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THESIS

COMPARISON OF INFORMATION
DELAY TYPES AND LEVELS IN
TACTICAL TIC-TAC-TOE (T4)

by

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COMPARISON OF INFORMATION DELAY TYPES AND LEVELS IN TACTICAL TIC-TAC-TOE (T4)

by

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B.S., University of New Mexico

Submitted in partial fulfillment
of the requirements for the degree of

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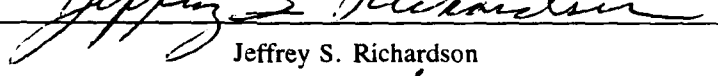
Author: 
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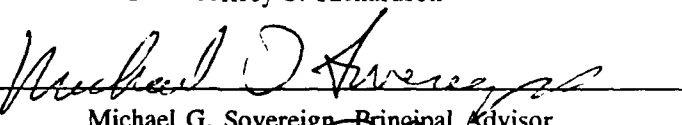
Approved by: 
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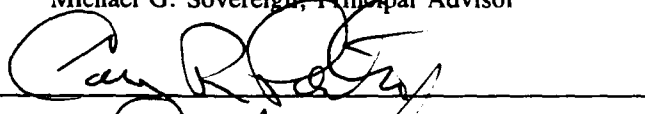
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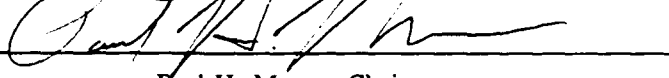
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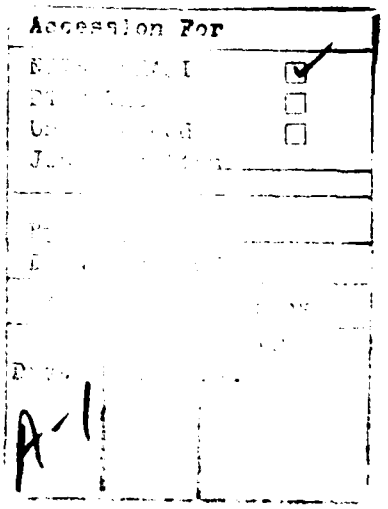
ABSTRACT

The objective of this thesis is to design, conduct, and analyze a command, control, and communications conflict simulation to investigate the effects of differing types and quantities of information delay on mission outcomes using the computer simulation game Tactical Tic Tac-Toe (T4). Three different types of delay were compared: tactical, area, and communications. Each type of delay was delayed from zero to nine moves. The results indicate that tactical delay had the greatest effect on mission outcome. Area delay had less of an impact. Communications delay had the least effect. Contrary to predictions, within each type of delay, different levels of delay did not significantly effect mission outcomes. This may be attributed to the high variability of the game scores. Generally, tactical and area delays graphically showed less mission impact at lower levels of delay, however communication delay indicated no trend in mission outcome at different levels of delay.



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I. INTRODUCTION

A. BACKGROUND

The study of Command, Control, and Communications (C3) places a large emphasis on the importance of information flow in combat operations. Considerable work has been done to define the C3 process. John Boyd developed the basic Observe, Orient, Decide, and ACT (O-O-D-A) C3 structured model. Similarly, Dr Joel Lawson developed his Command and Control (C2) process model using Sense, Process, Compare, Decide, and Act. In both the Boyd and Lawson models, information gathering is the first of a series of step-wise processes to define C3.

Obviously, the information used in the C3 process must be timely and accurate to successfully accomplish a mission. There are many examples in military history which show the disastrous effects of late and/or inaccurate information being used in the decision process. One example is the attack on the U.S.S. Liberty in 1967 where a delay in communications resulted in the ship being in the wrong location and mistakenly attacked by Israel. The attack killed 34, wounded 75, and destroyed the ship [Ref. 1:p. 10]. It is possible to investigate past military conflicts to determine the effect of information quality on the battle outcome. However, because of numerous other variables for each case, it would be

difficult to quantify a relationship between information quality and battle outcome.

An alternative to historical research is to use war games and simulation which have been used effectively to investigate C3 systems. War games use human subjects to make decisions where as in simulation, decisions are made according to a set of predetermined rules [Ref. 2:p. 6]. This thesis uses a computer simulation to investigate the effects of information delay on mission performance in a simulated environment.

B. OBJECTIVE

The objective of this thesis is to design, conduct, and analyze a C3 conflict simulation to investigate the effects of differing types and quantities of information delay on mission outcome using the computer simulation game Tactical Tic-Tac-Toe (T4). Three different types of information delay (area, communications, and tactical) are used in T4. Each type of delay can be set from zero up to nine moves.

1. Research Questions

Two research questions are to be answered:

- Of the three types of T4 delays (area, communications, and tactical), which one has the greatest effect on mission outcome?

- As information delays increase for each of the three types of delay, is there a point at which the mission outcomes do not continue to decline significantly as the delay increases?

2. Predictions

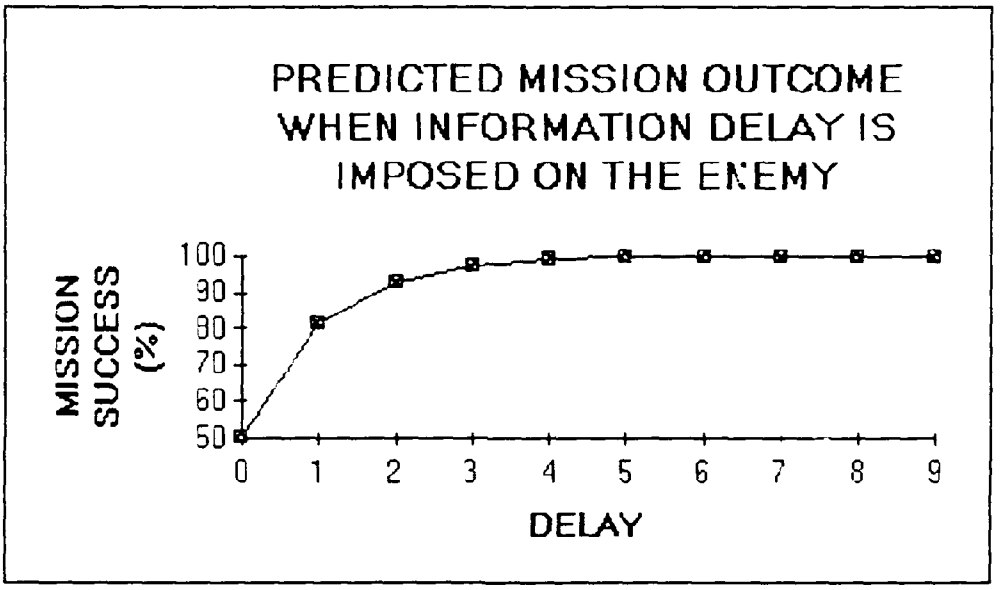
The outcome of simulated conflicts in T4 not only depends on the type and amount of delay but also on several other parameters which are programmed into the game. However, assuming the experiment is designed to neutralize the effects of collateral parameters and to isolate the effects of information delay, the following predictions were made:

- Tactical delay would have the most effect on mission outcome.
- Delays above three moves would have little effect on mission outcome for each of the three types of delay.

Tactical delay is the delay of intelligence on the enemy's position on the player's side of the board. The first prediction was made assuming that a delay in a player's knowledge of the opponent directly opposing him would have the greatest effect on the mission outcome. Area delay is a delay of intelligence on the enemy's position on the other side of the board. Communication delay is a delay of information between players on the same team. Both area and communication delay were predicted to effect the mission outcome less than tactical delay.

The second prediction was made based on the fact that T4 uses pattern recognition in computer simulation play. The computer sequentially looks at all eight of the ways that a three cell TTT can be scored and tries to match the three cell pattern with the game plan to determine a weighting factor. It is assumed that if information is delayed three moves, the

pattern recognition system will be severely effected and delays of more than three will have marginally less impact on the outcome. The plot shown in Graph 1 is a prediction of mission success when increasing information delay is imposed on an opponent.



Graph 1

Note that at zero delay, mission success is predicted to be 50 percent; each side would have an equal chance of winning. At delays of 3 and more, an almost 100 percent mission success is predicted.

C. TACTICAL TIC-TAC-TOE (T4)

T4 is a simple board game based on the well known game of Tic-Tac-Toe (TTT). It was developed by Mr Gary Porter, a former student and instructor at the Naval Postgraduate School. T4 has been used in operational science courses and

command and control courses to instruct students in designing, conducting, and analyzing system experiments.

T4 can be played in three different ways. First, it can be played with individual players opposing each other. Second, a team of individuals can play the computer. Finally, T4 can simulate all players in the automated version of the game. Only the automated version was used for this thesis.

T4 uses two tic-tac-toe boards with two teams, X and O. Each team has two players, a left side and right side, for a total of four players a game as shown in Figure 1.

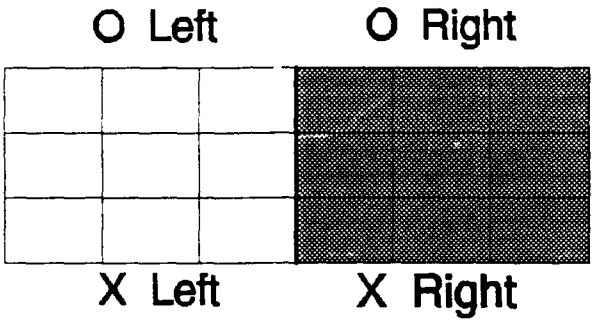


Figure 1. T4 Game Board

Each player moves only on their side of the board to score TTTs. Missions can be assigned to allow scoring of TTTs across game boards (crossover TTTs) encouraging players to gain information about their partner's and opponent's positions on the other board side. Each player moves simultaneously. If players move into the same cell on the same turn, conflict resolution processes occur depending on

how the game is set-up. The first same turn conflict can be decided randomly or awarded to a particular team. Subsequent same turn conflicts may be decided either randomly or alternately. Different turn conflicts can also occur when delays are introduced into the game because a player may try to move into a cell that appears empty to the player but, in fact, is already occupied. In this case, the first player in the cell keeps it and the other player losses the move.

In addition to the type of delay, amount of delay, and conflict resolution types, several other parameters can be varied in the game. Missions can be set up as victory or survival. A victory mission requires a team to score more TTTs than the other team in the assigned mission (game board) area (either left, right, crossover, or entire game board). Survival missions require a team to score as many or more TTTs as the opposition in the assigned mission area. Also in the automated mode, the game play recognition system is used which requires a data file describing simulated player personalities (offensive, defensive, passive, etc.). By using different data files, the automated player can play different strategies. A detailed set of T4 instructions are included in Appendix A.

Chapter II covers the selection of the parameters and the procedure used in T4 to investigate the two research questions. The resulting data and analysis are provided in

Chapter III. Chapter IV contains the interpretation of the results and recommendations for future T4 studies.

II. EXPERIMENTAL DESIGN

A. OVERVIEW

The automated version of T4 was used to investigate the two thesis research questions. The general approach was to perform multiple game repetitions for each type and amount of delay. Only one parameter at a time was changed for each set of replications. Differing types and levels of delay were applied to the O team. The X team was the control team. Both O team players were set for the same delay level and both X players were always set for zero delay. Multiple delay levels (two or more delay types set greater than zero) were not used in this investigation. Other game parameters were fixed for all replications. This chapter covers the selection of the parameters and the procedure used in T4 to investigate the two research questions.

B. APPARATUS

The automated T4 software was run on an Apple Macintosh computer using system version 6.0.5 with Hypercard version 2.0 software. The results of each game were stored in Excel version 4.0 spreadsheet software operating on an IBM PC type computer using Windows version 3.1 operating system. Minitab PC version 8 was used for statistical analysis.

C. GAME CONFIGURATIONS

In addition to the type and amount of delay, three other parameters must be set in the game plan -- conflict resolution, player missions, and player strategies. Since the type and amount of information delay were to be investigated, it was necessary to carefully select and fix the values for the other three parameters so the effects of interest could be measured in the game results. Figure 2 shows the game board at the end of the last game of the last replication.

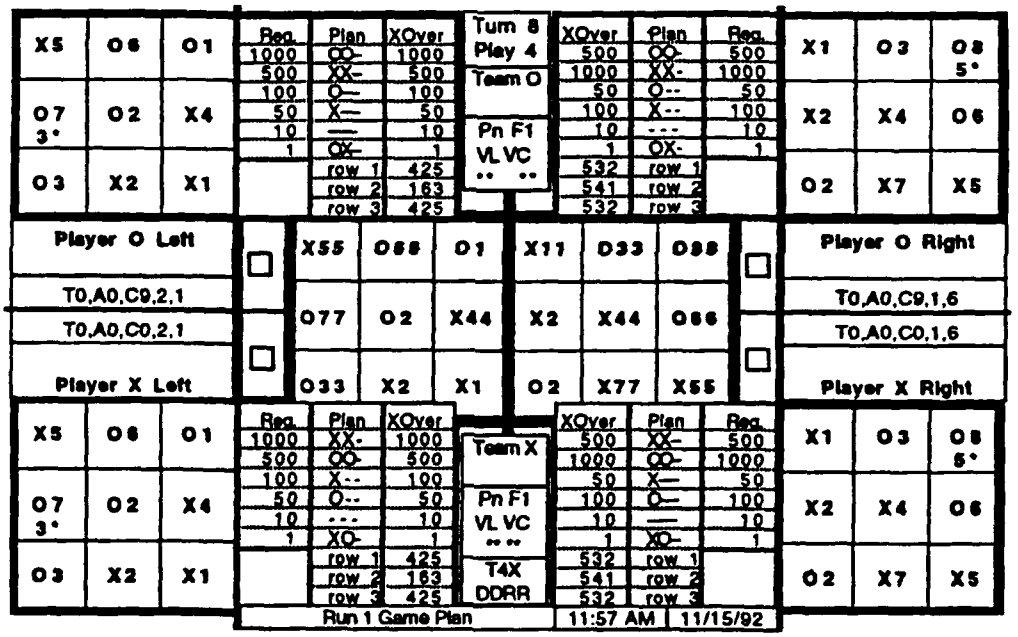


Figure 2. Pattern/Position Programming Board

This view of the game board has the game plans overlaid on it. It shows the delay level and the configuration of the other three parameters. Appendix A contains additional information on the configuration parameters. Except for the type and

amount of delay, the other game plan parameters remained the same for all replications.

1. Conflict Resolution

Conflict resolution for same turn conflicts was set to be random for every conflict. This provided an equal chance to both the X and O sides of winning conflicts when they occurred. The other options for conflict resolution are: (1) one team always win the initial conflict then teams alternate for the subsequent conflicts wins; (2) one team always wins the first conflict then randomly select which team wins the subsequent conflicts; and (3) randomly select the team which wins the first conflict then alternate teams for the subsequent conflicts.

2. Mission Assignments

Mission assignments for both sides were to set for victory left (VL) and victory crossover (VC). This combination allowed the game scores to reflect both one-sided play and crossover play. Also by setting both X and O sides to the same mission, their scores could be easily compared. The total possible missions for each side are victory (V) or survival (S) for the right side (R), left side (L), crossover (C), and overall (O). Therefore, a total of eight different missions could be assigned -- VR, VL, VC, VO, SR, SL, SC, SO.

3. Strategies

To run the automated version of T4, a game plan file is used to control how each of the four simulated players plays the game. Strategies for each player are established in a set of three game plan matrices used to decide each simulated player's move. The regular matrix controls player moves on the left or right sides of the board. The crossover matrix controls moves in the crossover area. The cell matrix breaks tries and determines where the player will move at the start of the game. Together the three matrices specify a simulated player's personality to be offensive, defensive, passive, team oriented, lone wolf, random, etc.

An offensive crossover (OC) strategy was chosen to achieve the VL mission while a defense crossover (DC) strategy was chosen to achieve the VC mission. OC was used for both the XL and OL players and DC was used for the XR and OR players. OC strategy encourages the simulated players to achieve TTTs on both their sides of the board and in the crossover area. DC encourages blocking opponent's TTTs at the expense of offensive scoring. See Appendix A for detailed information on how the T4 program uses game plan matrices to select the next move.

- OC Pattern weighting for OL:

Regular	Crossover	Cell
OO_ 1000	OO_ 1000	Row 1: 425
XX_ 500	XX_ 500	Row 2: 163
O__ 100	O__ 100	Row 3: 425
X__ 50	X__ 50	
___ 10	___ 10	
OX_ 1	OX_ 1	

- DC Pattern weighting for OR:

Regular	Crossover	Cell
OO_ 500	OO_ 500	Row 1: 532
XX_ 1000	XX_ 1000	Row 2: 541
O__ 50	O__ 50	Row 3: 532
X__ 100	X__ 100	
___ 10	___ 10	
OX_ 1	OX_ 1	

D. PROCEDURE

Three data collection files were created, one for each type of delay - tactical, area, and communications. Each file contains results of 30 replications for each level of delay. There were 3 types of delay and 10 levels of delay, each of which was run 30 times for a total of 900 games (3 x 10 x 30). All 900 games ran sequentially. The replications were started on 13 Nov 92 at 1726 hours and were completed on 15 Nov 92 at 1157 hours. The replications ran continuously without interruption. The results were saved as text files (*.txt) then transferred to an Excel spreadsheet for data reduction. Each of the 3 spreadsheets are 117 columns by 300 rows. Appendix B contains the replication set-up files. Selected data was transferred to Minitab for statistical analysis by

saving data in Excel using Lotus 1-2-3 format (*.WK1 files) and then retrieving it in Minitab using the Lotus data option. The data analysis procedure and the results are described in Chapter III.

III. DATA ANALYSIS

A. SCORING

One of the most important steps in system investigations is to select suitable measures of effectiveness (MOE) so the proper conclusions can be achieved. Several different MOEs were investigated by plotting out the average score of the 30 repetitions for each delay set, versus the amount of delay introduced on the O side. The total score for the O side, the difference between the total scores for the X and O sides, and the total TTTs were looked at as possible scoring measures. However, the difference between the X team and O team total TTTs in the assigned mission areas (VL and VC) was finally selected as the MOE.

The total score is the sum of scores for each mission assigned. A team is awarded one point for each mission that is successfully completed. Since two missions (VL and VC) were assigned and they were same for each side, there are only four different game score outcomes: 2-0; 1-1; 1-0; and 0-0. However, if scoring is measured in mission TTTs, as many as 18 or as few as 0 could be scored per side. Consider a game where the X side beats the O side 2-0 in total score. The X side may beat the O side by one TTT in each mission area; or in contrast, the X side my beat the O side by overwhelming margins in each mission area. Although the total score

determines the wi..ing team, it does not provide much insight about the margin of victory. Mission TTTs provide a much finer measurement and truer indication on game outcomes as compared to the total score.

By introducing a delay on the O side, it was hypothesized that O's mission performance would decrease. The performance decrease could occur either offensively (O scoring less TTTs), defensively (X scoring more TTTs), or a combination of the two. To ensure that a change in performance, both offensively and defensively, was reflected in the scoring measure, the difference between the X side and O side total TTTs in the assigned mission areas was selected as the scoring measurement. Note that if O's mission performance decreases, the scoring value will increase positively. If each side is configured with the same delay and game plan, then near equal performance is expected and the scoring values should be approximately zero.

B. STATISTICAL METHODS

1. Distribution

The average of TTTs in the mission areas for each 30 game repetition set was assumed to have a normal distribution by the Central Limit Theorem (CLT) of statistics. The CLT states that the averages of random samples taken from any type of distribution will approximate a normal distribution if the size of the samples (n) are sufficiently large. A rule of thumb for the size of n is that n must be greater than 30.

Since 30 repetitions were used for each game set, it was assumed that this was sufficient to justify using the normal distribution approximation. Also, since the scoring measure was the difference between TTTs for the X and O sides it would also be normally distributed since the difference is a linear combination of normally distributed variables.

2. Analysis of Variance

a. Single-Factor

The second research question: is there a point at which mission outcomes do not decline significantly as the delay increases, was investigated using single-factor Analysis of Variance (ANOVA). Each of the three types of delay (tactical, area, and communication) were examined separately. For each type of delay, there were 10 different amounts of delay used (I = 10; 0 - 9) and 30 repetitions performed (J = 30). To answer the thesis question, the null hypothesis must be checked to compare the means:

$H_O : \mu_0 = \mu_1 = \ldots = \mu_9$

versus

H_a : at least two of the μ_i's are different.

If the null hypothesis can not be rejected, then none of the delays resulted in significant changes in the scoring. If this is the case, there is not a point at which the mission outcomes do not significantly continue to decline as delay increases. However, if the null hypothesis can be rejected, then at least two of the means are different. Tukey's method

can then be used to determine which means are significantly different and possibly determine if there is a point at which mission outcome does not continue to decline.

b. Two-Factor

To answer the first research question: which of the three types of delay has the greatest effect on mission outcome, two factor ANOVA was used. The first ANOVA factor (A) is the type of delay consisting of three levels ($I = 3$; i = area, tactical, and communication). The second factor (B) was the amount of delay consisting of 9 levels ($J = 9$; $j = 1,2...9$). Delays of zero were not used in this analysis because when each of the types of delay are set to zero, the games are the same and identical results are expected. There were 30 observations for each of the IJ combinations ($K_{ij} = 30$). The following experimental model was used:

$$\mu_{ij} = \mu + \alpha_i + \beta_j + \gamma_{ij}$$

where:

μ_{ij} = the mean score of when $I = i$ and $J = j$

μ = the expected score averaged over all levels (the true grand mean).

α_i = main effects for type of delay factor when $I = i$

β_j = main effects for amount of delay factor when $J = j$

γ_{ij} = interaction parameter when $I = i$ and $J = j$

For this model three sets of hypotheses and alternate hypotheses are considered:

The no-interaction hypothesis:

H_{OAB} : $\gamma_{ij} = 0$ for all i,j

versus H_{aAB} : at least one $\gamma_{ij} \neq 0$

The main effects hypothesis for type of delay:

H_{OA} : $\alpha_1 = \alpha_2 = \alpha_3$

versus H_{aA} : at least one $\alpha_i \neq 0$

The main effects hypothesis for amount of delay:

H_{OB}: $\beta_1 = \beta_2 = \ldots = \beta_9 = 0$

versus H_{aB} : at least one $\beta_j \neq 0$

First the no-interactive hypothesis must be tested to see if the interactive effects are significant. If they are not significant, an additive model can be assumed and the two main effects can be checked for significance. If interaction is significant then graphical methods must be used to interpret the interaction.

The main effects hypothesis for the type of delay was used to test the first thesis question as to which type of delay has the greatest effect on mission outcome. If the hypothesis can be rejected, then at least one of the three types of delay is significantly different. In this case, Tukey's method can be used to identify which type of delay is significantly different.

3. Level of Significance

Traditional levels of significance are 0.10, 0.05, and 0.01. Previous statistical analyses on T4 have used a value

of 0.05 [Ref. 3:p. 28]. This value was also used throughout the data analysis in this study.

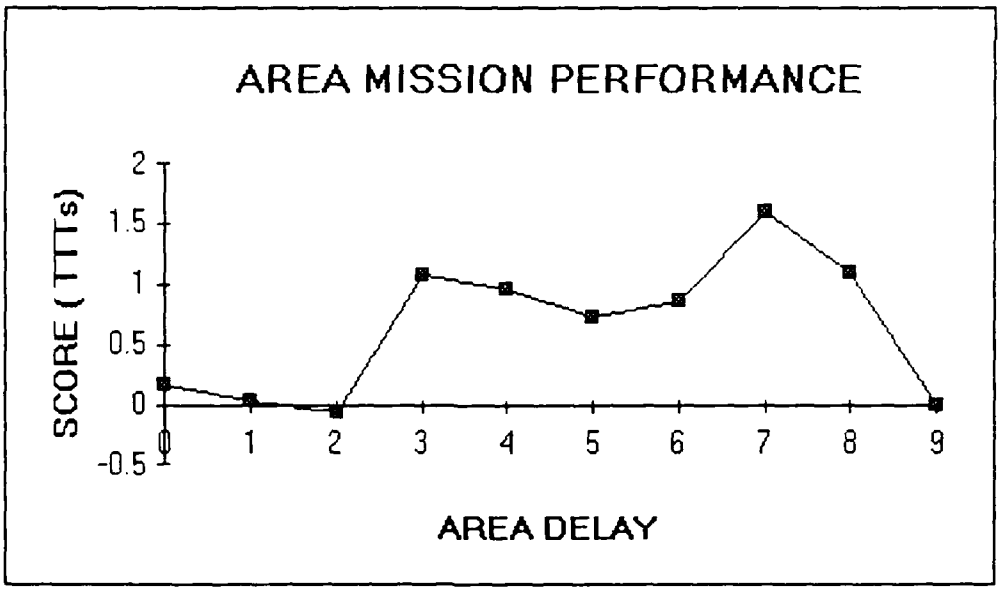
C. RESULTS

1. Increasing Delay Amounts

To answer the second research question, each of the delay types were studied independently to determine if there was a point at which increasing the delay amount did not effect mission outcome. Each type of delay was analyzed for delay amounts from zero to nine using the single-factor ANOVA procedure in Minitab. The Minitab analysis for area, communications, and tactical delay is provided in Appendix C. The scoring results for each game and the statistics for the 30 game repetition sets are provided in Appendix D. As expected, delay levels of zero for each type of delay resulted in scores of approximately zero.

a. Area Delay

Graph 2 shows the effect of increasing area delay on mission outcome.

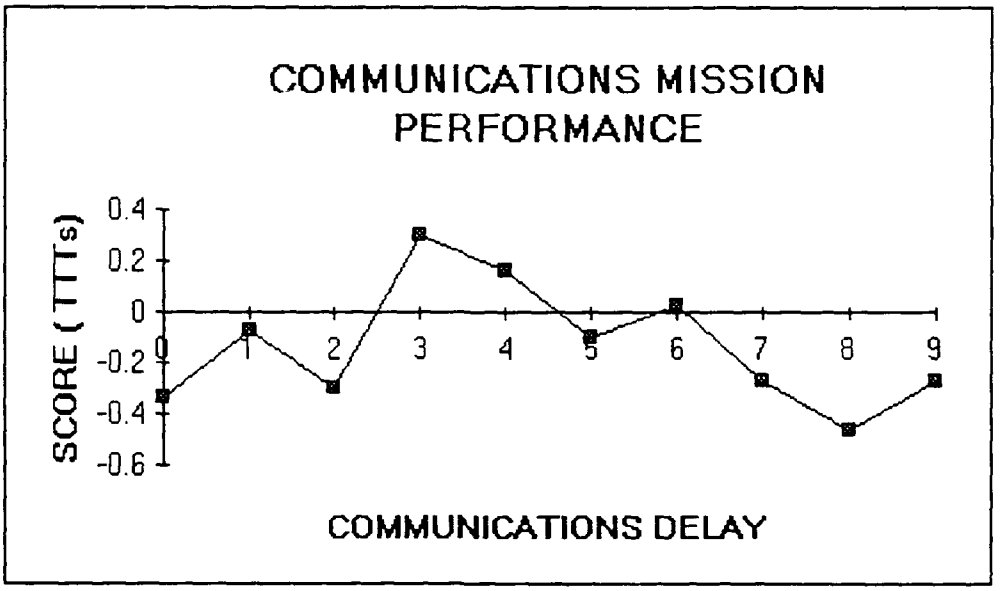


Graph 2

Delays of zero to two produced scores of approximately zero. Delays above three exhibited scores around 0.9 except at 7 and 9 where relatively high and low scores occurred, respectively. Single factor ANOVA produced a p-value of 0.122, greater than the 0.05 level of significance. Therefore, the null hypothesis can not be rejected and the delay amounts did not significantly effect the score.

b. Communications Delay

Graph 3 shows the effect of increasing communications delay on mission outcome.

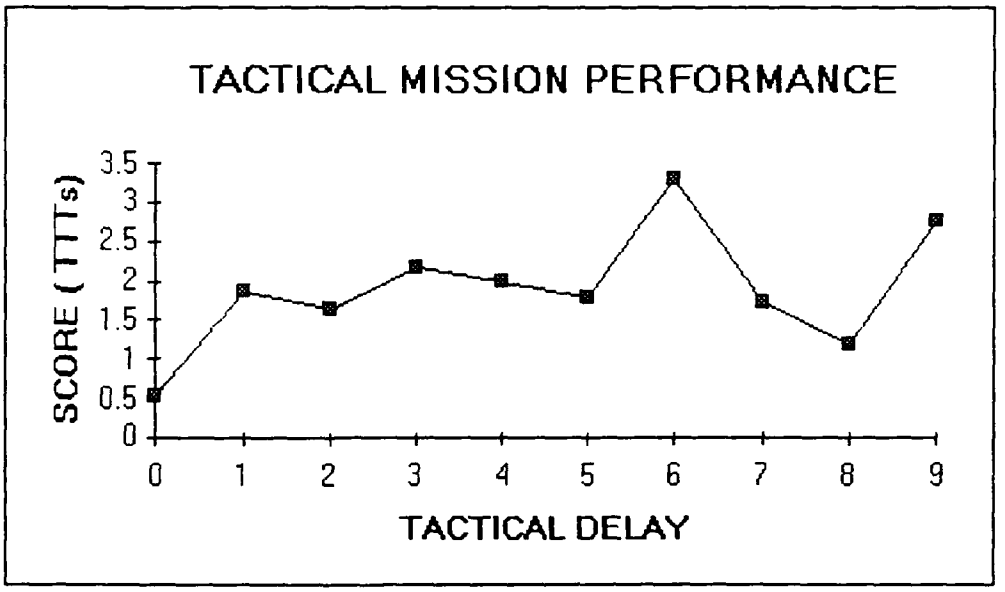


Graph 3

Graphically the results do not indicate any trend with increasing delay. Single-factor ANOVA strongly supports this indication with a p-value of 0.991, well above the 0.05 level of significance. The null hypothesis can not be rejected and the delay amounts did not significantly effect the score.

c. Tactical Delay

Graph 4 shows the effect of increasing tactical delay on mission outcome.



Graph 4

After 0 delay, the score increased to approximately 1.75 and remained at about that level except at delays of 6 and 9 where the score was approximately 2.7. Single-factor ANOVA analysis produced a p-value of 0.092 slightly above the 0.05 level of significance. The null hypothesis can not be rejected and therefore the delay amounts did not significantly effect the score.

2. Delay Types

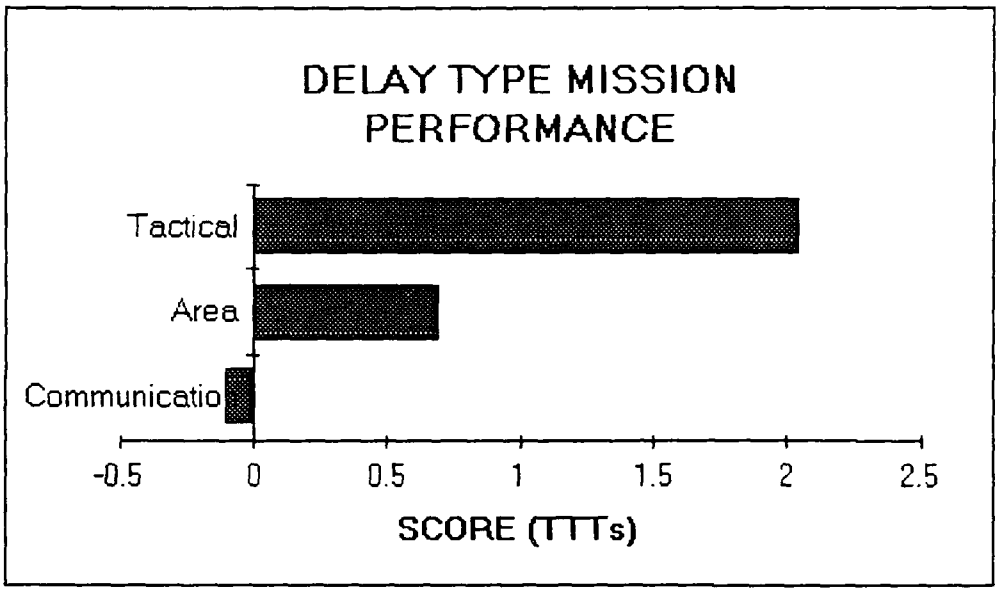
The two-factor ANOVA analysis using Minitab was used to answer the first research question. First, the no-interaction hypothesis was tested followed by the two main effects hypotheses. The Minitab results are provided in Appendix E.

The no-interaction hypothesis test resulted in a p-value of 0.528, greater than the 0.05 level of significance.

Therefore H_{OAB} can not be rejected and the interaction effects of amount and type of delay are not significant. The presence or absence of the main effects were then tested.

The main effects hypothesis test for type of delay resulted in a p-value of 0.000, less than the 0.05 level of significance. Therefore H_{OA} was rejected and the type of delay does effect the mission outcome.

To decide which types of delay are significantly different, Tukey's method was used. For the type of delay factor, $I = 3$, so with 0.05 level of significance and $IJ(K - 1) = (3)(9)(30 - 1) = 783$, $Q_{.05,3,783} = 3.31$. Then $w = Q((MSE/(JK))^{1/2} = 3.31(8.226/((9)(30)))^{1/2} = 0.578$. The overall means for area, communications, and tactical were 0.70, -0.11, and 2.05 respectively. By ordering the means, -0.11, 0.70, 2.05, it is clear that the difference between each mean is greater than 0.578 and therefore each delay type is significantly different from the other. Tactical delay had the greatest effect on mission outcome, followed by area, and communications having the least effect. Graph 5 compares the performance of the three types of delay.



Graph 5

The main effects hypothesis test for amount of delay resulted in a p-value of 0.395, greater than the 0.05 level of significance. Therefore H_{OB} can not be rejected and the amount of delay does not effect the mission outcome. Although this was not a specific research question, the results are consistent with the findings for the second research question. Differing delay amounts do not effect game outcomes significantly within each type of delay or overall as the main effects hypothesis indicates.

Chapter IV summarizes the results and provides some recommendations for future T4 studies.

IV. CONCLUSION

A. SUMMARY

Comparison of information types and levels in T4 produced the following results to the two original thesis questions:

- Of the three types of delay, tactical delay was found to have the greatest effect on mission outcome followed by area delay which had less of an effect. Communication delay did not have any discernible effect on mission outcome.

- For each type of delay, different levels of delay did not significantly effect mission outcome. However, area delay and tactical delay graphically indicated delay levels at which mission outcomes did not continued to decline as delay levels were increased.

As predicted, tactical delay had the greatest effect on mission outcome; however contrary to predictions, there was not a significant difference in the different levels of delay for each type of delay. Both area delay and tactical delay graphically showed a tendency not to continue to degrade mission outcome once past a certain delay level -- a delay of three for area and one for tactical. However, ANOVA analysis indicated no significant differences in mission outcomes for the different delay levels. This can be attributed to the relatively large variability in the data as indicated by the standard deviations of the scores for each 30 replication delay set. The standard deviations ranged from 2.67 to 3.68 for averages ranging from -0.467 to 3.300.

Three experimental design decisions probably contributed to the high variability of the data: mission assignments, conflict resolution, and game plans. Each team was assigned the same mission, strategy, and the same set of game plans which simulated their personalities. This combination could have resulted in each team having a tendency to perform similar moves resulting in a higher number of same turn conflicts. Since conflicts were decided randomly, more conflicts may have increased the variability in the game scores. No attempt was made to investigate this theory, although the data is available for future work.

B. RECOMMENDATIONS

One change in T4 that may be helpful would be to fill in zeros on the output spreadsheet for cells where zero scores occurred. At present, T4 leaves the cells empty for zero values. If scoring statistics are calculated using the Excel functions, the empty cells are omitted in the calculations resulting in incorrect statistical values. This was noticed when computing the 30 replication delay set averages. Excel computed sample sizes using cells with values and omitted the samples with zero scores. This can easy be worked around by using the Excel replace command to fill in the empty cells with zeros; however, a change in the T4 software to fill in zeros would save a step in the data analysis process.

There are many more possibilities for future studies using T4. The following are a few ideas:

- Investigate the effect of same and different mission assignments on mission outcomes.
- Investigate the effect of game plans on mission outcomes.
- Investigate the effect of same turn conflict resolution on mission outcomes. Also, look at the effects of the very first conflict wins for each game on mission outcomes.
- Investigate the effect of communication delay in greater detail. Communication delay did not appear to have any effect on mission outcome in this study.
- Experiment with multiple delay levels (two or three types of delay set greater than zero moves). Is there a synergistic effect on mission outcomes?

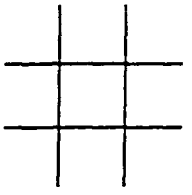
T4 is a powerfully simulation tool for instructing students in designing, conducting, and analyzing system experiments. The game has many variables that can be set to investigate the influence on mission outcomes. Many output parameters are also available to use as possible MOEs. This study attempted to provide some insight on the effects of information delay within T4. There are many more challenging areas available for future studies.

APPENDIX A

T^4 (TACTICAL T^3)

The T^4 game used in the OS4602 course last fall was derived from T^3 (Tic Tac Toe). This paper describes the evolution of the T^4 game, its variants and its potential use as a simple, but rich experimental testbed for future OS4602 experiments. Also provided is a discussion of a computer based aid for use by the controllers of the experiment. Use of the aid will result in more accurate results and faster (more) trials.

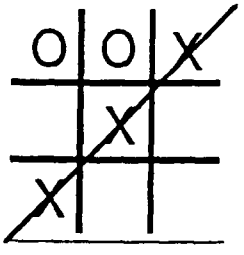
T^3 (TIC TAC TOE) REVIEW



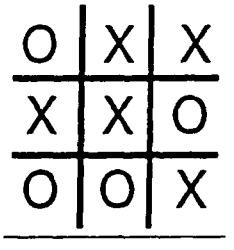
Rules:

- 2 Players (X and O)
- Alternate Turns (X plays first)
- First player to get 3 in a row (TTT) wins:
  - Horizontal
  - Vertical
  - Diagonal
- Ties (Cats Games) are possible

Examples:



Score: X Wins



Score: Tie

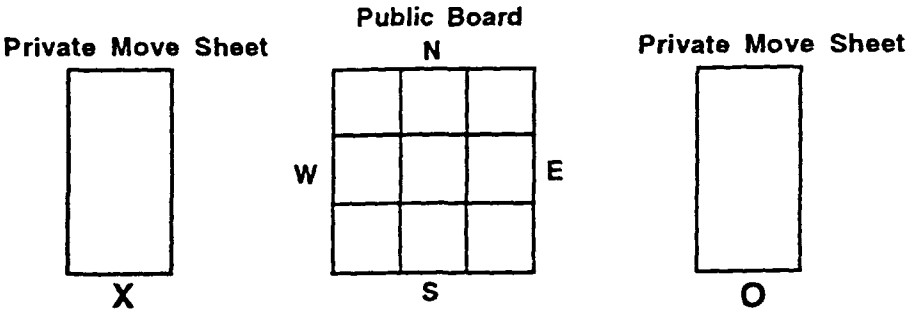
T^4 BASELINE

The T^4 baseline game is like T^3 except for the following:

• **Simultaneous moves**: Both players choose their moves in secret and then announce them simultaneously.

• **Conflict resolution**: The simultaneous move rule means that two players can move into the same cell on the same move. A coin is used to resolve the conflict. The winner of the coin toss is awarded the move. The loser is not allowed to make an alternate move; thus losing a turn.

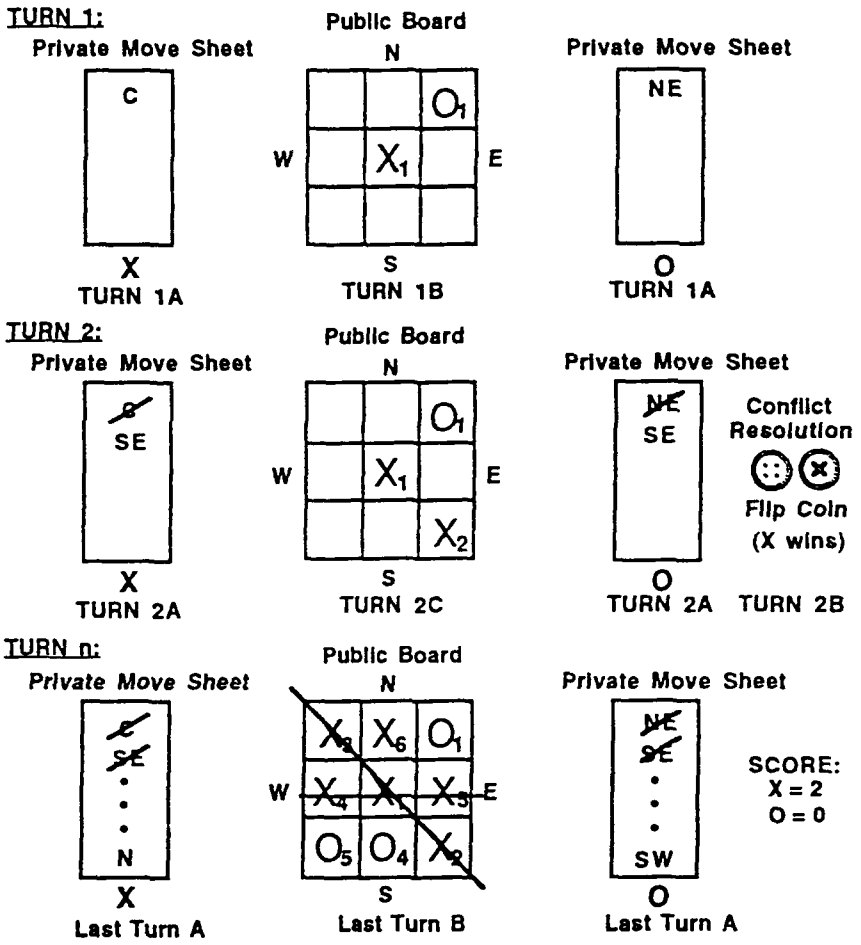
• **Scoring**: The player with the most TTTs wins (not the first TTT). Therefore the maximum score is 8 and the minimum score is 0. Although the Pr(8 TTTs) is about 1 in 20,000,000 (about the same odds as winning the Lotto).



Sequence of Play:

1. Write move on private move sheet.
2. Simultaneously announce moves.
3. Resolve conflicts.
4. Post on public board.

T^4 Baseline Example:



T^4 WITH INTELLIGENCE DELAY

The intelligence delay game is like the T^4 baseline game except an enemy detection delay factor is introduced. A player's knowledge of own moves is always real time, however the player's knowledge of the enemy's current move may be kept secret for one or more turns depending on the game configuration selected before game start. For example, assume player X is configured to play a one turn intelligence delay game and further assume that two moves for both players have already occurred. Then Player X knows of own moves (X_1 and X_2) but is only provided player O's first move (O_1). The configurations assigned to each player may be different. In the above example, player O might have been assigned no intelligence delay and therefore would know of all four moves (X_1, X_2, O_1 and O_2).

Games with intelligence time delays can result in cases where a rational player will move into a cell already occupied by the enemy (but because of the delay factor, the player is unaware of the enemy's location). The conflict is resolved by awarding the move to the player first occupying the square (LIFO). Players are notified of the conflict and of the resolution on a real time basis. T^4 with intelligence delays requires maintaining a private game board for each player and either an umpire or opponents who are good sports.

DOUBLE BOARD T^4 BASELINE

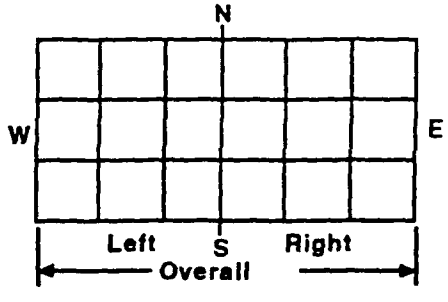
This version uses two standard 3 X 3 cell T^3 boards placed side-by-side designated **left** and **right** game boards. Thus, the total game board is 3 X 6 cells. This game is like the T^4 baseline game except:

- **4 Simultaneous Moves**: Both players announce their left and right moves simultaneously.

- **Crossover Scores**: A crossover score is a TTT that crosses over the center line between the left and right game boards. A crossover score can include TTTTTT (e.g.; X wins the top row of both the left and right game boards. Diagonal crossover TTTs are also possible, but vertical TTTs are not. Multiple TTTs are scored by counting the number of TTTs embedded in a string of multiple TTTs. I.e;

TTT = 1 TTT
TTTT = 2 TTTs
TTTTT = 3 TTTs
TTTTTT = 4 TTTs

The maximum possible score is 26, minimum score is 0.



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DOUBLE BOARD T^4 WITH INTELLIGENCE DELAY

This version combines the rules of the single board T^4 intelligence delay game with the double board T^4 baseline game. Again the enemy detection delay configuration can be set to real time (no delay), or a delay of one or more turns. A different delay factor can be chosen for each player, for each side of the board, or in combinations. For example one time delay configuration might allow player X to received real time intelligence on the left side of the board but never receive intelligence on the right side. While during the same game opponent player O receives intelligence delayed by one turn on both sides of the board.

DOUBLE BOARD T^4 WITH MISSIONS

Missions are assigned to achieve an **outcome** (victory or survival) within an **area** of the game board (left, right, crossover, or overall). Victory is achieved by scoring more TTTs than the enemy in the assigned mission area. Survival is achieved by not losing (i.e.; winning or tieing) the assigned mission area. The eight mission assignments are as follows:

LV = Left side victory: Score the most TTTs on the left side.
RV = Right side victory: Score the most TTTs on the right side.
CV = Crossover victory: Score the most crossover TTTs.
OV = Overall victory: Score the highest total TTTs (left, right, and crossovers).

LS = Left side survival: don't lose on the left side.
RS = Right side survival: don't lose on the right side.
CS = Crossover survival: don't lose in the crossover area.
OS = Overall survival: don't lose overall.

Up to four individual missions may be assigned to a player's mission set. Both players can be assigned different mission sets. Scoring is based on successful mission achievement (either by individual missions or by mission set). TTTs are used to decide mission outcome. Notice that non-zero sum games are possible. I.e.; both sides may achieve a degree of success in some game configurations.

DOUBLE BOARD T^4 WITH MISSIONS AND INTELLIGENCE DELAY

A combination of the double board T^4 baseline game with mission assignments (one or more of eight mission areas) and intelligence delay (real time, or delays of one or more turns.

TEAM GAMES

Team games consist of two players per side: One player on a team is assigned the left game board and the other the right. Team games are always played on double game boards with mission assignments. Missions (including mission sets) are assigned by team. I.e.; the players on a team are always assigned the same missions. However different mission sets may be assigned to the opposing team. As a general rule team games, especially combinations of games discussed below, require an umpire: Someone who administers the game to ensure that the appropriate amount of information is provided to all four players. As discussed below, players on the same team may be assigned different delay factors. Thus five private game boards are required: one for each player and the umpire. All players keep their game board secret from opponents and their own partner. The umpire's view of the game represents ground truth and is therefore also kept secret. Players secretly provide their moves to the umpire. The umpire then secretly updates ground truth, resolves conflicts, and then secretly returns the appropriate level of information to each player.

TEAM GAMES WITH INTELLIGENCE DELAY

The intelligence delay factor controls when players are provided the enemy's moves. Intelligence delay factors may be assigned independently of player and game board side. Define **Tactical** intelligence to be enemy position information on the player's side of the board, and **Area** intelligence to be enemy position information on the other side of the board. Then different tactical and area intelligence delay factors may be assigned each of the four players. E.g.; X left may be assigned a tactical intelligence delay factor of 1 turn and an area intelligence delay factor of 2 turns (X_L = T_1, A_2). The players partner (X_L) and the enemies (O_L, O_R) may each be assigned different intelligence delay factors .

TEAM GAMES WITH COMMUNICATIONS DELAYS

This version introduces a communications delay factor between players on the same team (partners). Communications delay controls the timeliness of receiving your partners move information. Like intelligence delay factors, communications delays may be set to real time (no delay) or a delay of one or more turns. Continuing the example, if player X_L is assigned a communications delay of one turn then $X_L = T_1$, A_2, C_1. Each of the four players may be assigned different communications delays.

TEAM GAMES WITH FEEDBACK DELAYS

This version specifies the number of moves each player must make before receiving feedback on enemy and partner locations. Like the three other delay factors the feedback delay can be set from no feedback delay to more than one turn feedback delay. In the no feedback delay configuration, normal feedback is provided after each turn. Where normal means providing the level of information dictated by the other delay factors (tactical intelligence, area intelligence, and communications delays). If the delay factor is greater than one, then multiple moves are required before normal feedback is provided. E.g.; if the feedback delay is set to 2, then the player must make two moves before receiving position information on other players' moves. In this configuration, information when received is current to the second turn (after adjusting for intelligence and communications delays). Each of the four players may be assigned different feedback delays.

TEAM GAMES WITH PLANNING

This version introduces planning constraints between partners. Planning is that part of the game that occurs before the first move is executed. There are three levels of planning. Planning levels assigned to partners must be the same. However the levels assigned opposing teams may be different.

• **Specific scenario planning allowed**. Scenarios are provided and direct conversation is allowed between partners before game start in order to plan the specific mission.

• **General planning allowed.** Team members are assigned and general planning sessions are allowed. Planning if not permitted after the specific game scenario (factors) are assigned.

• **Planning not allowed.** Players are assigned to teams from the player pool. No team conversation is permitted until the end of the game.

EXPERIMENTAL DESIGN COMBINATIONS FOR TEAM GAMES

Six factors each having multiple treatment levels have been introduced. They are

- Tactical Intelligence delay (T = 0, 1, 2, • • • 9) turns,
- Area Intelligence delay (A = 0, 1, 2, • • • 9) turns,
- Communications delay (C= 0, 1, 2, • • • 9) turns,
- Feedback delay (F = 0, 1, 2, • • • 9) turns,
- Planning levels (specific, general, and none = P_S, P_g, and P_n), and
- Mission sets consisting of one to four individual missions. E.g.; team X might be assigned win right and don't lose the crossovers (X = $M_{LV,CS}$)

The levels of each of the five factors may be distributed among players each game as follows:

- Tactical Intelligence delay: unrestricted assignment of levels to players,
- Area Intelligence delay: unrestricted assignment of levels to players,
- Communications delay: unrestricted assignment of levels to players,
- Feedback delay: unrestricted assignment of levels to players,
- Planning levels: The same level must be assigned to partners, and
- Mission assignments: The same mission set must be assigned to partners.

In order to get a feel for the magnitude of the experimental design options assume all factors are limited to three levels (the four delay factors are limited to real time, one turn delay, or no information (level 9) and Missions are limited to one of left victory, right victory, or overall victory then consider the following:

- T_0, T_1, T_9 with 4 players = 24 permutations
- A_0, A_1, A_9 with 4 players = 24 permutations
- C_0, C_1, C_9 with 4 players = 24 permutations

- F_0, F_1, F_9 with 4 players = 24 permutations
- P_s, P_g, P_n with 2 teams = 6 permutations
- M (LV, RV, OV) with 2 teams= 6 permutations

Combining the above six factors and their three levels by players yields a wide spectrum of experimental design opportunities. Allowing more than three levels (e.g.; mission sets from one to four missions may be assigned to the two teams where a mission set consists of combinations of the eight basic missions) would increase the number of permutations significantly.

Experience gained during the last T^4 experiment showed that while game play was fairly uncomplicated, the administration of the game by the controllers was cumbersome, confusing, time consuming, and error prone. A computer based aid for the controllers will improve this facet of the experiment. Using the aid will permit improved accuracy and allow more trials during a given time period. The next section discusses this computer aid in depth.

T4 SIMULATION

MOTIVATION

The initial T4 experiment was conducted as part of the OS4602 course in the fall of 1990. A subset of the students were assigned to the lead group. This group was responsible for the design, conduct, analysis and reporting the results of the experiment. The remainder of the students served as subjects. Each trial required for subjects assigned to two teams. Team O consisted of an O left and right player while team X consisted of a X left and X right player.

LESSONS LEARNED

In retrospect two problem areas were identified. 1.) The scope of the experimental design was overly ambitious given the class time constraints allotted to the lead group. The resulting small number of trials pre-preempted findings that were significant. 2.) Data collection errors were committed by the lead group during the conduct, scoring, and data reduction phases of the experiment. These errors may have led the lead group to reach an erroneous conclusion.

AUTOMATED T4

A automated version of the team T4 game has been developed to assist lead groups conduct more trials while hopefully eliminating the data errors experienced during the first T4 experiment. The automated T4 allows the lead group to configure game files based on the experimental design prior to the conduct of the trials. During the trials the lead group receives private moves from each of the four players and inputs them into the automated T4 display by clicking a mouse on the appropriate cell on the electronic game board. After the four moves are secretly input by the lead group, the program then evaluates each players moves based on the game configuration (for example the amount and type of delay) and then prints a new move sheet for each player containing this filtered information, The individual move sheets are returned to each player the next move cycle begins.

Data for each game is automatically collected. The data includes the game configuration data, a history of each move by player, and game scoring by TTTs, and mission areas. The program also allows

the lead group to write the results of the trials to a file in matrix (spreadsheet) format for further data reduction and analysis.

T4 SIMULATION

Developing a T4 simulation was a natural extension to the automated T4 game. The automated T4 game already contained the software to record legal moves, to collect a wealth of game data, to score the games, and to print the results to a data file. All that was required to complete the T4 simulation was 1.) creation of method to generate controlled game moves based on predefined user specified configurations and 2.) to construct a mechanism to allow multiple replications of these games, once specified without user intervention.

Advantages of T4 Simulation

The advantages of using a T4 simulation include 1.) testing the performance of the automated game, 2.) analyzing relationships between T4 configuration factors such as delays, missions assignments, player tactics, and initial wins, and 3.) permitting player versus computer trials which helps control the game play variables and increases the number of trials (1 human subject can play against 3 computer players instead of three players.

Status of T4 Simulation

The computer versus computer version of the simulation is complete. Item 1.) testing discussed above has been completed. The Item 3.) human versus computer play version is not yet available. Item 2.) analysis of relationships between game configurations factors is the subject of the remainder of this paper.

T4 SIMULATION OVERVIEW

The current version of the T4 simulation allows the user to configure play of a trial including configuration each of the four computer players. Configuration means specifying such items as team mission assignments, delays associated with each player, and player tactics. The user also specifies the number of replications desired for each trial configuration and which data file to save the data collected during the games. Multiple trial configurations may be specified for a given simulation run. For example 30 replications of one game configuration and 30 replications of one or more

variations to this configuration may be specified for a simulation run. Once the user starts the simulation run no further human intervention is required until the replication run is completed. the T4 simulation plays the games according to the predefined user specifications and sends the results to user specified data files. These data files may then be read by most spreadsheets or statistics packages for further data reduction under macro control. The following sections discuss the details of T4 simulation game configuration including creating game plans, specification of multiple factor levels, description of the data that is automatically collected, and use of multiple replications to simulate T4 results.

GAME PLANS

The user specifies the actions of the four computer players by creating a set of three game plans for each. The set of three game plans are the Regular game plan, the Crossover game plan, and the Cell game plan. The game plans enumerate all possible next plays for the player. The user, by assigning point values to these conditions, controls how the computer player plays the game.

The simulation matches the actual condition of the game board with the possible next moves and assigns point values to the empty cells (potential next moves). First the game board is matched against the regular game plan, then the crossover game plan, and finally the cell game plan. the scores of each are accumulated in the empty cells. The cell with the highest point count is chosen for the next move. Ties are randomly broken. A more complete description of each of the three types of game plans is provided below. Also included is an example game in progress to illustrate the concepts.

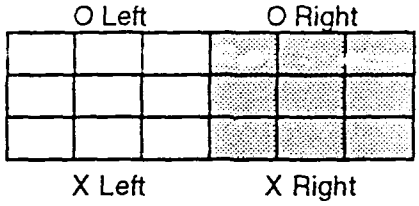
After describing game plans, the other user specified game configuration are discussed followed by the a discussion on the automatic data collection features of the simulation. We will then be prepared to discuss the design of experiment which when executed leads to a better understanding of the relationships of the game configuration variables.

REGULAR GAME PLAN

The regular game plan regulates the automated play of the computer player on the regular (non-crossover) portion of that player's side of the game board. If we assume we are describing Player O Left's game plan then O Left's regular portion of the

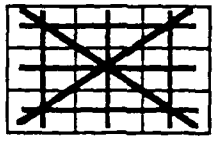
playing board is shown as unshaded in the figure below.

T4 Game Board



The simulation first sequentially "looks" at all eight of the ways that a three cell regular TTT can be scored as shown in the figure below.

Eight Regular TTTs



It first looks at the 3 horizontal TTTs, then the 3 vertical TTTs, then the 2 diagonal TTTs. During each of the eight looks it attempts to match the contents of the three cells in the look with a permutation of one of the codes in the regular game plan.

A regular game plan is a table which enumerates in coded form all possible next moves for a player and the point values assigned by the user to that move. Player O Left's regular game plan with sample values assigned to each condition is shown in the figure below.

Regular Game Plan

Player O Left

OO-	1,000
XX-	500
O--	100
X--	50
---	10
OX-	0

An X or an O in the code means a cell has an X or an O in it. A dash (-) means a cell is blank. As previously discussed, the program attempts to match the 3 cells in the current look with permutations

of the codes in the regular game plan. For example the simulation first looks at the three cells in first row of player O Left's game board and attempts to match the contents with a permutation of the first code "OO-" in the regular game plan. A match occurs if the three examined cells contain "OO-", "O-O", or "-OO". In other words, a match occurs if the three cells contain exactly three X's and a blank in any order. The remaining codes are evaluated in the same manner as shown in the figure below.

Regular Game Plan Definition

Player O Left		The three cells contain (in any order) exactly:
OO-	1,000	Two O's and one empty cell
XX-	500	Two X's and one empty cell
O - -	100	One O and two empty cells
X - -	50	One X and two empty cells
---	10	Three empty cells
OX-	0	One each O, X, and empty cell

When a match occurs the point value in the second column of the game plan is added to the blank cell. Notice that each code has at least one dash (-) in it, otherwise a next move for that code would not be possible.

The simulation then steps through each of the eight TTT looks, each time assigning the value of the permuted code it matches to the empty cell. Notice that if an empty cell is in the center of the game board then the point value represents the sum of four "looks" (two diagonal, one horizontal, and one vertical). An empty corner cell has three looks and an empty edge cell has two looks.

Similar procedures are used to add the values in the crossover and cell game plans to the empty cells. But first the following example is introduced to illustrated the procedure. The example game is joined in progress and the simulation is evaluating the next move for O left using the regular game plan shown above. Only one side of the game board is used to evaluate the regular game plan: in this case the left side.

O Left's Next move

O Left			O Right		
		X2		X2	
	X1		O2	O1	
	O2	O1		X1	
X Left			X Right		

First the three rows are evaluated. The top row (--X) matches a permutation of (X--) in the regular game plan. Therefore 50 points is assigned to both blank cells in the top row. The middle and bottom rows are evaluated in the same manner resulting in the interim point values as shown in the following figure.

O Left's Next move

O Left			O Right		
50	50	X2		X2	
50	X1	50	O2	O1	
1000	O2	O1		X1	
X Left			X Right		

The same procedures are followed in matching the three vertical columns and the two diagonals. The point values from the regular game plan is added to the values already in the empty cell (empty in the since that an X or O is not in the cell and thus it represents a possible next move). The results of matching and adding the three vertical rows is shown in the figure in the following figure on the left. The point values found from matching the two diagonals is added to the values in the left figure and shown in the right figure shown below.

O Left's Next move

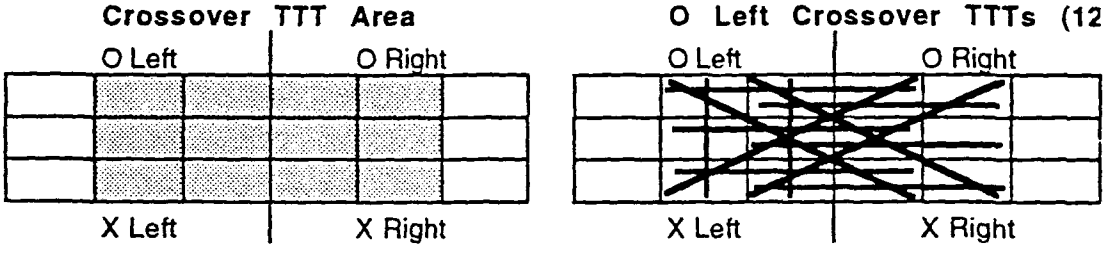
O Left			O Right		
60	50	X2		X2	
60	X1	50	O2	O1	
1010	O2	O1		X1	
X Left			X Right		

O Left's Next move

O Left			O Right		
60	50	X2		X2	
60	X1	50	O2	O1	
1510	O2	O1		X1	
X Left			X Right		

Based on the results of assigning point values to empty cells

based on the regular game plan only the next move selected would be the lower left cell (=1,510). However the Crossover and Cell game plans also contribute to the point values. The crossover area of a T4 team game consists of all the cells in TTTs that cross the centerline as shown in the following figures. The unshaded portion of the figure on the left is crossover area. The twelve crossover TTTs for player O Left are shown on the right.



Notice that while crossover TTTs by definition extend to the right side of the game board, the only points of interest to O Left are those on the left side of the board. Points on the right side of the game board are accumulated using the game plans for the O Right and X Right players. The Crossover game plan used for this player O Left example is shown below.

Crossover Game Plan

OO-	1,000
XX-	500
O--	100
X--	50
---	10
OX-	0

The procedures for adding point values to the empty (non X or O) cells after accounting for the topology of the 12 crossover TTTs are the same as those used to calculate the regular game plan points. Each of the three cells in the twelve crossover TTTs are matched with the crossover game plan and empty cells on the left side of the board are assigned point values as before.

The below figure on the left shows the point totals after the points associated with the three left-most horizontal "looks" have been matched and accumulated in the empty cells. The figure on the

right adds the points from the right-most horizontal "looks" to the accumulated totals

O Left's Next move

O Left			O Right		
60	100	X2		X2	
60	X1	50	O2	O1	
1510	O2	O1		X1	
X Left			X Right		

O Left's Next move

O Left			O Right		
60	100	X2		X2	
60	X1	1050	O2	O1	
1510	O2	O1		X1	
X Left			X Right		

The point totals after adding the remainder of the points based on the vertical and diagonal looks are as shown below. Note that the two vertical looks resulted in no points added to cells because they were a permutation of (XO-). And no points were added to empty cells based on the right most two diagonal looks because there weren't any empty cells.

O Left's Next move

O Left			O Right		
60	100	X2		X2	
60	X1	1160	O2	O1	
1510	O2	O1		X1	
X Left			X Right		

Finally the points associated with the Cell Move Plan are added in. The points in the example player O Left Cell move plan shown in the figure below left are simply transferred directly to any empty cells. It may appear that the points assigned to the Cell game plan in this example are too low to have an effect on the outcome. However they may serve as a tie breaker. The resultant final score is shown on the right.

Cell Game Plan

Player O Left		
2	3	5
1	4	5
2	3	5

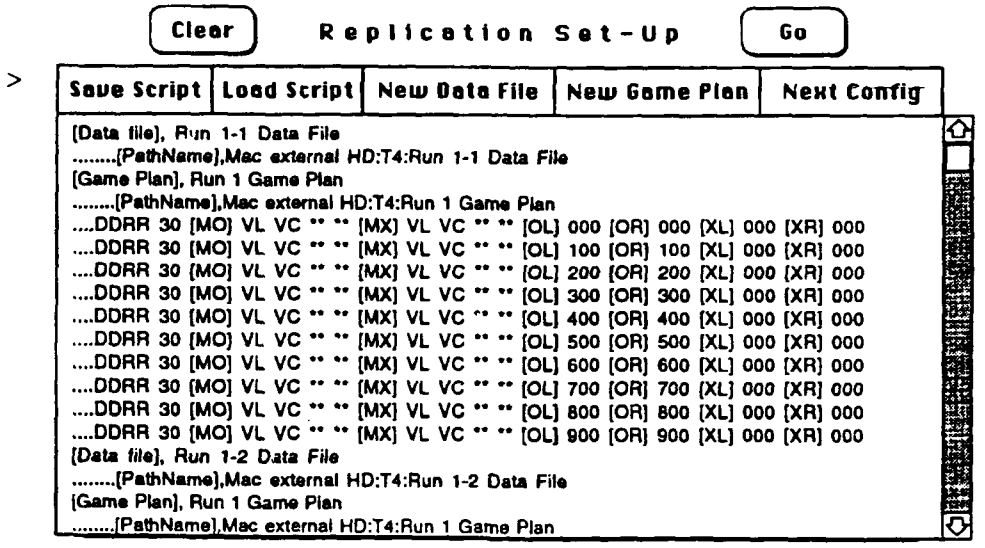
O Left's Next move

O Left			O Right		
62	103	X2		X2	
61	X1	1165	O2	O1	
1512	O2	O1		X1	
X Left			X Right		

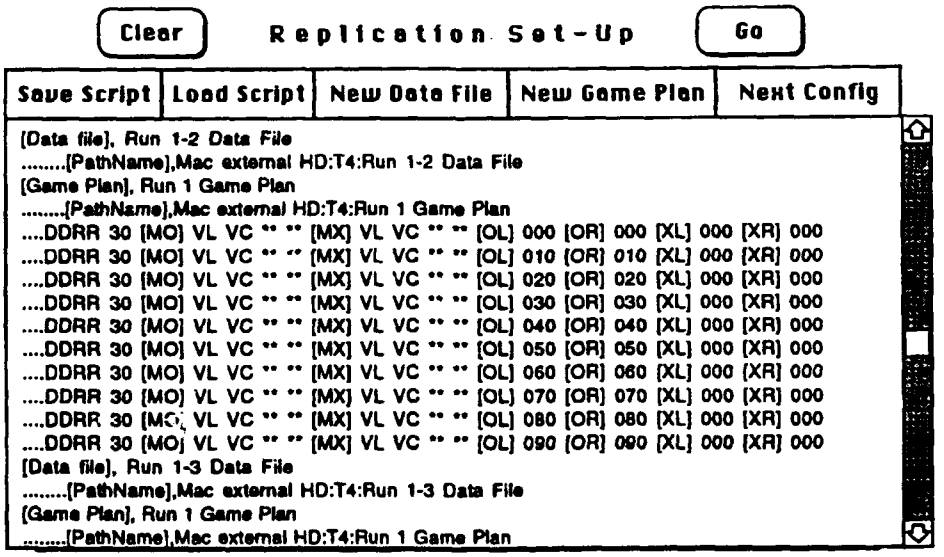
Because the lower left cell has the highest point total it is selected as player O Left's move for turn three.

The same procedures are used with each player's unique set of three game plans to select players O Right, X Left, and X Right next moves.

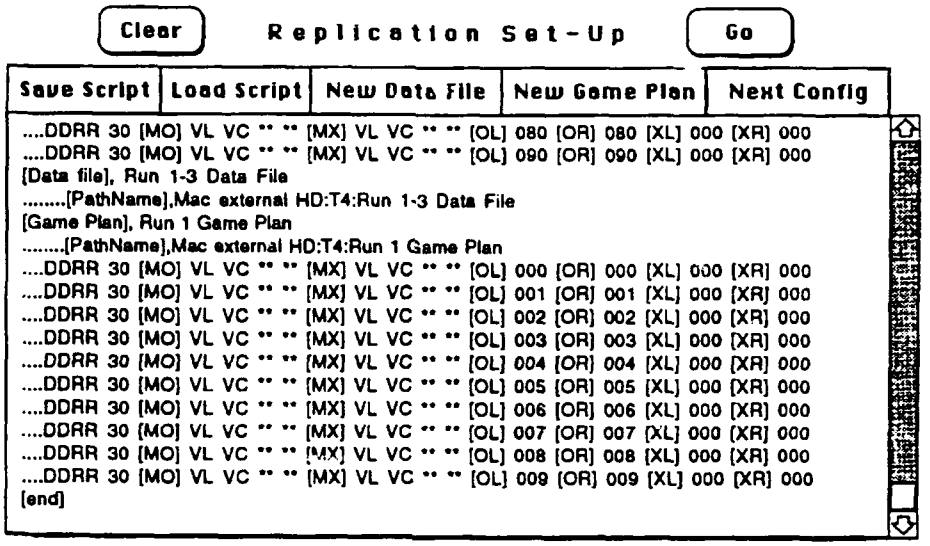
APPENDIX B



TACTICAL



AREA



COMMUNICATION

APPENDIX C

AREA DELAY

```
MTB > aovoneway c1-c10

ANALYSIS OF VARIANCE
SOURCE    DF      SS      MS      F      p
FACTOR     9   89.48    9.94   1.57  0.122
ERROR    290 1831.07    6.31
TOTAL    299 1920.55
                                INDIVIDUAL 95 PCT CI'S FOR MEAN
                                BASED ON POOLED STDEV
LEVEL     N    MEAN   STDEV ---------+---------+---------+------
A        30   0.167   3.064    (--------*--------)
B        30   0.033   2.442  (--------*--------)
C        30  -0.067   2.572  (--------*--------)
D        30   1.067   2.586            (--------*--------)
E        30   0.967   2.173           (--------*--------)
F        30   0.733   2.100         (--------*--------)
G        30   0.867   2.389           (--------*--------)
H        30   1.600   2.253                  (--------*--------)
I        30   1.100   2.295           (--------*--------)
J        30   0.000   3.051  (--------*--------)
                              ---------+---------+---------+------
POOLED STDEV =   2.513                0.0       1.0       2.0
```

COMMUNICATIONS DELAY

MTB > aovoneway c11-c20

ANALYSIS OF VARIANCE

SOURCE	DF	SS	MS	F	p
FACTOR	9	15.76	1.75	0.22	0.991
ERROR	290	2306.17	7.95		
TOTAL	299	2321.93			

INDIVIDUAL 95 PCT CI'S FOR MEAN
BASED ON POOLED STDEV

LEVEL	N	MEAN	STDEV	---------+---------+---------+-------
K	30	-0.333	2.783	(----------*----------)
L	30	-0.067	3.248	(----------*----------)
M	30	-0.300	3.164	(----------*----------)
N	30	0.300	2.926	(----------*----------)
O	30	0.167	2.465	(----------*----------)
P	30	-0.100	3.111	(----------*----------)
Q	30	0.033	2.659	(----------*----------)
R	30	-0.267	2.318	(----------*----------)
S	30	-0.467	2.738	(----------*----------)
T	30	-0.267	2.638	(----------*----------)

POOLED STDEV = 2.820 -0.80 -0.00 0.80

TACTICAL DELAY

```
MTB > aovoneway c21-c30


ANALYSIS OF VARIANCE
SOURCE    DF      SS      MS      F      p
FACTOR     9   158.0    17.6   1.69  0.092
ERROR    290  3019.8    10.4
TOTAL    299  3177.8
                                 INDIVIDUAL 95 PCT CI'S FOR MEAN
                                 BASED ON POOLED STDEV
LEVEL     N    MEAN   STDEV ----+---------+---------+---------+-
U        30   0.533   2.751 (-------*------)
V        30   1.867   3.371         (------*-------)
W        30   1.633   3.489         (-------*-------)
X        30   2.167   2.902           (------*-------)
Y        30   2.000   3.677           (------*-------)
Z        30   1.767   2.932         (-------*-------)
AA       30   3.300   2.855                 (-------*-------)
AB       30   1.733   3.513         (-------*------)
AC       30   1.200   3.624       (-------*-------)
AD       30   2.767   2.979                 (------*-------)
                      ----+---------+---------+---------+-
POOLED STDEV =  3.227          0.0       1.5       3.0       4.5
MTB > NoOutfile.
```

	O	O	O	O	X	X	X	X - O	X - O	X - O
	Delay	SCORING	BY TTs		SCORING	BY TTTs				
	TAC	TL	TC	TOTAL	TL	TC	TOTAL	TL	TC	TOTAL
	0	0	2	2	3	1	4	3	-1	2
	0	0	1	1	1	1	2	1	0	1
	0	1	0	1	0	4	4	-1	4	3
	0	1	4	5	0	0	0	-1	-4	-5
	0	1	2	3	0	0	0	-1	-2	-3
	0	1	1	2	1	2	3	0	1	1
	0	3	0	3	0	1	1	-3	1	-2
	0	1	0	1	1	1	2	0	1	1
	0	0	1	1	3	3	6	3	2	5
	0	0	1	1	2	0	2	2	-1	1
	0	1	2	3	1	0	1	0	-2	-2
	0	0	1	1	0	1	1	0	0	0
	0	0	1	1	2	2	4	2	1	3
	0	1	2	3	0	2	2	-1	0	-1
	0	0	1	1	2	0	2	2	-1	1
	0	0	0	0	2	0	2	2	0	2
	0	1	0	1	0	1	1	-1	1	0
	0	1	1	2	1	0	1	0	-1	-1
	0	1	0	1	0	1	1	-1	1	0
	0	1	2	3	0	1	1	-1	-1	-2
	0	0	0	0	3	2	5	3	2	5
	0	2	1	3	0	3	3	-2	2	0
	0	1	0	1	1	0	1	0	0	0
	0	1	6	7	1	0	1	0	-6	-6
	0	0	0	0	2	2	4	2	2	4
	0	1	0	1	1	4	5	0	4	4
	0	0	0	0	3	2	5	3	2	5
	0	0	0	0	1	1	2	1	1	2
	0	2	1	3	0	2	2	-2	1	-1
	0	1	1	2	1	0	1	0	-1	-1
Sum		22	31	53	32	37	69	10	6	16
Average		0.733333	1.033333	1.766667	1.066667	1.233333	2.3	0.333333	0.2	0.533333
Avedev		0.73968	1.325697	1.568732	1.048261	1.194335	1.622046	1.647011	2.074475	2.750966

APPENDIX D

	100	1	0	1	2	6	8	1	6	7
	100	0	2	2	0	0	0	0	-2	-2
	100	1	0	1	0	1	1	-1	1	0
	100	0	0	0	3	3	6	3	3	6
	100	0	0	0	3	2	5	3	2	5
	100	0	1	1	2	0	2	2	-1	1
	100	3	2	5	0	0	0	-3	-2	-5
	100	0	1	1	1	1	2	1	0	1
	100	0	0	0	2	1	3	2	1	3
	100	0	3	3	2	0	2	2	-3	-1
	100	0	0	0	4	7	11	4	7	11
	100	0	1	1	1	1	2	1	0	1
	100	0	1	1	2	2	4	2	1	3
	100	1	1	2	1	1	2	0	0	0
	100	0	2	2	2	0	2	2	-2	0
	100	2	2	4	0	1	1	-2	-1	-3
	100	1	1	2	1	2	3	0	1	1
	100	1	2	3	2	1	3	1	-1	0
	100	0	0	0	2	0	2	2	0	2
	100	0	0	0	6	1	7	6	1	7
	100	1	1	2	2	2	4	1	1	2
	100	3	1	4	0	2	2	-3	1	-2
	100	0	0	0	3	3	6	3	3	6
	100	0	2	2	2	1	3	2	-1	1
	100	0	1	1	2	2	4	2	1	3
	100	1	1	2	0	3	3	-1	2	1
	100	0	2	2	2	0	2	2	-2	0
	100	0	1	1	2	2	4	2	1	3
	100	1	0	1	2	4	6	1	4	5
	100	0	2	2	2	0	2	2	-2	0
Sum		16	30	46	53	49	102	37	19	56
Average		0.533333	1	1.533333	1.766667	1.633333	3.4	1.233333	0.633333	1.866667
StdDev		0.860366	0.870988	1.306043	1.304722	1.711691	2.429701	1.924136	2.326509	3.370596

	200	0	1	1	2	2	4	2	1	3
	200	2	1	3	0	0	0	-2	-1	-3
	200	1	5	6	1	0	1	0	-5	-5
	200	0	1	1	2	0	2	2	-1	1
	200	0	1	1	2	2	4	2	1	3
	200	0	0	0	4	0	4	4	0	4
	200	0	1	1	3	1	4	3	0	3
	200	1	1	2	2	5	7	1	4	5
	200	0	3	3	2	0	2	2	-3	-1
	200	0	4	4	2	1	3	2	-3	-1
	200	0	1	1	2	2	4	2	1	3
	200	1	1	2	2	3	5	1	2	3
	200	0	0	0	4	4	8	4	4	8
	200	1	1	2	1	0	1	0	-1	-1
	200	0	3	3	3	0	3	3	-3	0
	200	4	0	4	0	1	1	-4	1	-3
	200	0	1	1	0	3	3	0	2	2
	200	1	1	2	1	1	2	0	0	0
	200	1	2	3	2	2	4	1	0	1
	200	0	2	2	2	1	3	2	-1	1
	200	1	0	1	2	6	8	1	6	7
	200	1	6	7	1	0	1	0	-6	-6
	200	0	1	1	3	0	3	3	-1	2
	200	1	1	2	2	1	3	1	0	1
	200	1	0	1	2	6	8	1	6	7
	200	1	0	1	1	4	5	0	4	4
	200	0	2	2	1	0	1	1	-2	-1
	200	0	0	0	4	4	8	4	4	8
	200	0	1	1	2	2	4	2	1	3
	200	1	1	2	1	2	3	0	1	1
Sum		18	42	60	56	53	109	38	11	49
Average		0.6	1.4	2	1.866667	1.766667	3.633333	1.266667	0.366667	1.633333
StdDev		0.855006	1.476249	1.618854	1.074255	1.851064	2.281611	1.720732	2.894505	3.488734
	300	0	0	0	5	3	8	5	3	8
	300	1	2	3	1	2	3	0	0	0

	300	0	1	1	1	2	3	1	1	2
	300	2	1	3	0	2	2	-2	1	-1
	300	1	0	1	1	1	2	0	1	1
	300	0	1	1	4	0	4	4	-1	3
	300	0	2	2	2	0	2	2	-2	0
	300	0	0	0	4	4	8	4	4	8
	300	0	2	2	2	1	3	2	-1	1
	300	1	1	2	1	3	4	0	2	2
	300	0	0	0	5	1	6	5	1	6
	300	0	1	1	4	3	7	4	2	6
	300	0	1	1	3	3	6	3	2	5
	300	1	1	2	0	0	0	-1	-1	-2
	300	0	1	1	2	2	4	2	1	3
	300	0	2	2	2	1	3	2	-1	1
	300	0	3	3	3	0	3	3	-3	0
	300	1	0	1	2	3	5	1	3	4
	300	0	0	0	4	4	8	4	4	8
	300	1	0	1	2	1	3	1	1	2
	300	1	1	2	1	2	3	0	1	1
	300	0	2	2	2	0	2	2	-2	0
	300	0	1	1	3	1	4	3	0	3
	300	2	0	2	0	4	4	-2	4	2
	300	0	1	1	2	2	4	2	1	3
	300	1	2	3	0	0	0	-1	-2	-3
	300	0	2	2	3	0	3	3	-2	1
	300	0	1	1	1	1	2	1	0	1
	300	3	0	3	0	1	1	-3	1	-2
	300	1	1	2	2	2	4	1	1	2
Sum		16	30	46	62	49	111	46	19	65
Average		0.533333	1	1.533333	2.066667	1.633333	3.7	1.533333	0.633333	2.166667
StdDev		0.776079	0.830455	0.937102	1.484014	1.299425	2.1359	2.096521	1.902509	2.901644
	400	1	2	3	1	1	2	0	-1	-1
	400	1	0	1	2	6	8	1	6	7
	400	1	1	2	2	5	7	1	4	5
	400	0	2	2	2	0	2	2	-2	0

	400	1	4	5	1	0	1	0	-4	-4
	400	1	1	2	1	1	2	0	0	0
	400	0	0	0	5	6	11	5	6	11
	400	0	0	0	2	3	5	2	3	5
	400	0	1	1	2	2	4	2	1	3
	400	0	3	3	3	0	3	3	-3	0
	400	0	0	0	4	4	8	4	4	8
	400	0	0	0	4	4	8	4	4	8
	400	0	3	3	2	0	2	2	-3	-1
	400	0	0	0	2	3	5	2	3	5
	400	0	3	3	3	0	3	3	-3	0
	400	1	0	1	2	1	3	1	1	2
	400	0	1	1	2	2	4	2	1	3
	400	1	2	3	1	0	1	0	-2	-2
	400	0	2	2	2	0	2	2	-2	0
	400	1	1	2	1	2	3	0	1	1
	400	1	2	3	0	2	2	-1	0	-1
	400	0	2	2	2	1	3	2	-1	1
	400	0	2	2	2	0	2	2	-2	0
	400	0	1	1	3	2	5	3	1	4
	400	0	4	4	3	0	3	3	-4	-1
	400	0	2	2	2	0	2	2	-2	0
	400	0	1	1	4	0	4	4	-1	3
	400	0	2	2	2	1	3	2	-1	1
	400	1	0	1	2	6	8	1	6	7
	400	1	4	5	1	0	1	0	-4	-4
Sum		11	46	57	65	52	117	54	6	60
Average		0.366667	1.533333	1.9	2.166667	1.733333	3.9	1.8	0.2	2
StdDev		0.490133	1.279368	1.373392	1.085431	2.016028	2.564344	1.447947	3.08947	3.67658
	500	0	2	2	2	1	3	2	-1	1
	500	1	1	2	0	2	2	-1	1	0
	500	2	1	3	0	0	0	-2	-1	-3
	500	1	3	4	1	0	1	0	-3	-3
	500	1	2	3	1	1	2	0	-1	-1
	500	0	1	1	2	2	4	2	1	3

	500	1	1	2	1	0	1	0	-1	-1
	500	0	3	3	2	0	2	2	-3	-1
	500	1	3	4	1	0	1	0	-3	-3
	500	0	3	3	3	0	3	3	-3	0
	500	1	1	2	2	1	3	1	0	1
	500	0	0	0	3	3	6	3	3	6
	500	0	0	0	1	3	4	1	3	4
	500	0	2	2	2	1	3	2	-1	1
	500	1	1	2	1	0	1	0	-1	-1
	500	0	1	1	4	0	4	4	-1	3
	500	0	0	0	2	3	5	2	3	5
	500	1	2	3	2	2	4	1	0	1
	500	0	0	0	4	1	5	4	1	5
	500	0	3	3	3	0	3	3	-3	0
	500	0	0	0	3	4	7	3	4	7
	500	0	0	0	4	4	8	4	4	8
	500	0	0	0	4	0	4	4	0	4
	500	0	3	3	3	0	3	3	-3	0
	500	0	1	1	2	2	4	2	1	3
	500	1	2	3	2	2	4	1	0	1
	500	1	1	2	1	5	6	0	4	4
	500	0	2	2	2	2	4	2	0	2
	500	1	1	2	1	3	4	0	2	2
	500	1	1	2	2	5	7	1	4	5
Sum		14	41	55	61	47	108	47	6	53
Average		0.466667	1.366667	1.833333	2.033333	1.566667	3.6	1.566667	0.2	1.766667
StdDev		0.571346	1.0662	1.261727	1.129032	1.590561	1.940494	1.590561	2.340056	2.93238
	600	0	0	0	2	1	3	2	1	3
	600	1	0	1	1	1	2	0	1	1
	600	0	0	0	1	5	6	1	5	6
	600	0	1	1	3	1	4	3	0	3
	600	1	0	1	2	6	8	1	6	7
	600	1	3	4	2	1	3	1	-2	-1
	600	2	0	2	0	0	0	-2	0	-2
	600	0	0	0	2	3	5	2	3	5

	600	1	0	1	1	4	5	0	4	4
	600	1	1	2	1	2	3	0	1	1
	600	0	2	2	3	1	4	3	-1	2
	600	1	0	1	1	2	3	0	2	2
	600	1	0	1	1	6	7	0	6	6
	600	1	0	1	2	4	6	1	4	5
	600	1	1	2	1	1	2	0	0	0
	600	0	0	0	4	4	8	4	4	8
	600	1	3	4	2	1	3	1	-2	-1
	600	0	0	0	3	3	6	3	3	6
	600	0	1	1	4	1	5	4	0	4
	600	1	0	1	2	2	4	1	2	3
	600	0	2	2	2	0	2	2	-2	0
	600	0	0	0	4	4	8	4	4	8
	600	0	1	1	2	2	4	2	1	3
	600	1	0	1	2	6	8	1	6	7
	600	1	1	2	1	3	4	0	2	2
	600	1	1	2	2	5	7	1	4	5
	600	1	1	2	2	5	7	1	4	5
	600	1	1	2	1	3	4	0	2	2
	600	1	2	3	1	1	2	0	-1	-1
	600	0	0	0	3	3	6	3	3	6
Sum		19	21	40	58	81	139	39	60	99
Average		0.633333	0.7	1.333333	1.933333	2.7	4.633333	1.3	2	3.3
StdDev		0.556053	0.915386	1.093345	1.014833	1.841102	2.157318	1.4657	2.421171	2.854518
	700	0	2	2	2	0	2	2	-2	0
	700	0	0	0	4	1	5	4	1	5
	700	1	1	2	2	5	7	1	4	5
	700	1	3	4	1	0	1	0	-3	-3
	700	0	1	1	2	2	4	2	1	3
	700	1	4	5	1	0	1	0	-4	-4
	700	0	2	2	2	0	2	2	-2	0
	700	0	2	2	2	0	2	2	-2	0
	700	0	1	1	3	1	4	3	0	3
	700	0	1	1	4	3	7	4	2	6

	700	0	0	0	3	1	4	3	1	4
	700	0	2	2	2	0	2	2	-2	0
	700	0	3	3	2	0	2	2	-3	-1
	700	0	1	1	4	3	7	4	2	6
	700	0	2	2	2	1	3	2	-1	1
	700	0	0	0	4	1	5	4	1	5
	700	0	0	0	4	3	7	4	3	7
	700	0	0	0	3	3	6	3	3	6
	700	0	1	1	1	2	3	1	1	2
	700	1	1	2	1	1	2	0	0	0
	700	0	1	1	5	2	7	5	1	6
	700	4	3	7	0	0	0	-4	-3	-7
	700	0	2	2	2	1	3	2	-1	1
	700	1	0	1	2	6	8	1	6	7
	700	1	1	2	1	2	3	0	1	1
	700	0	3	3	2	0	2	2	-3	-1
	700	0	1	1	3	1	4	3	0	3
	700	1	2	3	1	1	2	0	-1	-1
	700	1	2	3	1	0	1	0	-2	-2
	700	1	2	3	1	2	3	0	0	0
Sum		13	44	57	67	42	109	54	-2	52
Average		0.433333	1.466667	1.9	2.233333	1.4	3.633333	1.8	-0.06667	1.733333
StdDev		0.8172	1.074255	1.561388	1.222866	1.522249	2.220334	1.845778	2.347902	3.512866
	800	0	1	1	3	1	4	3	0	3
	800	0	1	1	2	2	4	2	1	3
	800	0	2	2	2	0	2	2	-2	0
	800	0	0	0	3	3	6	3	3	6
	800	0	0	0	4	1	5	4	1	5
	800	0	0	0	3	3	6	3	3	6
	800	0	2	2	2	0	2	2	-2	0
	800	1	2	3	2	1	3	1	-1	0
	800	2	2	4	0	1	1	-2	-1	-3
	800	0	2	2	2	0	2	2	-2	0
	800	1	0	1	2	2	4	1	2	3
	800	0	2	2	2	1	3	2	-1	1

	800	0	0	0	3	3	6	3	3	6
	800	0	2	2	2	0	2	2	-2	0
	800	0	2	2	4	0	4	4	-2	2
	800	0	0	0	2	1	3	2	1	3
	800	0	2	2	2	0	2	2	-2	0
	800	1	2	3	2	2	4	1	0	1
	800	1	2	3	1	0	1	0	-2	-2
	800	0	2	2	1	0	1	1	-2	-1
	800	4	9	13	0	0	0	-4	-9	-13
	800	0	2	2	2	1	3	2	-1	1
	800	0	0	0	3	0	3	3	0	3
	800	0	0	0	5	1	6	5	1	6
	800	0	1	1	4	0	4	4	-1	3
	800	0	1	1	2	2	4	2	1	3
	800	0	2	2	2	0	2	2	-2	0
	800	0	2	2	2	1	3	2	-1	1
	800	0	3	3	2	1	3	2	-2	0
	800	1	2	3	1	1	2	0	-1	-1
Sum		11	48	59	67	28	95	56	-20	36
Average		0.366667	1.6	1.966667	2.233333	0.933333	3.166667	1.866667	-0.66667	1.2
StdDev		0.856732	1.701202	2.404327	1.098588	0.997534	1.611993	1.751143	2.318803	3.663493
	900	1	1	2	2	2	4	1	1	2
	900	0	2	2	2	0	2	2	-2	0
	900	2	0	2	0	4	4	-2	4	2
	900	0	1	1	4	0	4	4	-1	3
	900	2	2	4	0	1	1	-2	-1	-3
	900	0	2	2	2	1	3	2	-1	1
	900	0	0	0	4	0	4	4	0	4
	900	0	1	1	4	3	7	4	2	6
	900	0	1	1	3	2	5	3	1	4
	900	0	1	1	4	0	4	4	-1	3
	900	0	0	0	3	3	6	3	3	6
	900	1	1	2	2	5	7	1	4	5
	900	0	0	0	4	0	4	4	0	4
	900	0	1	1	3	1	4	3	0	3

	900	1	0	1	0	2	2	-1	2	1
	900	0	4	4	2	0	2	2	-4	-2
	900	1	0	1	2	6	8	1	6	7
	900	0	0	0	2	3	5	2	3	5
	900	0	0	0	3	4	7	3	4	7
	900	0	1	1	4	3	7	4	2	6
	900	0	0	0	5	1	6	5	1	6
	900	0	0	0	4	0	4	4	0	4
	900	0	2	2	2	0	2	2	-2	0
	900	2	1	3	0	0	0	-2	-1	-3
	900	1	1	2	1	4	5	0	3	3
	900	0	0	0	2	1	3	2	1	3
	900	0	0	0	2	1	3	2	1	3
	900	1	3	4	1	0	1	0	-3	-3
	900	0	2	2	2	0	2	2	-2	0
	900	0	0	0	4	2	6	4	2	6
Sum		12	27	39	73	49	122	61	22	83
Average		0.4	0.9	1.3	2.433333	1.633333	4.066667	2.033333	0.733333	2 766667
StdDev		0.682288	1.032716	1.261401	1.399331	1.760961	2.070197	1.97272	2.361952	2.967393
	0	0	2	2	2	0	2	2	-2	0
	0	1	4	5	1	1	2	0	-3	-3
	0	0	1	1	2	1	3	2	0	2
	0	0	1	1	1	1	2	1	0	1
	0	2	2	4	0	0	0	-2	-2	-4
	0	0	2	2	1	0	1	1	-2	-1
	0	0	2	2	4	1	5	4	-1	3
	0	1	1	2	2	1	3	1	0	1
	0	1	0	1	0	1	1	-1	1	0
	0	0	2	2	3	1	4	3	-1	2
	0	1	2	3	1	1	2	0	-1	-1
	0	1	0	1	1	1	2	0	1	1
	0	2	2	4	0	1	1	-2	-1	-3
	0	1	0	1	0	5	5	-1	5	4
	0	1	0	1	1	2	3	0	2	2
	0	1	0	1	1	5	6	0	5	5

	0	2	3	5	0	0	0	-2	-3	-5
	0	1	1	2	0	3	3	-1	2	1
	0	1	2	3	0	0	0	-1	-2	-3
	0	1	1	2	1	4	5	0	3	3
	0	2	4	6	1	1	2	-1	-3	-4
	0	0	0	0	6	1	7	6	1	7
	0	2	1	3	1	0	1	-1	-1	-2
	0	2	2	4	0	0	0	-2	-2	-4
	0	1	1	2	1	0	1	0	-1	-1
	0	0	1	1	2	2	4	2	1	3
	0	2	2	4	0	1	1	-2	-1	-3
	0	0	0	0	1	3	4	1	3	4
	0	3	1	4	0	2	2	-3	1	-2
	0	0	1	1	1	2	3	1	1	2
Sum		29	41	70	34	41	75	5	0	5
Average		0.966667	1.366667	2.333333	1.133333	1.366667	2.5	0.166667	0	0.166667
StdDev		0.845154	1.115277	1.567842	1.355521	1.421163	1.88264	1.995068	2.195495	3.097751
	10	0	2	2	1	0	1	1	-2	-1
	10	2	1	3	0	3	3	-2	2	0
	10	1	1	2	0	2	2	-1	1	0
	10	1	1	2	1	3	4	0	2	2
	10	1	1	2	0	1	1	-1	0	-1
	10	1	0	1	1	2	3	0	2	2
	10	2	1	3	0	3	3	-2	2	0
	10	0	4	4	2	0	2	2	-4	-2
	10	0	4	4	2	1	3	2	-3	-1
	10	2	0	2	0	1	1	-2	1	-1
	10	1	1	2	1	0	1	0	-1	-1
	10	5	2	7	0	0	0	-5	-2	-7
	10	1	2	3	0	1	1	-1	-1	-2
	10	1	2	3	1	0	1	0	-2	-2
	10	0	1	1	3	2	5	3	1	4
	10	1	1	2	1	2	3	0	1	1
	10	1	1	2	1	1	2	0	0	0
	10	3	1	4	0	2	2	-3	1	-2

	10	2	2	4	0	2	2	-2	0	-2
	10	0	4	4	2	1	3	2	-3	-1
	10	1	3	4	0	1	1	-1	-2	-3
	10	1	1	2	1	0	1	0	-1	-1
	10	0	2	2	2	1	3	2	-1	1
	10	1	1	2	1	1	2	0	0	0
	10	1	0	1	1	4	5	0	4	4
	10	0	2	2	2	3	5	2	1	3
	10	0	2	2	2	2	4	2	0	2
	10	1	1	2	1	2	3	0	1	1
	10	0	0	0	2	2	4	2	2	4
	10	0	0	0	2	2	4	2	2	4
Sum		30	44	74	30	45	75	0	1	1
Average		1	1.466667	2.466667	1	1.5	2.5	0	0.033333	0.033333
StdDev		1.085053	1.121883	1.351882	0.865314	1.089583	1.378047	1.811295	1.860928	2.365599
	20	1	3	4	1	1	2	0	-2	-2
	20	1	0	1	1	3	4	0	3	3
	20	2	1	3	0	3	3	-2	2	0
	20	1	2	3	2	2	4	1	0	1
	20	0	0	0	0	1	1	0	1	1
	20	1	0	1	1	1	2	0	1	1
	20	0	1	1	1	2	3	1	1	2
	20	0	3	3	3	0	3	3	-3	0
	20	1	1	2	1	3	4	0	2	2
	20	0	1	1	1	2	3	1	1	2
	20	1	1	2	2	3	5	1	2	3
	20	0	4	4	2	0	2	2	-4	-2
	20	1	2	3	1	2	3	0	0	0
	20	1	4	5	0	0	0	-1	-4	-5
	20	1	3	4	1	1	2	0	-2	-2
	20	1	0	1	0	1	1	-1	1	0
	20	1	1	2	0	0	0	-1	-1	-2
	20	1	2	3	1	0	1	0	-2	-2
	20	1	3	4	1	1	2	0	-2	-2
	20	1	2	3	2	2	4	1	0	1

	20	1	3	4	0	0	0	-1	-3	-4
	20	3	1	4	0	0	0	-3	-1	-4
	20	1	1	2	2	2	4	1	1	2
	20	1	1	2	1	1	2	0	0	0
	20	0	4	4	1	0	1	1	-4	-3
	20	0	0	0	3	4	7	3	4	7
	20	1	2	3	0	0	0	-1	-2	-3
	20	0	1	1	0	2	2	0	1	1
	20	1	0	1	0	3	3	-1	3	2
	20	1	1	2	1	2	3	0	1	1
Sum		25	48	73	29	42	71	4	-6	-2
Average		0.833333	1.6	2.433333	0.966667	1.4	2.366667	0.133333	-0.2	-0.06667
StdDev		0.658405	1.293218	1.378047	0.905647	1.20753	1.696127	1.301761	2.230554	2.609664
	30	0	0	0	2	2	4	2	2	4
	30	2	1	3	0	2	2	-2	1	-1
	30	2	0	2	0	3	3	-2	3	1
	30	1	1	2	1	2	3	0	1	1
	30	0	0	0	4	1	5	4	1	5
	30	1	1	2	1	2	3	0	1	1
	30	2	0	2	0	3	3	-2	3	1
	30	3	0	3	0	3	3	-3	3	0
	30	1	2	3	0	2	2	-1	0	-1
	30	2	1	3	0	2	2	-2	1	-1
	30	2	0	2	0	5	5	-2	5	3
	30	0	1	1	1	3	4	1	2	3
	30	1	1	2	1	2	3	0	1	1
	30	1	0	1	2	2	4	1	2	3
	30	0	1	1	3	0	3	3	-1	2
	30	1	0	1	2	3	5	1	3	4
	30	1	2	3	1	1	2	0	-1	-1
	30	0	1	1	0	2	2	0	1	1
	30	1	3	4	1	1	2	0	-2	-2
	30	1	1	2	2	5	7	1	4	5
	30	2	0	2	0	3	3	-2	3	1
	30	1	0	1	1	2	3	0	2	2

	30	0	1	1	2	3	5	2	2	4
	30	2	0	2	0	3	3	-2	3	1
	30	2	2	4	0	1	1	-2	-1	-3
	30	2	3	5	0	1	1	-2	-2	-4
	30	0	1	1	2	5	7	2	4	6
	30	2	4	6	1	1	2	-1	-3	-4
	30	1	2	3	1	1	2	0	-1	-1
	30	0	1	1	2	0	2	2	-1	1
Sum		34	30	64	30	66	96	-4	36	32
Average		1.133333	1	2.133333	1	2.2	3.2	-0.13333	1.2	1.066667
StdDev		0.848064	1.069045	1.390503	1.051623	1.250616	1.527256	1.760262	1.998152	2.631282
	40	1	3	4	1	1	2	0	-2	-2
	40	1	1	2	1	1	2	0	0	0
	40	1	0	1	1	4	5	0	4	4
	40	1	1	2	1	2	3	0	1	1
	40	2	0	2	0	3	3	-2	3	1
	40	1	0	1	1	3	4	0	3	3
	40	0	1	1	1	2	3	1	1	2
	40	1	1	2	1	2	3	0	1	1
	40	1	0	1	1	3	4	0	3	3
	40	1	0	1	0	3	3	-1	3	2
	40	1	2	3	0	1	1	-1	-1	-2
	40	1	1	2	0	1	1	-1	0	-1
	40	1	1	2	1	3	4	0	2	2
	40	0	1	1	1	2	3	1	1	2
	40	1	4	5	1	1	2	0	-3	-3
	40	0	1	1	2	1	3	2	0	2
	40	1	1	2	2	4	6	1	3	4
	40	2	1	3	0	2	2	-2	1	-1
	40	0	1	1	0	1	1	0	0	0
	40	1	1	2	2	2	4	1	1	2
	40	1	0	1	1	2	3	0	2	2
	40	2	0	2	0	3	3	-2	3	1
	40	1	0	1	2	3	5	1	3	4
	40	1	1	2	2	2	4	1	1	2

	40	2	1	3	0	2	2	-2	1	-1
	40	1	2	3	1	2	3	0	0	0
	40	3	3	6	0	1	1	-3	-2	-5
	40	0	1	1	1	4	5	1	3	4
	40	1	1	2	1	2	3	0	1	1
	40	2	0	2	0	3	3	-2	3	1
Sum		32	30	62	25	66	91	-7	36	29
Average		1.066667	1	2.066667	0.833333	2.2	3.033333	-0.23333	1.2	0.966667
StdDev		0.680481	0.981353	1.2516	0.693034	0.966177	1.295122	1.167077	1.746918	2.211702
	50	1	1	2	2	2	4	1	1	2
	50	0	1	1	1	2	3	1	1	2
	50	1	0	1	0	4	4	-1	4	3
	50	2	3	5	0	1	1	-2	-2	-4
	50	1	0	1	1	3	4	0	3	3
	50	1	0	1	1	4	5	0	4	4
	50	1	1	2	0	1	1	-1	0	-1
	50	2	1	3	0	1	1	-2	0	-2
	50	1	3	4	1	0	1	0	-3	-3
	50	1	0	1	0	3	3	-1	3	2
	50	1	1	2	1	3	4	0	2	2
	50	1	3	4	1	2	3	0	-1	-1
	50	1	3	4	1	1	2	0	-2	-2
	50	1	0	1	2	4	6	1	4	5
	50	1	1	2	1	2	3	0	1	1
	50	0	3	3	1	1	2	1	-2	-1
	50	1	1	2	1	2	3	0	1	1
	50	1	0	1	0	4	4	-1	4	3
	50	1	1	2	1	4	5	0	3	3
	50	1	1	2	0	3	3	-1	2	1
	50	1	2	3	1	3	4	0	1	1
	50	2	0	2	0	4	4	-2	4	2
	50	1	1	2	1	1	2	0	0	0
	50	1	1	2	0	2	2	-1	1	0
	50	1	1	2	1	2	3	0	1	1
	50	1	1	2	1	1	2	0	0	0

	50	1	1	2	1	0	1	0	-1	-1
	50	2	1	3	0	2	2	-2	1	-1
	50	1	1	2	1	1	2	0	0	0
	50	0	1	1	2	1	3	2	0	2
Sum		31	34	65	23	64	87	-8	30	22
Average		1.033333	1.133333	2.166667	0.766667	2.133333	2.9	-0.26667	1	0.733333
StdDev		0.457558	0.990099	1.048104	0.5914	1.25553	1.345491	0.897451	2.026305	2.123061
	60	1	1	2	1	4	5	0	3	3
	60	1	2	3	1	2	3	0	0	0
	60	1	2	3	1	1	2	0	-1	-1
	60	0	1	1	3	2	5	3	1	4
	60	1	1	2	1	0	1	0	-1	-1
	60	2	2	4	0	2	2	-2	0	-2
	60	1	3	4	1	2	3	0	-1	-1
	60	1	1	2	1	1	2	0	0	0
	60	2	0	2	0	4	4	-2	4	2
	60	0	1	1	1	1	2	1	0	1
	60	1	0	1	0	3	3	-1	3	2
	60	2	1	3	0	2	2	-2	1	-1
	60	2	1	3	0	2	2	-2	1	-1
	60	1	0	1	0	4	4	-1	4	3
	60	0	2	2	1	2	3	1	0	1
	60	3	1	4	0	0	0	-3	-1	-4
	60	1	0	1	1	1	2	0	1	1
	60	1	1	2	0	3	3	-1	2	1
	60	1	0	1	1	4	5	0	4	4
	60	1	1	2	0	0	0	-1	-1	-2
	60	1	1	2	2	3	5	1	2	3
	60	2	1	3	0	3	3	-2	2	0
	60	0	2	2	2	1	3	2	-1	1
	60	0	1	1	0	2	2	0	1	1
	60	0	1	1	1	2	3	1	1	2
	60	1	0	1	0	3	3	-1	3	2
	60	1	3	4	1	1	2	0	-2	-2
	60	0	1	1	2	2	4	2	1	3

	60	1	3	4	2	1	3	1	-2	-1
	60	1	0	1	1	8	9	0	8	8
Sum		30	34	64	24	66	90	-6	32	26
Average		1	1.133333	2.133333	0.8	2.2	3	-0.2	1.066667	0.866667
StdDev		0.755929	0.88918	1.104179	0.818505	1.195229	1.319613	1.398451	1.774199	2.007376
	70	1	2	3	1	1	2	0	-1	-1
	70	0	0	0	2	2	4	2	2	4
	70	1	0	1	0	3	3	-1	3	2
	70	1	0	1	2	3	5	1	3	4
	70	1	1	2	1	2	3	0	1	1
	70	2	4	6	0	1	1	-2	-3	-5
	70	2	1	3	0	2	2	-2	1	-1
	70	1	1	2	1	2	3	0	1	1
	70	0	3	3	1	1	2	1	-2	-1
	70	1	0	1	1	2	3	0	2	2
	70	1	0	1	1	2	3	0	2	2
	70	1	0	1	2	1	3	1	1	2
	70	1	0	1	1	3	4	0	3	3
	70	1	1	2	1	1	2	0	0	0
	70	1	0	1	0	3	3	-1	3	2
	70	1	1	2	1	2	3	0	1	1
	70	1	0	1	0	1	1	-1	1	0
	70	1	1	2	0	3	3	-1	2	1
	70	1	0	1	1	3	4	0	3	3
	70	0	1	1	2	2	4	2	1	3
	70	0	0	0	1	3	4	1	3	4
	70	0	1	1	1	2	3	1	1	2
	70	1	0	1	1	5	6	0	5	5
	70	0	3	3	2	1	3	2	-2	0
	70	1	1	2	0	2	2	-1	1	0
	70	0	1	1	2	2	4	2	1	3
	70	0	0	0	3	4	7	3	4	7
	70	1	1	2	1	2	3	0	1	1
	70	1	0	1	0	1	1	-1	1	0
	70	1	0	1	0	4	4	-1	4	3

Sum		24	23	47	29	66	95	5	43	48
Average		0.8	0.766667	1.566667	0.966667	2.2	3.166667	0.166667	1.433333	1.6
StdDev		0.559292	1.048104	1.210585	0.801784	0.990099	1.355521	1.235756	1.778359	2.277
	80	1	1	2	1	2	3	0	1	1
	80	1	0	1	2	3	5	1	3	4
	80	2	2	4	1	1	2	-1	-1	-2
	80	0	3	3	1	0	1	1	-3	-2
	80	1	1	2	1	2	3	0	1	1
	80	2	0	2	0	3	3	-2	3	1
	80	2	1	3	0	4	4	-2	3	1
	80	0	1	1	0	0	0	0	-1	-1
	80	1	0	1	1	4	5	0	4	4
	80	1	0	1	2	6	8	1	6	7
	80	2	0	2	0	4	4	-2	4	2
	80	1	2	3	2	2	4	1	0	1
	80	1	2	3	1	1	2	0	-1	-1
	80	0	1	1	2	2	4	2	1	3
	80	1	2	3	0	2	2	-1	0	-1
	80	1	0	1	1	3	4	0	3	3
	80	1	1	2	0	3	3	-1	2	1
	80	1	2	3	1	2	3	0	0	0
	80	2	0	2	0	4	4	-2	4	2
	80	3	0	3	0	3	3	-3	3	0
	80	0	1	1	3	1	4	3	0	3
	80	0	0	0	1	4	5	1	4	5
	80	0	4	4	2	1	3	2	-3	-1
	80	1	0	1	1	2	3	0	2	2
	80	4	1	5	0	1	1	-4	0	-4
	80	1	1	2	0	2	2	-1	1	0
	80	1	0	1	1	3	4	0	3	3
	80	2	1	3	0	3	3	-2	2	0
	80	1	1	2	1	1	2	0	0	0
	80	1	1	2	1	2	3	0	1	1
Sum		35	29	64	26	71	97	-9	42	33
Average		1.166667	0.966667	2.133333	0.866667	2.366667	3.233333	-0.3	1.4	1.1

StdDev		0.928477	1.017095	1.156477	0.833415	1.373572	1.527256	1.560756	2.179732	2.335209
	90	4	3	7	0	0	0	-4	-3	-7
	90	0	1	1	1	2	3	1	1	2
	90	0	2	2	3	1	4	3	-1	2
	90	1	0	1	1	6	7	0	6	6
	90	2	0	2	0	5	5	-2	5	3
	90	0	1	1	0	2	2	0	1	1
	90	1	1	2	1	4	5	0	3	3
	90	0	0	0	1	2	3	1	2	3
	90	4	3	7	0	0	0	-4	-3	-7
	90	2	1	3	0	2	2	-2	1	-1
	90	1	1	2	1	2	3	0	1	1
	90	2	0	2	0	3	3	-2	3	1
	90	1	1	2	1	2	3	0	1	1
	90	2	3	5	1	1	2	-1	-2	-3
	90	0	1	1	2	0	2	2	-1	1
	90	1	1	2	1	1	2	0	0	0
	90	2	2	4	0	0	0	-2	-2	-4
	90	1	2	3	1	2	3	0	0	0
	90	0	0	0	2	4	6	2	4	6
	90	1	3	4	1	1	2	0	-2	-2
	90	1	2	3	1	1	2	0	-1	-1
	90	2	1	3	1	3	4	-1	2	1
	90	2	1	3	0	2	2	-2	1	-1
	90	1	1	2	1	0	1	0	-1	-1
	90	3	2	5	0	1	1	-3	-1	-4
	90	0	3	3	2	1	3	2	-2	0
	90	1	0	1	1	2	3	0	2	2
	90	1	1	2	1	2	3	0	1	1
	90	3	1	4	0	2	2	-3	1	-2
	90	1	2	3	2	0	2	1	-2	-1
Sum		40	40	80	26	54	80	-14	14	0
Average		1.333333	1.333333	2.666667	0.866667	1.8	2.666667	-0.46667	0.466667	0
StdDev		1.142549	1.003688	1.758162	0.75918	1.481412	1.64975	1.765153	2.277	3.09934

	0	4	1	5	0	0	0	-4	-1	-5
	0	0	0	0	4	3	7	4	3	7
	0	1	1	2	0	0	0	-1	-1	-2
	0	0	2	2	4	1	5	4	-1	3
	0	0	3	3	2	0	2	2	-3	-1
	0	1	3	4	1	0	1	0	-3	-3
	0	0	1	1	0	1	1	0	0	0
	0	1	0	1	0	3	3	-1	3	2
	0	0	0	0	2	1	3	2	1	3
	0	2	0	2	0	3	3	-2	3	1
	0	2	3	5	0	0	0	-2	-3	-5
	0	1	2	3	0	0	0	-1	-2	-3
	0	0	2	2	2	1	3	2	-1	1
	0	1	2	3	1	1	2	0	-1	-1
	0	0	0	0	2	2	4	2	2	4
	0	1	2	3	0	1	1	-1	-1	-2
	0	1	1	2	1	1	2	0	0	0
	0	1	0	1	1	2	3	0	2	2
	0	0	1	1	2	0	2	2	-1	1
	0	1	1	2	0	2	2	-1	1	0
	0	1	3	4	1	0	1	0	-3	-3
	0	1	3	4	1	1	2	0	-2	-2
	0	1	1	2	0	3	3	-1	2	1
	0	2	1	3	1	2	3	-1	1	0
	0	1	2	3	0	2	2	-1	0	-1
	0	5	2	7	0	1	1	-5	-1	-6
	0	0	1	1	1	1	2	1	0	1
	0	1	0	1	0	1	1	-1	1	0
	0	1	2	3	1	0	1	0	-2	-2
	0	2	1	3	1	2	3	-1	1	0
Sum		32	41	73	28	35	63	-4	-6	-10
Average		1.066667	1.366667	2.433333	0.933333	1.166667	2.1	-0.13333	-0.2	-0.33333
StdDev		1.148998	1.049278	1.63701	1.131719	1.025536	1.556806	1.988266	1.864234	2.831908
	1	0	1	1	0	1	1	0	0	0
	1	1	0	1	1	1	2	0	1	1

	1	0	5	5	2	0	2	2	-5	-3
	1	0	2	2	1	0	1	1	-2	-1
	1	2	1	3	0	2	2	-2	1	-1
	1	2	1	3	0	2	2	-2	1	-1
	1	0	0	0	3	1	4	3	1	4
	1	1	2	3	1	0	1	0	-2	-2
	1	0	0	0	6	1	7	6	1	7
	1	5	1	6	0	1	1	-5	0	-5
	1	2	0	2	0	4	4	-2	4	2
	1	2	0	2	0	0	0	-2	0	-2
	1	3	1	4	0	0	0	-3	-1	-4
	1	0	0	0	3	2	5	3	2	5
	1	1	2	3	0	1	1	-1	-1	-2
	1	1	2	3	0	0	0	-1	-2	-3
	1	1	2	3	1	0	1	0	-2	-2
	1	2	0	2	0	1	1	-2	1	-1
	1	1	1	2	1	2	3	0	1	1
	1	1	4	5	0	0	0	-1	-4	-5
	1	1	1	2	1	2	3	0	1	1
	1	1	1	2	1	3	4	0	2	2
	1	0	2	2	2	0	2	2	-2	0
	1	1	0	1	0	1	1	-1	1	0
	1	1	0	1	1	1	2	0	1	1
	1	2	1	3	0	2	2	-2	1	-1
	1	0	0	0	3	2	5	3	2	5
	1	1	1	2	1	1	2	0	0	0
	1	0	0	0	3	4	7	3	4	7
	1	2	3	5	0	0	0	-2	-3	-5
Sum		34	34	68	31	35	66	-3	1	-2
Average		1.133333	1.133333	2.266667	1.033333	1.166667	2.2	-0.1	0.033333	-0.06667
StdDev		1.113066	1.222732	1.559967	1.412471	1.145778	1.92533	2.259626	2.048068	3.16617
	2	0	0	0	3	0	3	3	0	3
	2	5	4	9	0	0	0	-5	-4	-9
	2	1	0	1	2	4	6	1	4	5
	2	0	0	0	3	1	4	3	1	4

	2	2	1	3	1	2	3	-1	1	0
	2	1	0	1	0	1	1	-1	1	0
	2	1	2	3	1	0	1	0	-2	-2
	2	0	0	0	1	1	2	1	1	2
	2	0	1	1	2	0	2	2	-1	1
	2	1	0	1	1	2	3	0	2	2
	2	0	0	0	3	1	4	3	1	4
	2	0	0	0	0	3	3	0	3	3
	2	1	1	2	1	1	2	0	0	0
	2	1	3	4	1	1	2	0	-2	-2
	2	3	1	4	0	0	0	-3	-1	-4
	2	1	2	3	0	0	0	-1	-2	-3
	2	1	2	3	0	0	0	-1	-2	-3
	2	0	1	1	1	0	1	1	-1	0
	2	0	1	1	2	2	4	2	1	3
	2	1	0	1	0	1	1	-1	1	0
	2	2	0	2	0	1	1	-2	1	-1
	2	1	2	3	0	0	0	-1	-2	-3
	2	2	1	3	0	1	1	-2	0	-2
	2	1	0	1	0	0	0	-1	0	-1
	2	3	2	5	0	1	1	-3	-1	-4
	2	1	0	1	0	1	1	-1	1	0
	2	0	0	0	4	1	5	4	1	5
	2	3	0	3	0	1	1	-3	1	-2
	2	1	3	4	0	0	0	-1	-3	-4
	2	2	1	3	0	2	2	-2	1	-1
Sum		35	28	63	26	28	54	-9	0	-9
Average		1.166667	0.933333	2.1	0.866667	0.933333	1.8	-0.3	0	-0.3
StdDev		1.186957	1.131719	1.980819	1.175489	0.976321	1.655711	2.081469	1.782509	3.217103
	3	1	0	1	0	1	1	-1	1	0
	3	0	3	3	2	1	3	2	-2	0
	3	1	1	2	0	0	0	-1	-1	-2
	3	3	0	3	0	0	0	-3	0	-3
	3	0	1	1	2	0	2	2	-1	1
	3	0	0	0	1	2	3	1	2	3

	3	0	0	0	6	3	9	6	3	9
	3	2	0	2	0	1	1	-2	1	-1
	3	0	0	0	2	1	3	2	1	3
	3	2	0	2	0	0	0	-2	0	-2
	3	0	0	0	2	2	4	2	2	4
	3	2	1	3	0	0	0	-2	-1	-3
	3	0	0	0	4	1	5	4	1	5
	3	2	0	2	0	1	1	-2	1	-1
	3	0	0	0	0	2	2	0	2	2
	3	2	1	3	0	0	0	-2	-1	-3
	3	4	1	5	0	0	0	-4	-1	-5
	3	2	0	2	0	0	0	-2	0	-2
	3	2	0	2	0	0	0	-2	0	-2
	3	1	0	1	0	1	1	-1	1	0
	3	0	1	1	1	0	1	1	-1	0
	3	1	0	1	1	1	2	0	1	1
	3	1	0	1	0	1	1	-1	1	0
	3	4	0	4	0	1	1	-4	1	-3
	3	0	0	0	1	3	4	1	3	4
	3	0	1	1	2	1	3	2	0	2
	3	1	1	2	1	2	3	0	1	1
	3	1	0	1	0	1	1	-1	1	0
	3	1	0	1	0	3	3	-1	3	2
	3	1	1	2	0	1	1	-1	0	-1
Sum		34	12	46	25	30	55	-9	18	9
Average		1.133333	0.4	1.533333	0.833333	1	1.833333	-0.3	0.6	0.3
StdDev		1.186957	0.676852	1.29892	1.40723	0.963624	1.995068	2.297461	1.320546	2.967393
	4	1	0	1	0	3	3	-1	3	2
	4	1	2	3	0	0	0	-1	-2	-3
	4	2	2	4	0	0	0	-2	-2	-4
	4	1	0	1	0	3	3	-1	3	2
	4	2	0	2	0	1	1	-2	1	-1
	4	3	0	3	0	1	1	-3	1	-2
	4	1	2	3	1	1	2	0	-1	-1
	4	2	0	2	0	0	0	-2	0	-2

	4	1	0	1	1	0	1	0	0	0
	4	0	0	0	1	2	3	1	2	3
	4	1	0	1	0	3	3	-1	3	2
	4	2	2	4	0	1	1	-2	-1	-3
	4	0	0	0	2	1	3	2	1	3
	4	2	1	3	0	0	0	-2	-1	-3
	4	3	1	4	0	2	2	-3	1	-2
	4	0	0	0	2	1	3	2	1	3
	4	2	1	3	0	0	0	-2	-1	-3
	4	1	0	1	0	1	1	-1	1	0
	4	0	1	1	2	1	3	2	0	2
	4	2	0	2	0	1	1	-2	1	-1
	4	2	0	2	0	4	4	-2	4	2
	4	1	1	2	1	3	4	0	2	2
	4	1	0	1	0	0	0	-1	0	-1
	4	0	1	1	0	1	1	0	0	0
	4	1	0	1	2	3	5	1	3	4
	4	0	2	2	1	0	1	1	-2	-1
	4	0	1	1	0	1	1	0	0	0
	4	1	0	1	1	2	3	0	2	2
	4	0	0	0	2	4	6	2	4	6
	4	2	0	2	0	1	1	-2	1	-1
Sum		35	17	52	16	41	57	-19	24	5
Average		1.166667	0.566667	1.733333	0.533333	1.366667	1.9	-0.63333	0.8	0.166667
StdDev		0.915117	0.779984	1.221725	0.783135	1.2653	1.624171	1.524028	1.739854	2.498275
	5	3	0	3	0	0	0	-3	0	-3
	5	0	1	1	2	0	2	2	-1	1
	5	3	0	3	0	3	3	-3	3	0
	5	3	0	3	0	1	1	-3	1	-2
	5	2	0	2	0	0	0	-2	0	-2
	5	0	1	1	1	1	2	1	0	1
	5	2	1	3	0	0	0	-2	-1	-3
	5	1	0	1	1	1	2	0	1	1
	5	8	2	10	0	0	0	-8	-2	-10
	5	1	3	4	0	1	1	-1	-2	-3

	5	1	0	1	2	5	7	1	5	6
	5	0	1	1	0	1	1	0	0	0
	5	2	1	3	0	3	3	-2	2	0
	5	3	1	4	0	2	2	-3	1	-2
	5	0	1	1	2	0	2	2	-1	1
	5	1	0	1	0	1	1	-1	1	0
	5	0	1	1	1	0	1	1	-1	0
	5	0	0	0	3	1	4	3	1	4
	5	2	0	2	0	0	0	-2	0	-2
	5	1	1	2	1	0	1	0	-1	-1
	5	0	0	0	3	4	7	3	4	7
	5	1	0	1	0	4	4	-1	4	3
	5	0	0	0	2	1	3	2	1	3
	5	0	2	2	1	0	1	1	-2	-1
	5	0	2	2	3	0	3	3	-2	1
	5	1	0	1	0	1	1	-1	1	0
	5	3	0	3	0	1	1	-3	1	-2
	5	1	0	1	1	0	1	0	0	0
	5	2	0	2	0	0	0	-2	0	-2
	5	0	1	1	3	0	3	3	-1	2
Sum		41	19	60	26	31	57	-15	12	-3
Average		1.366667	0.633333	2	0.866667	1.033333	1.9	-0.5	0.4	-0.1
StdDev		1.680077	0.820008	1.898924	1.048104	1.412471	1.846312	2.426252	1.824167	3.140393
	6	3	2	5	0	0	0	-3	-2	-5
	6	0	0	0	2	2	4	2	2	4
	6	0	1	1	1	3	4	1	2	3
	6	0	1	1	1	0	1	1	-1	0
	6	2	0	2	0	1	1	-2	1	-1
	6	1	1	2	0	0	0	-1	-1	-2
	6	2	1	3	0	1	1	-2	0	-2
	6	1	0	1	0	1	1	-1	1	0
	6	1	1	2	1	0	1	0	-1	-1
	6	0	1	1	2	2	4	2	1	3
	6	0	1	1	1	0	1	1	-1	0
	6	0	1	1	2	0	2	2	-1	1

	6	1	0	1	0	0	0	-1	0	-1
	6	1	0	1	1	2	3	0	2	2
	6	1	0	1	1	3	4	0	3	3
	6	2	0	2	0	0	0	-2	0	-2
	6	2	0	2	0	3	3	-2	3	1
	6	3	2	5	0	1	1	-3	-1	-4
	6	1	1	2	0	0	0	-1	-1	-2
	6	1	0	1	0	5	5	-1	5	4
	6	1	0	1	0	4	4	-1	4	3
	6	2	2	4	0	0	0	-2	-2	-4
	6	0	0	0	2	1	3	2	1	3
	6	1	2	3	0	0	0	-1	-2	-3
	6	1	0	1	1	1	2	0	1	1
	6	1	0	1	0	4	4	-1	4	3
	6	3	0	3	0	0	0	-3	0	-3
	6	1	2	3	0	0	0	-1	-2	-3
	6	1	0	1	1	3	4	0	3	3
	6	1	0	1	1	0	1	0	0	0
Sum		34	19	53	17	37	54	-17	18	1
Average		1.133333	0.633333	1.766667	0.566667	1.233333	1.8	-0.56667	0.6	0.033333
StdDev		0.915117	0.768852	1.292266	0.73612	1.509412	1.712746	1.524028	2.007376	2.705586
	7	3	0	3	0	3	3	-3	3	0
	7	1	1	2	0	1	1	-1	0	-1
	7	0	1	1	2	1	3	2	0	2
	7	1	3	4	0	0	0	-1	-3	-4
	7	3	0	3	0	0	0	-3	0	-3
	7	1	0	1	0	0	0	-1	0	-1
	7	0	0	0	0	1	1	0	1	1
	7	2	2	4	0	0	0	-2	-2	-4
	7	2	1	3	0	1	1	-2	0	-2
	7	1	0	1	0	1	1	-1	1	0
	7	0	0	0	3	2	5	3	2	5
	7	1	1	2	1	2	3	0	1	1
	7	0	0	0	3	0	3	3	0	3
	7	1	0	1	0	1	1	-1	1	0

	7	1	1	2	0	1	1	-1	0	-1
	7	1	0	1	0	3	3	-1	3	2
	7	2	1	3	0	1	1	-2	0	-2
	7	0	3	3	1	1	2	1	-2	-1
	7	2	0	2	0	0	0	-2	0	-2
	7	0	1	1	1	1	2	1	0	1
	7	1	0	1	0	1	1	-1	1	0
	7	2	0	2	0	1	1	-2	1	-1
	7	0	0	0	0	1	1	0	1	1
	7	3	0	3	0	0	0	-3	0	-3
	7	0	0	0	1	0	1	1	0	1
	7	0	0	0	2	2	4	2	2	4
	7	1	0	1	1	3	4	0	3	3
	7	1	2	3	0	0	0	-1	-2	-3
	7	2	0	2	0	1	1	-2	1	-1
	7	3	0	3	0	0	0	-3	0	-3
Sum		35	17	52	15	29	44	-20	12	-8
Average		1.166667	0.566667	1.733333	0.5	0.966667	1.466667	-0.66667	0.4	-0.26667
StdDev		0.976321	0.907006	1.25651	0.91107	0.92582	1.404602	1.680077	1.452024	2.300139
	8	1	0	1	0	1	1	-1	1	0
	8	1	0	1	0	2	2	-1	2	1
	8	1	0	1	2	4	6	1	4	5
	8	0	0	0	3	3	6	3	3	6
	8	3	1	4	0	2	2	-3	1	-2
	8	1	0	1	1	1	2	0	1	1
	8	2	4	6	0	0	0	-2	-4	-6
	8	1	1	2	0	0	0	-1	-1	-2
	8	2	1	3	0	0	0	-2	-1	-3
	8	0	4	4	1	0	1	1	-4	-3
	8	0	1	1	0	1	1	0	0	0
	8	2	2	4	0	0	0	-2	-2	-4
	8	0	2	2	1	0	1	1	-2	-1
	8	0	0	0	1	0	1	1	0	1
	8	1	1	2	0	0	0	-1	-1	-2
	8	1	0	1	0	3	3	-1	3	2

	8	1	0	1	1	3	4	0	3	3
	8	2	0	2	0	1	1	-2	1	-1
	8	0	0	0	1	1	2	1	1	2
	8	1	1	2	1	1	2	0	0	0
	8	1	0	1	0	1	1	-1	1	0
	8	2	1	3	0	1	1	-2	0	-2
	8	2	0	2	0	3	3	-2	3	1
	8	1	0	1	0	1	1	-1	1	0
	8	0	1	1	1	1	2	1	0	1
	8	2	0	2	0	0	0	-2	0	-2
	8	3	2	5	0	0	0	-3	-2	-5
	8	1	0	1	1	2	3	0	2	2
	8	2	2	4	0	0	0	-2	-2	-4
	8	3	0	3	0	1	1	-3	1	-2
Sum		37	24	61	14	33	47	-23	9	-14
Average		1.233333	0.8	2.033333	0.466667	1.1	1.566667	-0.76667	0.3	-0.46667
StdDev		0.88918	1.136064	1.535299	0.737791	1.175489	1.63701	1.441811	2.033585	2.771246
	9	5	0	5	0	0	0	-5	0	-5
	9	0	1	1	1	2	3	1	1	2
	9	2	2	4	0	0	0	-2	-2	-4
	9	1	1	2	1	0	1	0	-1	-1
	9	0	1	1	4	2	6	4	1	5
	9	3	0	3	0	1	1	-3	1	-2
	9	1	0	1	1	1	2	0	1	1
	9	3	0	3	0	1	1	-3	1	-2
	9	1	0	1	0	3	3	-1	3	2
	9	1	0	1	1	3	4	0	3	3
	9	5	0	5	0	0	0	-5	0	-5
	9	2	0	2	0	1	1	-2	1	-1
	9	0	0	0	2	0	2	2	0	2
	9	1	0	1	1	1	2	0	1	1
	9	3	0	3	0	3	3	-3	3	0
	9	1	0	1	1	0	1	0	0	0
	9	1	1	2	1	1	2	0	0	0
	9	1	1	2	0	1	1	-1	0	-1

	9	2	1	3	0	2	2	-2	1	-1
	9	0	0	0	1	2	3	1	2	3
	9	0	1	1	0	1	1	0	0	0
	9	4	1	5	0	0	0	-4	-1	-5
	9	0	0	0	1	0	1	1	0	1
	9	1	0	1	0	1	1	-1	1	0
	9	2	1	3	0	0	0	-2	-1	-3
	9	0	0	0	2	3	5	2	3	5
	9	3	0	3	0	1	1	-3	1	-2
	9	0	1	1	1	0	1	1	-1	0
	9	2	1	3	0	1	1	-2	0	-2
	9	1	0	1	0	2	2	-1	2	1
Sum		46	13	59	18	33	51	-28	20	-8
Average		1.533333	0.433333	1.966667	0.6	1.1	1.7	-0.93333	0.666667	-0.26667
StdDev		1.478083	0.572351	1.511858	0.902924	1.032716	1.490528	2.136938	1.293218	2.673994

APPENDIX E

```
MTB > anova c3=c1|c2
```

Note: A = Type of Delay , B = Level of Delay

Factor	Type	Levels	Values							
A	fixed	3	1	2	3					
B	fixed	9	1	2	3	4	5	6	7	8	9

Analysis of Variance for C

Source	DF	SS	MS	F	P
A	2	640.425	320.212	38.93	0.000
B	8	69.217	8.652	1.05	0.395
A*B	16	123.042	7.690	0.93	0.528
Error	783	6440.700	8.226		
Total	809	7273.384			

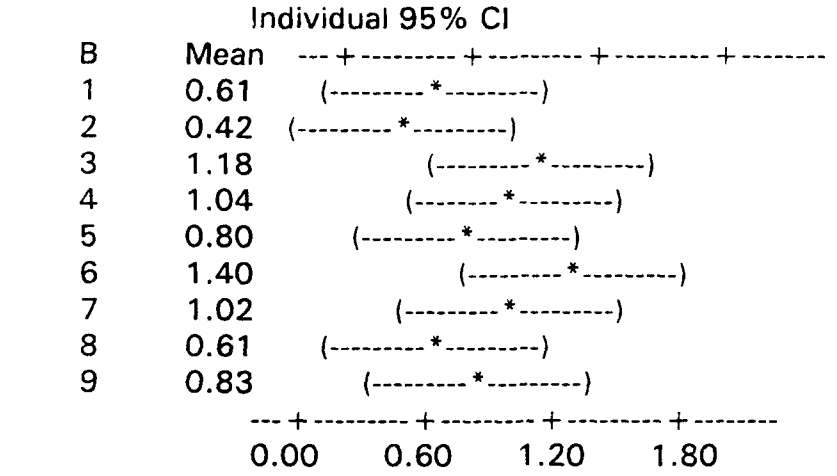
```
MTB > twoway c3 c1 c2;
SUBC> mean c1 c2.
```

ANALYSIS OF VARIANCE C

SOURCE	DF	SS	MS
A	2	640.42	320.21
B	8	69.22	8.65
INTERACTION	16	123.04	7.69
ERROR	783	6440.70	8.23
TOTAL	809	7273.38	

Individual 95% CI

```
A      Mean  -------+---------+---------+---------+----
1      0.70            (----*----)
2     -0.11   (---*----)
3      2.05                             (----*----)
            -------+---------+---------+---------+----
              0.00      0.70      1.40      2.10
```



MTB > NoOutfile.

LIST OF REFERENCES

1. Committee on the Armed Services, House of Representatives, 92nd Congress, First Session, Report of the Armed Services Investigating Subcommittee, *Review of the Department of Defense Worldwide Communications*, May 1971.

2. Sherfey, Linda M., *Wargamming in Support of the Commnd, Control, and Communications Experiments*, Naval Postgraduate School, March 1992.

3. Norris, Lisa A., *Modeling C3: The Effects of Information Delay In Tactical Tic-Tac-Toe (T4)*, Master's Thesis, Naval Postgraduate School, Monterey, California, June 1992.

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