

This item was submitted to [Loughborough's Research Repository](#) by the author.
Items in Figshare are protected by copyright, with all rights reserved, unless otherwise indicated.

Communication in the context of design teams

PLEASE CITE THE PUBLISHED VERSION

PUBLISHER

© Loughborough University

LICENCE

CC BY-NC-ND 4.0

REPOSITORY RECORD

Williams, Anthony. 2019. "Communication in the Context of Design Teams". figshare.
<https://hdl.handle.net/2134/1470>.

Communication in the context of design teams

Anthony Williams

University of Newcastle, Australia

Abstract

The importance of Multi Disciplinary Design Teams (MDDT) in the design world has long been recognised. MDDTs provide the diversity of design and technology, knowledge and experience, needed in the development of complex projects. Despite their frequent use in the industrial world, research has been limited in the perusal of an understanding of the reasoning heuristics used by designers working in teams in the development of design outcomes.

This paper will focus on the specific aspect of the communication strategies and techniques used by members of these MDDTs while contributing to the design process within the context of team meetings. This communication relates to the explanation of discipline specific information or the request for clarification of discipline specific information between team members.

From the finding of the research in communication strategies used by MDDTs it is possible to identify a range of curriculum issues. This paper examines these issues and provides some curriculum strategies that would equip Design students with the skills necessary to be an effective member of a design team

The world of design is expansive and technology has provided boundless opportunity for designers. Technology has not only provided opportunity but it has also contributed to the complexity of many design processes. In the Industrial world there often exists the need for large teams of designers to work collaboratively in the design and production of comprehensive or multifarious projects. This paper reports the initial findings of ongoing research into such teams and identifies some of the issues that have become apparent to curriculum planners and educators in the field of design education.

It is in the situation where the projects identified above exist that Multi Disciplinary Design Teams (MDDTs) are formed. The rationale for working collaboratively in the design process are twofold:

- 1 The complexity of designing a major item, eg. in the design of a large building specialists including architects, quantity surveyors, structural and service engineers¹, would be required.
- 2 The group's effectiveness in reaching a successful outcome is greater than the effectiveness of an individual designer

undertaking the same problem².

In considering MDDTs there is obviously the complexity due to the range of technological domains present in the team but analogous to this is the diversity of design models practised by the individual team members. The design model used in engineering differing from the design model used in Industrial Design. Jackling³ demonstrated this through the development of a design continuum with boundaries as shown below:

ALGORITHMIC————— HEURISTIC

Disciplines including the range of engineering branches which deal with problems that are solved by using a structured procedure to reach an analytically correct solution are placed at the algorithmic end of the continuum. At the heuristic end of the continuum are placed the more open ended artistic categories of design, eg. fashion design and graphic design. Spread out along the continuum are the diversity of design disciplines. Architecture, for example, is seen as taking the median ground of the continuum.

Roozenberg and Cross⁴ chose to develop two broader models of design:

- 1 the consensus model (the engineering type of design),
- 2 generator-conjecture-analysis model (architectural/industrial design).

The above models represent only a few of the range of models developed. What is consistent among these models is that they demonstrate the design process undertaken by individual design discipline fields or areas. The diversity of design processes, when considered conjointly with the specific discipline knowledge that each of the design specialists uses, shows the functional complexity of MDDTs. It is within this dynamic situation that designers are having to participate in performing their design function.

Background Research in the Area of MDDTs

To date research has been limited⁵ in the acquisition of an understanding of the reasoning heuristics used by designers working in the context of functioning (real world) MDDTs. Also there is limited understanding⁶ of how MDDTs actually function and what strategies individuals need to acquire in order to facilitate the level of co-operation and interaction necessary for effective participation and contribution to these design teams.

What research has been conducted in the area of design teams is limited to homogenous disciplinary teams in a laboratory environment. These teams working on problems within a limited time frame and the participants in the team being students or recent graduates.

The activities of MDDTs in many ways parallel the activities of biological research teams, though again the teams in this situation are of a single discipline. Due to this similarity research on the activities and scientific reasoning of these teams has relevance when considering MDDTs. Dunbar⁷ categorised the limited research, undertaken in "Real-World Scientific Reasoning", into the following groups:

- 1 Psychologists have thus far limited their investigations of scientific reasoning to individuals. In reality science takes place in the context of groups.
- 2 Scientists have used tasks that are not real scientific problems.
- 3 Non scientists solving science problems are generally used for researching scientific problem solving processes.
- 4 Subjects in psychology laboratory experiments work on problems that may last for as little as ten minutes and involve no extensive knowledge of a scientific topic.

Another important consideration in the organisation perspective of an MDDT is the process of reorganisation of knowledge attributable to participation in these teams. As a result of a design meeting it would be expected that an individual's "knowledge", established prior to the meeting, would change and be augmented as a result of the interactions and experiences of participation in the meeting. Dunbar⁸ in research relating to scientific research groups established that individuals were more likely to change their thinking about a problem as a result of comments from a team discussion than would be evident in a scientist working individually. It must be recognised that there is a considerable degree of enhancement in problem solving ability in the environment of teams.

The Project

Over a two year period two design teams, at Goninans Engineering in Newcastle Australia, were monitored during their formal design meetings. The teams were involved in the design of differing Railway projects. The design teams comprised a range of professionals from differing disciplinary backgrounds, also of interest is that Goninans employ designers from a significant number of nations. Teams were organised into system sub-teams, e.g. brake systems, interiors etc. Also of importance is the fact that there were no shared members between the two teams monitored. The first team was involved in the design of a new locomotive, for the National Rail Authority, confronting the complex design issues required of such a task.

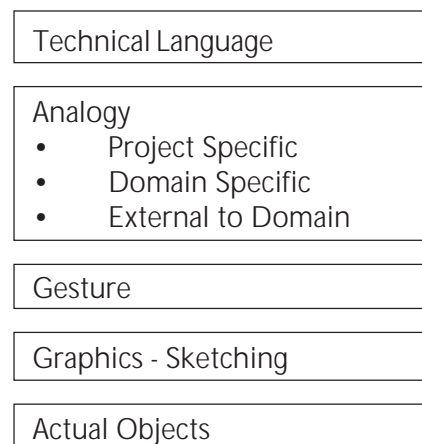
The second project team was designing a Light Rail carriage (similar to a tram) for use in Hong Kong. This project involved the development of an updated version of an existing model, though the previous models had not been designed by Goninans. The design had restricted dimensional parameters to work within but was required to emend the technology and address the need to improve maintenance requirements.

The formal design meetings of the teams were observed, and in the case of the light rail project videoed, in order to analyse the design process carried out by the two teams. The meetings were analysed using a paradigm of Protocol Analysis comparable to that used in the Desys Project^{9,10}. The meetings consisted of a wide range of design activities, consistent with the findings of Gay and Lantini¹¹ who identified ten different design activities. The ten activities are:

- 1 Orienting
- 2 Sub-dividing the problem
- 3 Establishing roles
- 4 Information seeking
- 5 Information sharing
- 6 Monitoring
- 7 Negotiating understanding
- 8 Designing
- 9 Building
- 10 Evaluating

Of specific interest to this study was the manner in which the members of the teams communicated and transferred domain or technically specific information to each other whilst involved in the activities of negotiating understanding, information seeking and sharing.

During the observation of the first project (the locomotive) it was identified that there was an apparent progression of strategies used by teams members to communicate between each other. This progression was also exhibited in the second team but with variations which could be attributed to the constitution of the team, many of the team members having not worked with each other previously. The following diagram outlines the stages of this hierarchy:



Technical Language

This is recognised as the use of technically specific language that is using the correct name or procedure to be used in the project, eg servo motor or plug welding.

Analogy

In research done to date on problem solving in scientific research teams¹² two levels of analogy were identified. The first or local analogy relates to using examples drawn from the specific project, National Rail or Hong Kong, the team is working on, eg "its what we did at the drivers cab end". The second or domain specific analogy relates to the use of examples drawn from the experiences of the team members from within the industry itself, eg "its like we did on the ThaiRail project". In this study of MDDTs it was established that the team members used a third level of analogy, this relating to the use of metaphors drawn from outside the specific design domain that the team is working within. This third level of analogy related to the use of examples drawn from outside the railway domain. Examples could be drawn from the automobile, aircraft or marine domains or even simpler examples could be drawn on, eg "its the black stuff used to hold car windscreens in".

Gesture

This involves the use of hand and arm movements and also includes a type of graphic level, drawing with the finger on the surface of the table. These gestures are used to depict

a number of aspects about the design project¹³, they include:

- size,
- function/mechanism,
- relationship to other components,
- shape.

Drawings

The use of graphics or freehand drawing by the team members was usually a result of having been unsuccessful in gaining acknowledgement of understanding by group members as a result of the using the above strategies. It is interesting to note that some members seemed to be more comfortable with the use of graphics and would initiate its use much sooner in the discussion of issues. 2D drawings and sectional drawings were the most commonly used with 3D used only on rare occasions. Graphics on both paper and white board was used most commonly in demonstrating shape, articulation and situational change.

The Object

The final strategy for transfer of technical information or design discussion is when the actual object being discussed is used to demonstrate the issues under examination. This strategy is used lastly in the vast majority of design meetings observed and generally caused disruption to the meeting as someone had to leave to get the item or the meeting would have to be reconvened at another location. An example of such a situation was the explanation of a partial window hopper being discussed by the team. One member had trouble with aspects of the window so a team member left the room to find one to demonstrate this aspect.

The above progression of communication strategies was identified through the observations but it is not possible to consider this hierarchy as consistently accurate. This inconsistency is due to the fact that entry and exit points from the progression differ with each transfer of information. What is consistent is the fact that if an initial explanation is unsuccessful then the designer will invariably drop to a lower level of the progression of strategies. Initial findings indicate that in the MDDT setting the

frequency of information transfer interaction without having to drop down the progression is low.

What can be drawn from this situation is that designers have to be competent with the communication strategies at each level of the hierarchy outlined above. This situation is most evident in the MDDT design environment as using domain specific technical language is recognised as a poor communication strategy.

Recommendations for Design Education

It is a recognised fact that many designers are going to spend a large proportion of their career working collaboratively¹⁴. Yet it would appear, especially in the context of Australia, there has not been extensive consideration of the design process as it occurs in the industrial world¹⁵ and applying this information to design education.

In applying the outcomes of the above project to design education it would be essential to include a number of innovations in the syllabus of design education. These innovations would need to encompass the training curriculums of the range of design disciplines, eg engineering, architecture and industrial design. These curriculum inclusions would address the role of the designer as a collaborator, initially within the designers own disciplinary domain, and secondly as a collaborator interacting with other designers in an MDDT situation.

To achieve the above curriculum enhancement the following strategies would need to be included in a design curriculum:

- Increase opportunity for solving technical problems within a collaborative situation.
- Increase the depth of interaction
- Increase the breadth of interaction

It is essential for students to be provided with the opportunity to work in situations involving them confronting different design models, concepts and theories. This will allow students to construct models and solve problems in miscellaneous social and contextual paradigms. Protocols need to be generated which afford support to the design process in

a collaborative situation. The collaborative experiences must provide the three levels of diversity identified above, students must work collaboratively within their own discipline area but this is only the initial phase of the programme. Also to be included in the programme is the opportunity for the students to collaborate with designers from outside their disciplinary domain. It is in the capacity of working within a MDDT that students will be provided with the opportunity to experience the depth and breadth of interaction necessary for the effective function of the MDDT and also their role as a member and contributor to such a team.

Within the context of group design sessions students should be encouraged to interact with the other members of the MDDT. It is through this experience that students will become aware of the role that they will most likely play in their future as designers. This awareness will then assist them in identifying those skills that will assist them in this role.

The curriculum planners must also provide, within the structure of the program, opportunity for students to accumulate the skills identified above. The skill of simple sketching and the ability to use it as a communication tool is often overlooked. Sketching as a means of explanation should be encouraged and developed.

As with sketching the skill of explaining something to a group and the protocols behind this activity should not be left to chance. These protocols would include the presence of mind to use analogy as an effective means of information transfer as it is an effective communication and problem solving tool, as identified by Dunbar and Schunn's¹⁶ study. Which established that through the solution of one problem the performance of the problem solver in an analogically similar problem was enhanced. This use of analogy also enhances design practice itself¹⁷.

Conclusion

It is apparent from this study that there is still a significant amount of research to be done in the field of MDDTs. There is at the present time little understanding about the heuristics

and protocols relating to this common design activity. What can be understood from the above study is that effectiveness in this situation will in many respects rely on the designer being able to communicate design and technical information efficiently and accurately.

References

- 1 Lawson, B. *How Designers Think: The Design Process Demystified*, Butterworth Architecture, Oxford, 1990.
- 2 Keller, R.T. Predictors of the Performance of Project Groups in R & D Organizations, *Academy of Management Journal*, Vol. 29 No. 4, 1986, pp 715-726
- 3 Jackling, N., Lewis, J., Brandt, D. Problem Solving in the Professions, *Higher Education Research and Development*, Vol. 9, No. 2, 1990, pp 133-149
- 4 Roozenburg, N.F.M. and Cross, N.G. Models of the Design Process: Integrating Across the Disciplines, *Design Studies*, Vol. 12, No. 4, 1991, 215-220
- 5 Peng, C. Exploring Communication in Collaborative Design: Co-operative Architectural Modelling, *Design Studies*, Vol. 15, No. 1, 1994, pp19-28
- 6 Radcliffe, D.F., Currency of Actions, Ideas, and Knowledge Displays Within a Design Team, *Delft Protocols Workshop*, 1994
- 7 Dunbar, K. How Scientists Really Reason: Scientific Reasoning in Real World Laboratories, in Sternberger, R.J. & Davidson, J., *Mechanisms of Insight*. Cambridge MA:MIT Press, 1995, pp 365-395.
- 8 Dunbar, K. How Scientists Really Reason: Scientific Reasoning in Real World Laboratories, in Sternberger, R.J. & Davidson, J., *Mechanisms of Insight*. Cambridge MA:MIT Press, 1995, pp 365-395.
- 9 Van Breeman, E.J.J. *Characterisation of Information in the Product Development*

- Processes*. Delft University of Technology, Faculty of Industrial Design, Internal Memo K311, 1994.
- 10 Knoop, W.G. and Weigers, T. *The Desys D1 Experimental Procedure: A Method to Observe Information Handling in actual Product Development Process*. Delft University of Technology, Faculty of Industrial Design Engineering, Internal Memo K328, 1995
- 11 Gay, G. and Lantini, M. *Use of Communication Resources in a Networked Collaborative Design Environment*, Interactive Multimedia Group, Cornell University, 1995, pp 1-12
- 12 Dunbar, K. How Scientists Really Reason: Scientific Reasoning in Real World Laboratories, in Sternberger, R.J. & Davidson, J., *Mechanisms of Insight*. Cambridge MA:MIT Press, 1995, pp 365-395.
- 13 Tang, J.C. *Listing Drawing and Gesturing in Design: A Study of the Use of Shared Workspaces by Design Team*. Xerox Corporation, Palo Alto Research Centre, SSL-89-3, 1989.
- 14 Lawson, B. *How Designers Think: The Design Process Demistified*, Butterworth Architecture, Oxford, 1990.
- 15 Minneman, S. L. *The Social Construct of Technical Reality: Empirical Studies of Group Engineering Practice*, Xerox Corporation, Palo Alto Research Centre, SSL-91-22, 1991.
- 16 Dunbar, K. & Schun, C.D. The Temporal Nature of Scientific Study: The Roles of Priming and Analogy, *Eleventh Annual Conference of Cognitive Science Society*, Michigan, 1989.
- 17 Qiang, L. and Gero, J.S. An Approach to Design Exploration Using Analogy, *Third International Round Table Conference on Computational Models of Creative Design*, Heron Island, December, 1995, pp 3-36.