INTERNATIONAL CONFERENCE ON ENGINEERING DESIGN, ICED'09
24 - 27 AUGUST 2009, STANFORD UNIVERSITY, STANFORD, CA, USA

SUPERTEAMS: COMBINING TEAMS IN DIFFERENT LOCATIONS

Douglas Wilde
Stanford University

ABSTRACT
Consider teams, constructed according to Jungian cognition theory, at various locations and that are themselves to be combined into larger "superteams". Combination is done by treating each component team as a single person having a cognitive mode pattern made up of the maximum scores for each mode. These equivalent "persons" are then combined for cognitive variety in the same way pairs of persons would be formed. It is shown how to do this so that the superteams will have the high cognitive mode scores desired. In an example simulation. the superteam scores are almost as high as those obtainable when everyone is in the same location.

Keywords: design teams, cognitive modes, teamology, cognitive variety, personality theory

1 INTRODUCTION
Academic engineering design courses now widely involve student teams [1], both in senior level "capstone" courses [2], and in freshman "cornerstone" courses [3]. Video-conferencing, e-mail and related communications systems have brought about the formation of what will be called here "superteams": combinations of small "sub-teams" distant from each other [4]. At Stanford in 2007 for instance, eleven superteam sextets were formed from twenty-two sub-team trios, half at Stanford and half outside the U.S. A. In an example studied here, three trios from a pool of nine people at one location (*AI*) are paired with three trios from a pool of nine people at another location (*JR)* to form three superteams having six members each.
Here the trio subteams in each location are constructed from their local personnel pools using the cognitive variety procedures described in Ch. 3 of [5]. This approach uses a personality questionnaire from which simple but rigorous formulas calculate preference scores relative to the four dimensions of psychiatrist Carl Gustav Jung's theory of cognitive modes – eight ways of solving problems creatively [6]. For each mode, a number of people equal to the number of teams (3 in the example) is assembled into an "affinity group" whose membership is limited to those with the highest scores for the mode. The goal of this team formation procedure is to give every team a member from each affinity group. Every mode on every team then would have an affinity group member. For the example subteam trios, this would mean someone from the upper third for every mode score.
It is suggested here that the same approach be applied to combining the subteams into superteams. This would treat each subteam as a single person, using the maximum score for each mode as the "subteam mode score". Each subteam then has a "team pattern" comprised of the eight maximum mode scores. From the team mode scores in the team patterns, "subteam affinity groups" would be formed, each having as many subteams as there are superteams to be formed, three in the example. The superteam goal then is that every superteam have a subteam affinity group member, itself a subteam, for every mode.
The effectiveness of a set of teams is estimated quantitatively by the pattern of minimum scores for each mode, such minima being called "thresholds". Higher threshold values are assumed to indicate greater team effectiveness. Thus comparing threshold patterns gives a way to rank team formation strategies. Naturally, as pointed out in [5] (Sect. 4.3.5), larger teams can only have higher threshold values for a given personnel pool. Thus the most effective set of superteams would be achieved if everyone were in the same location. In the example this would mean that three sextets would certainly be better than the six trio subteams. It is encouraging that, in the example at least, the thresholds for the double-trio superteams are not only much better than those for the subteams, but also almost as good as for the sextets.

2 EXAMPLE

The tables following illustrate these ideas for an example constructed from the cognitive mode scores of eighteen Stanford sophomores from the author's 2006 Teamology seminar. These are in fact the first eighteen of the twenty-one patterns used in Ch. 3 of [5], letters abbreviating the names arranged alphabetically, e. g., "*A*" for "Alice". The first nine students – *A* through *I* – were assumed to be at one location, labeled "*AI*"; the other nine – *J* through *R* – in another place called " *JR*". Table 1 gives the mode scores for the three affinity group members, one for each trio to be formed, at location *AI*.

Table 1. Location AI Affinity Groups With Mode Scores

Name	*EN*	*EF*	*ES*	*ET*	*IN*	*IF*	*IS*	*IT*
A		**2**	**4**			**2**	**8**	
B				**1**	**2**			
C						**2**		**4**
D		**6**	**3**				**9**	
E			**3**	**2**		3	**7**	**2**
F	**7**				**1**			
G	**3**			**1**		**2**		
H					**1**			**6**
I	**1**	**2**	**5**					

Similar information for location *JR* is given in Table 2.

Table 2. Location JR Affinity Groups With Mode Scores

Name	*EN*	*EF*	*ES*	*ET*	*IN*	*IF*	*IS*	*IT*
J		**6**			**0**			
K				**5**	**0**		**4**	**5**
L								**6**
M	**1**	**4**			**1**	**0**	**4**	
N			**4**	**7**			**7**	
O	**1**	**1**			**1**			
P			**5**	**8**				
Q	**8**				**0**			
R			**6**			**3**		**4**

If everyone were at the same location, the affinity groups for the three sextets to be constructed would contain the top three scores out of the eighteen in the pool – the top one-sixth. The threshold (minimum) values for the sextet modes are shown in the first row of Table 3. Five of the threshold scores are considered "significant" because they are 4 or greater. It will be seen that all of these scores are "better", i. e., greater than or equal to, those for both the *AI* trios (row 2) or the *JR* trios (row 3), which can be found easily by inspecting Tables 1 and 2 respectively. Even these latter are better than those for the thresholds for all six trios together, shown in row four. Looking ahead, the bottom row shows the threshold pattern for the double-trios about to be constructed. The point of this article is that these double-trio superteams are almost as good as the hypothetical sextets.

Table 3. Threshold Patterns

Boldface italic *indicates significant mode scores (≤ 4).*

	EN	*EF*	*ES*	*ET*	*IN*	*IF*	*IS*	*IT*	Significant
Sextets	3	***4***	***5***	***5***	1	2	*7*	***5***	5
***AI* trios**	1	2	3	1	1	2	*7*	2	1
***JR* trios**	1	1	***4***	***5***	0	<0	***4***	***4***	4
All Trios	1	1	3	1	0	<0	***4***	*2*	1
Dbl-Trios	3	***4***	***4***	***5***	1	2	3	***4***	4

3 SUPERTEAM CONSTRUCTION

Table 4 shows, for location *AI,* the cognitively diverse trios formed by the procedure given in Ch. 3 of [5], together with the mode scores of their members, for the three trios *AI*1, *AI*2 and *AI*3,

Table 4. Location AI Trios With Mode Scores

Trio	Name	*EN*	*EF*	*ES*	*ET*	*IN*	*IF*	*IS*	*IT*
***A*1**	***F***	**7**				**1**			
***A*1**	***A***		**2**	**4**			**2**	**8**	
***A*1**	***E***			**3**	**2**			**7**	**2**
A2	***G***	**3**			**1**		**2**		
A2	***D***		**6**	**3**				**9**	
A2	***H***					**1**			**6**
A3	***I***	**1**	**2**	**5**					
A3	***C***						**2**	**3**	**4**
A3	***B***				**1**	**3**			

Table 5. Location JR Trios With Mode Scores

Trio	Name	*EN*	*EF*	*ES*	*ET*	*IN*	*IF*	*IS*	*IT*
***J*1**	***M***	**1**	**4**			**1**	**0**		
***J*1**	***N***			**4**	**7**			**7**	
***J*1**	***L***								**6**
***J*2**	***O***	**1**	**1**			**1**			
***J*2**	***R***			**6**			**3**		**4**
***J*2**	***K***				**5**			**4**	**5**
***J*3**	***Q***	**8**				**0**			
***J*3**	***J***		**6**				**<0**		
***J*3**	***P***			**5**	**8**	**0**		**2**	**2**

Table 5 displays similar information for the new trios at location JR.

Tables 4 and 5 are compressed in Table 6 into mode patterns for the six trios constructed. When these six trios are combined to form three double-trios, each trio will be treated as if it were a single person. In each mode column, the top three scores -- regardless of location -- are marked by asterisks (*) to show that their trios are members of the subteam affinity group for that mode..

Table 6. Trio Mode Patterns

Asterisks (*) Indicate Top 3 Trio Scores For Mode.

Underscores Indicate Marginal Ties.

Trio	*EN*	*EF*	*ES*	*ET*	*IN*	*IF*	*IS*	*IT*
***AI*1**	**7***	**2**	**4**	**2**	**1**	**2**	**8***	**2**
***AI*2**	**3***	**6***	**3**	**1**	**1**	**2**	**9***	**6***
***AI*3**	**1**	**2**	**5***	**1**	**2***	**2**	**3**	**4**
***JR*1**	**1**	**4***	**4**	**7***	**1**	**0**	**7***	**6***
***JR*2**	**1**	**1**	**6***	**5***	**1**	**3***	**4**	**5***
JR3	**8***	**6***	**5***	**8***	**0**	**<0**	**2**	**2**

Consider first mode *EN*, the first to be assigned. Location *AI* has only one trio, *AI*3, whose *EN* person is NOT IN the superteam *EN* affinity group. Hence it must be matched with team *JR*3, the only *JR* trio IN the superteam *EN* affinity group. This yields superteam Alpha on the first two lines of Table 7. This produces unavoidable duplication of *IN* and *IS* superteam affinity group members.

Of the four trios remaining, *AI*2 with its *EF* affinity group member must match with *JR*2 which lacks one, forming superteam Beta on the third and fourth lines of Table 7. Superteam Gamma is then composed of the remaining two subtrios, as shown on lines 5 and 6 of Table 7. The double-trio threshold pattern on the bottom line of Table 3 was obtained from the superteam patterns of Table 7.

Table 7. Superteam Sextet Mode Scores

Asterisks (*) Indicate Top Double-Trio Score For Mode

Dbl-T	Trio	*EN*	*EF*	*ES*	*ET*	*IN*	*IF*	*IS*	*IT*
Alpha	***AI*1**	**7***	**2**	**4**	**2**	**1***	**2***	**8***	**2**
Alpha	***JR*1**	**1**	**4***	**4**	**7***	**1***	**0**	**7***	**6***
Beta	***AI*2**	**3***	**6***	**3**	**1**	**1***	**2***	**9***	**6***
Beta	***JR*2**	**1**	**1**	**6***	**5***	**1**	**3***	**4**	**5***
Gamma	***JR*3**	**8***	**6***	**5***	**8***	**0**	**<0**	**2**	**2**
Gamma	***AI*3**	**1**	**2**	**5***	**1**	**2***	**2***	**3**	**4**

4 CONCLUSIONS

The example demonstrates that double-trio superteams can have a cognitive mode threshold pattern almost as good as that for sextets, the ideal arrangement. As conjectured, the double-trio pattern is clearly almost as good as that for a set of six trios.

REFERENCES

[1] Dym, C. l., Agogino, A. M., Eris, O., Frey, D. D. and Leifer, L. J., "Engineering Design Thinking, Teaching, and Learning", *J. Engineering Education,* 94, 1, 2005, pp 103-120.

[2] Dutson, A. J., Todd, R. H., Magleby, S. P., and Sorensen, C. D., "A Review of Literature on Teaching Design Through Project-Oriented Capstone Courses" *J. Engineering Education,* 76, 1, 1997, pp. 17-28.

[3] Agogino, A. M., Sheppard, S. D., and Oladipupo, A., "Making Connections to Engineering During the First Two Years", *Proc. 1992 Frontiers on Education Conference,* Inst. Electrical and Electronic Engrs.".

[4] Dutta, D., and Weilbut, V. "Team Teaching and Team Learning on a Global Scale": An Insider's Account of a Successful Experiment", *Proc. 2002 Networked Learning Conference",* Berlin, May 2002.

[5] Wilde, D. J., *Teamology: The Construction and Organization of Effective Teams,* 2008 (Springer-Verlag, London).

[6] Jung, C. G., *Psychological Types,* 1921, 1971 (Princeton University Press, Princeton, NJ).