appreciated his attention and became more cohesive as a result.

## 3. Process and the Importance of Empathy

It almost goes without saying that empathy helps reduce social distance. If colleagues can talk informally around a nice tea – whether about work or about personal matters – they are more likely to develop an empathy that helps them interact productively in more-formal contexts. Because geographically dispersed team members lack regular face time, they are less likely to have a sense of mutual understanding. To foster this, global team leaders need to make sure they build the following “deliberate moments” into the process for meeting virtually: feedback on routine interactions; unstructured time; and time to disagree.

### 3.1. Feedback on routine interactions

Face-to-face visits are one, but not the only, way to acquire learning about the impacts of set work routines. Remote team members can also use the phone, e-mail, or even videoconferencing to check in with one another and ask how the collaboration is going. The point is that leaders and members of global enhanced interdisciplinary teams must actively elicit

Fig. 2. Key messages





this kind of “reflected knowledge,” or awareness of how others see them.

### 3.2. Unstructured time

Think back to your last face-to-face meeting. During the first few minutes before the official discussion began, what was the atmosphere like? Were people comparing notes on the weather, their kids, that new restaurant in a town? Unstructured communication like this is positive, even when people are spread all over the world, small talk is still a powerful way to promote trust. Especially during the first meetings, take the lead in initiating informal discussions about work and non-work matters that allow team members to get to know their distant counterparts.

### 3.3. Time to disagree

Leaders should encourage disagreement both about the team’s tasks and about the process by which the tasks get done. The challenge, of course, is to take the heat out of the debate. Framing meetings as brainstorming opportunities lowers the risk that people will feel pressed to choose between sides. Instead, they will see an invitation to evaluate agenda items and contribute their ideas. As the leader, model the act of questioning to get to the heart of things. Solicit each team member’s views on each topic you discuss, starting with those who have the least status or experience with the group so that they don’t feel intimidated by others’ comments. This may initially seem like a waste of time, but if you seek opinions up front, you may make better decisions and get buy-in from more people.

### 4. Language and the Fluency Gap

Good communication among coworkers drives effective knowledge sharing, decision making, coordination, and, ultimately, performance. But in global teams, varying levels of fluency with the chosen common language are inevitable – and likely to heighten social distance. The team members who can communicate best in the organization’s lingua franca (usually English) often exert the most influence, while those who are less fluent

often become inhibited and withdraw [4]. Mitigating these effects typically involves insisting that all team members respect three rules for communicating in meetings: dial down dominance; dial up engagement; and balance participation to ensure inclusion.

#### 4.1. Dial down dominance

Strong speakers must agree to slow down their speaking pace and use fewer idioms, slang terms, local technical terms, and esoteric cultural references when addressing the group. They should limit the number of comments they make within a set time frame, depending on the pace of the meeting and the subject matter. They should actively seek confirmation that they’ve been understood, and they should practice active listening by rephrasing others’ statements for clarification or emphasis.

#### 4.2. Dial up engagement

Less fluent speakers should monitor the frequency of their responses in meetings to ensure that they are contributing. Don’t let them use their own language and have a teammate translate, because that can alienate others. As with fluent speakers, team members who are less proficient in the language must always confirm that they have been understood. Similarly, when listening, they should be empowered to say they have not understood something. It can be tough for nonnative speakers to make this leap, yet doing so keeps them from being marginalized.

#### 4.3. Balance participation to ensure inclusion

Getting commitments to good speaking behavior is the easy part; making the behavior happen will require active management. Global team leaders must keep track of who is and isn’t contributing and deliberately solicit participation from less fluent speakers. Sometimes it may also be necessary to get dominant-language speakers to dial down to ensure that the proposals and perspectives of less fluent speakers are heard.

The leader could try as a tactic for

his own team to create the “Rules of Engagement for Team Meetings”.

### 5. Identity and the Mismatch of Perceptions

Globally enhanced interdisciplinary teams work, most smoothly, when members “get” where their colleagues are coming from. However, deciphering someone’s identity and finding ways to relate is far from simple. People define themselves in terms of a multitude of variables – age, gender, nationality, ethnicity, religion, occupation, political ties, and so forth. And although behavior can be revealing, particular behaviors may signify different things depending on the individual’s identity. Misunderstandings are a major source of social distance and distrust, and global team leaders have to raise everyone’s awareness of them. This involves mutual learning and teaching [5].

When adapting to a new cultural environment, a savvy leader will avoid making assumptions about what behaviors mean. Take a step back, watch, and listen. For example, in America, someone who says, “Yes, I can do this” likely means she is willing and able to do what you asked. In India, however, the same statement may simply signal that she wants to try – not that she’s confident of success. Before drawing conclusions, therefore, ask a lot of questions. In the example just described, you might probe to see if the team member anticipates any challenges or needs additional resources. Asking for this information may yield greater insight into how the person truly feels about accomplishing the task.

In this model, everyone is a teacher and a learner, which enables people to step out of their traditional roles. Team members take on more responsibility for the development of the team as a whole. Leaders learn to see themselves as unfinished and are thus more likely to adjust their style to reflect the team’s needs. They instruct but they also facilitate, helping team members to parse their observations and understand one another’s true identities.

### 6. Technology and the Connection Challenge

The modes of communication used by global interdisciplinary teams must be carefully considered, because the technologies can both reduce and increase social distance. Videoconferencing, for instance, allows rich communication in which both context and emotion can be perceived. E-mail offers greater ease and efficiency but lacks contextual cues. In making decisions about which technology to use, a leader must ask the following: Should communication be instant?

Teleconferencing and videoconferencing enable real-time (instant) conversations. E-mail and certain social media formats require users to wait for the other party to respond. Choosing between instant and delayed forms of communication can be especially challenging for global interdisciplinary teams.

Instant technologies are valuable when leaders need to persuade others to adopt their viewpoint. But if they simply want to share information, then delayed methods such as e-mail are simpler, more efficient, and less disruptive to people’s lives. Leaders must also consider the team’s interpersonal dynamics. If the team has a history of conflict, technology choices that limit the opportunities for real-time emotional exchanges may yield the best results.

### 7. Conclusions

Flexibility and appreciation for diversity are at the heart of managing a global interdisciplinary team. Leaders must expect problems and patterns to change or repeat themselves as teams shift, disband, and regroup. But there is at least one constant: To manage social distance effectively and maximize the talents and engagement of team members, leaders must stay attentive to all five dimensions presented. Decisions about structure create opportunities for good process, which can mitigate difficulties caused by language differences and identity issues. If leaders act on these fronts, while marshaling technology to improve

communication among geographically dispersed colleagues, social distance is sure to shrink, not expand. When that happens, engineering education teams can become truly representative of the "global village" – not just because of their international makeup, but also because

their members feel mutual trust and a sense of kinship. They can then embrace and practice the kind of innovative, respectful, and groundbreaking interactions that drive the best ideas forward, generating the new generation of global engineers.

#### REFERENCES

1. Neeley, Tsedal. "Global Teams That Work". Harvard Business Review 93, no. 10 (October 2015): pp. 74–81.
2. Kettunen, J. (2010), "Strategy process in higher education", Journal of Institutional Research, 15(1), pp. 16–27.
3. Graybill J.K., Dooling S., Shandas V., Withey J., Greve A. & Simon G. L. 2006. A Rough Guide to Interdisciplinarity – Graduate Student Perspectives. Bioscience. September 2006, Vol. 56, No 9, pp. 757–763.
4. Stober Myra H. (2011). Communicating Across the Academic Divide. Chronicle of Higher Education, Vol 57, Issue 18, 2011, A23
5. Aniky Kálmán, Lászly Farkas, Donát Dékány (2015): Budapest BME: Developing a Student Innovation Ecosystem. In: Pia Lappalainen, Markku Markkula, Hank Kune (ed.) Orchestrating Regional Innovation Ecosystems: Espoo Innovation Garden. Espoo: Aalto University; Laurea University of Applied Science; Built Environment RYM Oy, 2015. pp. 241–254.

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## Engineers for interdisciplinary teams and projects: management of training process

National Research Tomsk Polytechnic University  
Association for Engineering Education of Russia  
Yu.P. Pokholkov

The paper deals with the management issues of training specialists in the field of engineering and technology ready to work in interdisciplinary teams and projects. Interdisciplinarity in the engineering education is considered as a basis for critically new competitive engineering solutions. The indicators proving the presence of interdisciplinary management system at university are outlined. Based on the elaborated principles of interdisciplinary activities a set of required tools and elements to manage interdisciplinary training of engineers is presented.

**Key words:** interdisciplinarity, engineering education, indicators, principles and elements of interdisciplinary activities, management system, interdisciplinary teams and projects.

Competitiveness and economic security of any country is provided by natural, human, energy, material and non-material resources. There is a pattern indicating the relationship between economic competitiveness and volume of GDP per person [1]. The latter is associated with the level of wellbeing of the population (Fig.1).

These figures to a large extent depend on the quality of human capital, with such important characteristics as education of the population and its willingness to change in accordance with changing conditions of external and internal environment. Global challenges of the modern world - climate change, globalization, demographic situation, competition for resources, technological revolution, etc. – become powerful drivers for development of new trends in the social, economic, technical and political spheres. One of such trends in science, technology and education is interdisciplinarity, that can be determined as a "principle of organization of scientific knowledge, which opens wide possibilities of interaction of many disciplines in solving complex problems of nature and society" [2].

Definition of interdisciplinarity (multidisciplinarity, crossdisciplinarity, etc.)

includes a transdisciplinary perspective as "a way to expand the scientific outlook considering any phenomenon outside the framework of any single scientific discipline" [3].

The idea of synthesis and integration of knowledge, that lies in the foundation of this principle probably have more than one millennium already [4].

A detailed analysis of the common terminology in this area can be found in studies completed by Akof L.R., Ausburg T., Bushkovskaya E.A., Jacobs H.H., Borland J.H. and others as well as in the proceedings of international conferences held in recent decades, including those held under UNESCO auspices [5,6,7,8,9,10,11].

Nicolás Lori, vice-president of the Association of Fulbright scholarship program for Portugal (Fulbrighters Portugal), in his presentation made at the international conference "Management of interdisciplinary projects in engineering education: planning and execution" in Portugal, 2014, emphasized that "interdisciplinarity should not be:

- a group of people each an expert on everything;
- putting people from different expertise in the same place;



Yu.P. Pokholkov