THE PLANNING AND CONTROLLING OF INFANTRY AND ARTILLERY JOINT COMBAT OPERATION

DR.MAZEN J. ALWANI
SENIOR EXPERT IN PLANNING,MINISTRY OF INTERIOR,KUWAIT
VISITING RESEARCH FELLOW,BRADFORD UNIVERSITY MANAGEMENT CENTRE U.K.

THIS PAPER DEMONSTRATES THE USE OF SYSTEM DYNAMICS AS A DEVICE TO SIMULATE A SYSTEM OF INFANTRY AND ARTILLERY CO-OPERATING IN JOINT COMBAT OPERATION

THE SYSTEM UNDER STUDY DOES NOT REPRESENT A REAL OR ACTUAL BATTLE_FIELD .THE MODEL REPRESENTS A SCENARIO DESCRIBES HYPOTHETICAL SYSTEM OF ACCEPTED THEORETICAL STRUCTURE OF HOW INFANTRY AND ARTILLERY MAY CO-OPERATE IN ORDER TO ACHIEVE A DESIRED ADVANCE ON A REAL BATTLE_FIELD.

THE PAPER WILL GIVE ATTENTION TO THE PLANNING AND CONTROLLING OF ANY NEED TO SUCH CO-OPERATION,AND WILL GIVE BETTER INSIGHTS TO DECISION MAKERS BEFORE AND DURING SUCH JOINT OPERATIONS.

WE MAKE NO CLAIM FOR REVEALING ANALYSIS OF ANY ARMY STRATEGY ,AND SEEK ONLY TO SHOW HOW A SYSTEM DYNAMICS MODEL COULD DO IF IT WERE CONSTRUCTED BY PEOPLE WHO FULLY UNDERSTOOD THE PROBLEMS AND HAD ACCESS TO INFORMATION AT WHICH WE CAN ONLY MAKE GUESSES.

THE PAPER SEEKS TO HIGHLIGHT THE MAIN VARIABLES AND MAIN FEEDBACK LOOPS AFFECTING THE PERFORMANCE OF THE SYSTEM AND PRODUCING ITS MAIN DYNAMIC BEHAVIOURS. IT SHOWS HOW ARTILLERY GAINS ITS EFFECTIVENESS TO INSURE HIGHER CUMULATIVE ADVANCE TO THE INFANTRY, HOW THE PROCESS OF ARTILLERY COMMITMENT TAKES PLACE.AND HOW ENEMY EFFECTIVENESS CAN BE REDUCED.

WE BY NO MEANS REGARD THE PAPER AS A FOREGONE CONCLUSION SUCH AN ANALYSIS WOULD OF VALUE IF IT HAD ,SAY,THREE MAN-MONTHS OF WORK BY WELL-INFORMED EXPERTS.

THE MODEL DESIGNER WILL USE MICRO COMPUTER SOFTWARE(DYSMAP2) TO RUN AND ANALYSE THE MODEL.

THIS MILITARY STUDY IS PART OF THE RESEARCH ACTIVITIES OF THE SYSTEM DYNAMICS GROUP IN KUWAIT WHICH HAS BEEN FORMED RECENTLY WITH THE SCIENTIFIC CO-OPERATION OF BRADFORD UNIVERSITY MANAGEMENT CENTRE(U.K.).

THE APPLICABILITY OF SYSTEM DYNAMICS IN COMBAT OPERATIONS

IN SPITE OF THE FACT THAT THE USE OF SYSTEM DYNAMICS IS FAR FROM NEW IN MILITARY ANALYSIS IN GENERAL (1),WE WILL GIVE SOME MORE DETAILS OF THE APPLICABILITY OF SYSTEM DYNAMICS IN SUCH SYSTEMS SIMILAR TO THE SYSTEM UNDER STUDY.
FIRST WE EXAMINE THE PROSPECTS FOR APPLYING SYSTEM DYNAMICS IN RELATIVELY SMALL MILITARY SYSTEMS, IN ORDER TO, ANALYSE THEIR SHORT TERM OPERATIONAL BEHAVIOUR. THEN WE ATTEMPT TO INCORPORATE CONTINUAL CONTROL AND ADJUSTMENTS TO THE ARISING SITUATIONS OF A LIMITED BATTLE FIELD, TO MAKE IT ADVANCE ,IN THE LIGHT OF ENEMY REACTION ,IN THE DIRECTION PLANNED AND DESIRED BY THE COMMANDER.

SETS OF THE CHARACTERISTICS WHICH DESCRIBE THE PROBLEMS OF MANAGING OR LEADING A JOINT COMBAT OPERATION ARE DISCUSSED BELOW:

1. THEY ARE CONTROL PROBLEMS

COMMANDS OUGHT TO BE CONTROLLED AND READJUSTED ACCORDING TO THE ENEMY CHANGE AND RECHANGE OF POLICIES. THIS PROCESSES TAKES PLACE IN ANY DYNAMIC SYSTEM BY THE NEGATIVE FEEDBACK LOOPS STRUCTURED IN THE SYSTEM (2).
SYSTEMS OF COMBAT OPERATIONS CONTAIN ENORMOUS NUMBERS OF POSITIVE AND NEGATIVE FEEDBACK LOOPS. A BROAD BOUNDARY OF THE SYSTEM AND ITS MAIN FEEDBACK LOOPS ARE SHOWN IN FIGURE (1).

IF A SYSTEM UNDER STUDY SEEMS TO LACK CONTROL LOOPS IN THE MENTAL MODEL OF THE MANAGER, THE RESEARCHER HAS TO SEEK TO FIND THEM IN THE LITERATURE OF THE REAL SYSTEM. THE MORE FEEDBACK NEGATIVE LOOPS INTRODUCED TO THE SYSTEM, THE MORE POSSIBILITY OF ENHANCEMENT ITS CONTROLLABILITY AND PERFORMANCE.
THE DYNAMICS PRODUCED FROM THE FEEDBACK LOOPS OF THE SYSTEM UNDER STUDY SHOULD BE DOING WHAT THEY ARE SUPPOSED TO DO. IN THIS CASE THE CUMULATIVE INFANTRY ADVANCE SHOULD BE AS CLOSE TO THE DESIRED INFANTRY CUMULATIVE ADVANCE AS POSSIBLE.

2. THEY ARE DYNAMIC PROBLEMS:

THE ENVIRONMENT IN WHICH COMBAT OPERATIONS ARE MANAGED IS DYNAMIC RATHER THAN STATIC.
THE PAST DYNAMICS OF THE JOINT COMBAT OPERATIONS SYSTEM ILLUSTRATE ITS PAST PERFORMANCE WHICH ARE NATURALLY THE RESULTS OF THE COMMANDER PAST POLICIES IN RESPONSE TO PAST EXOGENOUS SHOCKS.
THE FUTURE DYNAMICS ARE THE EXPECTED PERFORMANCE OF THE SYSTEM IN THE FUTURE. IN FACT, THEY ARE THE RESULTS OF THE SIMULATED POLICIES IN THE MODEL. IT IS NECESSARY THAT THE MODEL SHOULD SHOW, WITH SUFFICIENT CONFIDENCE, THE MANNER AND TRENDS OF THE FUTURE DYNAMICS OF THE MODELLED POLICIES.
THE MAIN EXOGENOUS DYNAMIC SHOCKS WHICH COMBAT OPERATIONS ARE EXPOSED TO ARE THE FOLLOWINGS:

- THE ENEMY REACTION AGAINST CERTAIN AVERAGE OF INFANTRY ADVANCE.
- ENEMY FORCES DEPLOYMENT STRUCTURE.
- READY FOR DISPATCH FRIEND ARTILLERY.

3-THEY ARE PRBLEMS IN SYSTEM WITH NON-LINEAR RELATIONSHIPS:

A SYSTEM WILL BE NON-LINEAR IF AT LEAST ONE OF ITS CAUSAL RELATIONSHIPS BETWEEN TWO VARIABLES IS NON-LINEAR.
MOST OF CAUSAL LINKS OR CAUSAL RELATIONSHIPS IN A COMBAT SYSTEM ARE NON-LINEAR. WE CAN SAY WITH REASONABLE CONFIDENCE THAT THE AMOUNT AND DIRECTION OF ENEMY REACTION TO CERTAIN CHANGES OF FRIEND POLICIES WILL NEVER BE LINEAR.

4. THEY ARE PROBLEMS OF COPING WITH DELAYS:

IN A COMBAT OPERATION SYSTEM, DELAYS EXIST IN MOST FLOW CHANNELS OR RATES. THE ARTILLERY COMMITMENT RATE AND THE ENEMY REACTION TO CERTAIN AVERAGE OF FRIEND INFANTRY ADVANCE ARE EXAMPLES OF DELAYS IN THE SYSTEM.

THE ABOVE MENTIONED CHARACTERISTICS OF A JOINT COMBAT SYSTEM PROBLEMS NOMINATE THE SYSTEM DYNAMICS MODELLING METHOD AS A VERY SUITABLE CANDIDATE TO STUDY THEM.

THE SIMULATION MODEL

THE SIMULATION MODEL IN SYSTEM DYNAMICS IS A PURPOSIVE DEVICE. IT REPRESENTS AND SIMULATES A SYSTEM UNDER STUDY. THE MODELLING PROCESS IN ORDER TO BE IMPLEMENTED, REQUIRES A CLEAR UNDERSTANDING OF, FIRSTLY, THE PURPOSE AND, SECONDLY, THE BOUNDARY OF THE MODEL.

THE PURPOSE OF THE MODEL:

THE FIRST STAGE IN MODELLING A PROJECT IS THE DEFINITION OF ITS PURPOSE. THE PURPOSE OF A MODEL DETERMINE ITS BOUNDARY AND PLAYES THE ESSENTIAL ROLE IN THE SELECTION PROCESS OF THE VARIABLES TO BE INCLUDED IN THE MODEL.
THE PURPOSE OF THIS MODEL IS TO DEMONSTRATE HOW A SYSTEM DYNAMICS MODELLING APPROACH CAN BE USED TO SIMULATE A JOINT COMBAT OPERATION SYSTEM AND ANALYSE ITS BEHAVIOUR, AIMING AT DISCOVERING THE RIGHT POLICIES TO BE FOLLOWED AND APPLIED IN A REAL SIMILAR BATTLE_FIELD.

THE MODEL BOUNDARY:

A VERY ESSENTIAL LESSON ANY OFFICER IN THE ARMY MUST LEARN IS HOW, WHY, AND WHEN TO BEGIN FIRING AND HOW, WHY, AND WHEN TO CEASE FIRE. IT IS NOT AN EASY MATTER AT ALL. SIMILARLY IN THE DRAWING OF THE BOUNDARY OF A MODEL, SIMILAR QUESTIONS SHOULD BE ANSWERED AND THE SAME DIFFICULTY IS FACED. IN FACT IT IS WELL KNOWN THAT IT IS HARD TO GET STARTED ON A DYNAMIC MODEL AND EVEN HARDER TO STOP. ANYWAY, THE MODEL BOUNDARY CAN BE DEFINED AS THE VOLUME OF THE SYSTEM AREA WHICH IS ENOUGH TO BE MODELLED IN ORDER TO MAKE IT POSSIBLE TO FULFIL THE PURPOSE OF THE MODEL. THAT MEANS THAT THE MODEL BOUNDARY DEPENDS UPON ITS PURPOSE AND THE SIZE OF THE SYSTEM. IN GENERAL, THE MODEL BOUNDARY MUST CONTAIN THE MAIN FEEDBACK LOOPS WHICH LINK THE MAIN VARIABLES AND CAUSE THE MAIN DYNAMICS OF THE SYSTEM CONCERNED.

FIGURE (1) SHOWS THE BROAD BOUNDARY OF THE MODEL WHICH IS THE SUBJECT OF THIS STUDY.

IT CONSISTS OF THE FOLLOWING AREAS:

1- THE FRIEND POLICIES OF THE READY FOR DISPATCH ARTILLERY WHICH AFFECTS THE ARTILLERY COMMITMENT RATE.
THE ARTILLERY COMMITMENT RATE IMPOSES THE AVAILABLE ARTILLERY.

2- THE FRIEND ARTILLERY EFFECTIVENESS WHICH IS INFLUENCED BY THE MARGIN BETWEEN THE ARTILLERY AND THE INFANTRY AND BY BOTH THE ARTILLERY AND THE SHELLS SUFFICIENCY .

3- THE ENEMY DEPLOYMENT FACTOR WHICH WITH THE SUPPORT OF THE ENEMY AIR INTERFERENCE CAPABILITY INFLUENCES THE FRIEND INFANTRY ADVANCE RATE .

4- THE FRIEND AND ENEMY REACTION TO CERTAIN RATE OF ADVANCE OF THE INFANTRY. IF THE INFANTRY ADVANCE RATE IS LESS THAN WHAT IT HAS BEEN DECIDED, THE FRIEND AIR FORCES WILL REACT AND INTERVENE TO INTERCEPT AND REDUCE THE ENEMY AIR INTERFERENCE CAPABILITY WHICH INFLUENCE BOTH FRIEND INFANTRY AND ARTILLERY ADVANCE RATE.

5- THE INFLUENCE DIAGRAM CAN SHOW THE ESSENTIAL CAUSAL RELATIONSHIPS BETWEEN THE MAIN COMPONENTS OF THE MODEL. FOR EXAMPLE, IT ILLUSTRATES HOW THE ARTILLERY EFFECTIVENESS AFFECTS THE ENEMY DEPLOYMENT STRUCTURE WHICH IN ITS TURN AFFECTS THE INFANTRY ADVANCE RATE.

IT IS VERY IMPORTANT TO BE CLEAR THAT THE MODEL WILL BE CARRIED OUT AT A HIGH LEVEL OF AGGREGATION. THEREFORE, THE VARIABLES WHICH ARE INCLUDED IN THE MODEL ARE THE MAJOR AGGREGATES OF THE COMBAT JOINT OPERATIONS.

SESCRIPTION OF THE SYSTEM

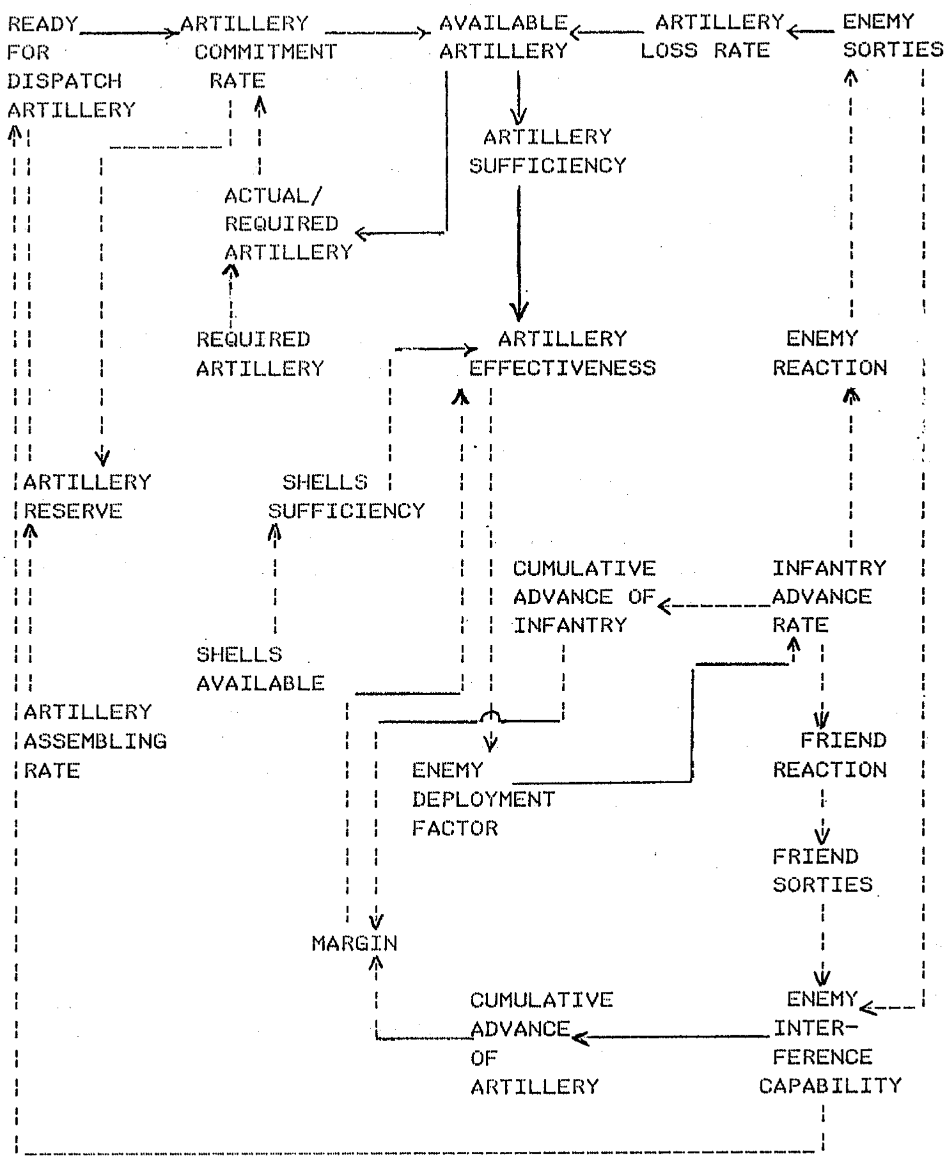
THREE MAIN FACTORS AFFECT THE INFANTRY ADVANCE IN A BATTLE_FIELD FIRST, THE SOLIDITY OF ENEMY FORCES AND THE WAY THEY ARE DEPLOYED. THAT IS THE STRUCTURE THE ENEMY ORGANISES ITS INFANTRY, ARTILLERY AND OTHER DEFENDING FORCES. THIS SOLIDITY OF THE ENEMY DEPLOYMENT CAN BE SHAKEN AND WEAKENED BY EFFECTIVE FRIEND ARTILLERY. THE MORE EFFECTIVE FRIEND ARTILLERY , THE WEAKER THE ENEMY DEPLOYMENT AND HENCE, THE LESS POSSIBILITY TO STOP THE ADVANCE OF THE FRIEND INFANTRY.

SECOND, THE ENEMY AIR ACTIVITY MAKES ADVANCE VERY DIFFICULT FOR BOTH FRIEND ARTILLERY AND INFANTRY. THE ONLY WAY TO REDUCE THE THREAT AND IMPACT OF ENEMY AIR ACTIVITY IS BY INCREASING THE NUMBER OF FRIEND INTERCEPTIVE SORTIES.

THIRD, THE NATURE OF THE LAND ON WHICH THE INFANTRY IS ADVANCING. SOME LANDS GIVE COVER AND FACILITATE THE INFANTRY ADVANCE, BUT SOME CREATE GREAT DIFFICULTIES. THE EFFECT OF THIS FACTOR HAS BEEN SHOWN IN THE MODEL AS A RANDOM SINE WAVE WITH SOME NOISE FACTORS ON IT.

THE MODEL SHOWS HOW THESE THREE FACTORS WORK TO HINDER AND DELAY OR STOP THE INFANTRY ADVANCE. IT ALSO DEMONSTRATES THE ACTION WHICH MIGHT BE TAKEN BY COMMANDERS ON BOTH SIDES. NATURALLY THE SIZE OF INFORMATIONS AND THEIR RELIABILITY THE COMMANDERS ARE TAKING INTO CONSIDERATION PLAY DECISIVE ROLE IN SECURING DESIRED PERFORMANCE. BECAUSE WE HAVE NO CLEAR IDEA ABOUT THE REAL AND ACTUAL INFORMATION COMMANDERS MAY USE , WE TOOK REFUGE TO (DYSMAP TABHL FUNCTIONS) WHERE WE ONLY MADE SOME GUESSES.

INFLUENCE DIAGRAM OF JOINT COMBAT OPERATIONS



CONCLUSION

THE ANALYSIS OF THE RESULTS GIVEN BY RUNNING THE MODEL, WITH DIFFERENT CONTROL POLICIES, GIVES SOME BETTER INSIGHT OF HOW CHANGING COMBAT OPERATIONS COULD BE MANAGED. IT HELPS FOR EXAMPLE TO DECIDE WHEN AND HOW MORE ARTILLERY OR AIR SORTIES TO BE COMMITTED AND FOR WHAT PURPOSE.

IT IS CLEAR THAT USING SUCH SYSTEM DYNAMICS MODEL DOES NOT ONLY HELP IN EASIER ADVANCE BUT IT ALSO DOES HELP TO REDUCE CASUALTIES AND IMPROVE THE WHOLE ECONOMICS OF THE OPERATION.

WE HAVE TRIED TO GIVE EMPHASISE TO HOW SYSTEM DYNSMICS METHOD OF ANALYSIS, WHICH IS OF PROVEN SUCCESS IN THE FIELD OF BUSINESS PLANNING, COULD BE APPLIED TO SOME ASPECTS OF DEFENCE STUDIES.

OUR DEMONSTRATION HAS BEEN OF SIMPLE MODEL IN THE SENSE THAT WE HAVE NO ACCESS TO INFORMATION WHICH WOULD EXPAND AND IMPROVE IT.

IN OUR JUDGEMENT, HOWEVER, THERE WILL BE NO PARTICULAR TECHNICAL DIFFICULTIES IN DEVELOPING THE MODEL AS REALISTIC AS ONE WISHED, PROVIDING THE NEEDED INFORMATION COULD BE MADE AVAILABLE.()

IN FACT, WE CONSIDER THAT SYSTEM DYNAMICS HAS USEFUL APPLICATIONS IN MILITARY TRAINING ACTIVITIES. MILITARY COLLEGE CADETS CAN GAIN EXPERIENCE IN THE SIMULATING OF REAL WELL KNOWN PAST COMBAT OPERATIONS AND TRY TO IMPROVE THEIR PERFOMANCE IN SUCH A COPETITIVE EVIRONMENT, WITHOUT THE DISASTROUS CONSEQUENCES SHOULD THEY MISGUDJE OR MAKE MISTAKES.

REFERENCES

1- R. GEOFFREY COYLE 1980,A MODEL OF THE DYNAMICS OF THE THIRD WORLD WAR ,WORKING PAPER ,BRADORD UNIVERSITY MANAGEMENT CENTRE.

2- JAY W.FORRESTER 1961,INDUSTIAL DYNAMICS,THE M.I.T. PRESS.

MODEL FOR COMBAT JOINT OPPERATIONS BASIC MODEL

TIME	MARG CINFAD CARAD	INFADR ARADR FAFAD	FAREFF ENDEPF ENINTF	ARCR ENSOR RFDARR
0.00000	2.0000 0.00000 -2.0000	2.7000 0.00000 0.30000	1.0000 1.0000 0.30000	0.00000 6.0000 6.2500
2.0000	6.7261 5.7179 -1.0081	0.00000 4.0000 0.40000	0.79034 0.78067 0.40000	0.00000 4.2535 6.7500
4.0000	7.3152 10.700 3.3846	0.00000 4.9804 0.49804	0.65063 0.60000 0.49804	0.00000 3.0196 7.2500
6.0000	5.0514 15.096 10.045	4.6489 0.00000 0.49223	0.54611 0.49223 0.66067	0.00000 2.1966 31.000
8.0000	5.3784 19.578 14.199	2.2611 0.00000 0.36317	0.46317 0.36317 0.74827	132.00 1.7586 33.000
10.000	4.7382 24.583 19.845	3.6032 0.00000 0.50828	0.55414 0.50828 0.77472	0.00000 1.6264 26.750
12.000	5.3835 29.544 24.161	4.2589 0.00000 0.38368	0.48368 0.38368 0.79192	115.00 1.5404 28.750
14.000	4.5460 34.701 30.155	8.1958 0.00000 0.58872	0.59436 0.58872 0.78301	0.00000 1.5850 23.563
16.000	4.7248 40.408 35.684	6.4447 0.00000 0.51550	0.55775 0.51550 0.76461	102.25 1.6770 25.563

MODEL FOR COMBAT JOINT OPPERATIONS BASIC MODEL

TIME	MARG CINFAD CARAD	INFADR ARADR FAFAD	FAREFF ENDEPF ENINTF	ARCR ENSOR RFDARR
18.000	4.7646 46.448 41.684	5.0260 0.00000 0.60000	0.64822 0.60000 0.73113	0.00000 1.8443 21.172
20.000	7.2559 53.440 46.184	0.00000 6.0000 0.60000	0.60847 0.60000 0.65669	92.688 2.2165 23.172
22.000	7.0250 59.293 52.268	0.00000 6.0000 0.60000	0.68176 0.60000 0.66922	0.00000 2.1539 19.379
24.000	6.8682 65.137 58.268	0.00000 6.0000 0.60000	0.64071 0.60000 0.67234	85.516 2.1383 21.379
26.000	7.4998 72.063 64.563	0.00000 6.0984 0.60984	0.70492 0.60984 0.62130	0.00000 2.3935 18.034
28.000	7.7723 78.360 70.588	0.00000 6.0000 0.60000	0.66131 0.60000 0.61423	80.137 2.4289 20.034
30.000	4.9683 83.534 78.566	4.7264 0.00000 0.63578	0.71789 0.63578 0.67434	0.00000 2.1283 17.026