

APPLICATION EXPERT COURSE - GROUP 2

**THEME: REDUCE THE NUMBER OF STRUCTURAL WORK REQUESTS
COMPLETED LATE WHILE MAINTAINING QUALITY**

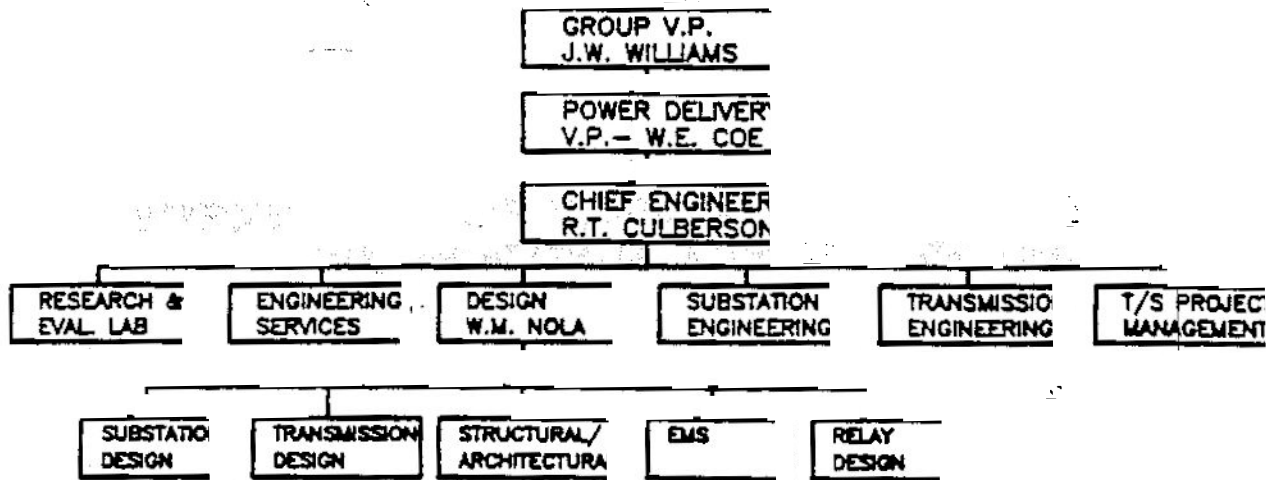
**PRESENTER: BARBARA JAINDL
REPRESENTING STRUCTURAL SECTION
SUPERVISORY TEAM LOCATED IN
GENERAL ENGINEERING, JUNO BEACH**

PRESENTATION DATE 3/30/88

1**REASON
FOR IMPROVEMENT**

**THEME: REDUCE THE NUMBER OF STRUCTURAL WORK REQUESTS COMPLETED LATE
WHILE MAINTAINING QUALITY.**

**DEPARTMENT: STRUCTURAL/ARCHITECTURAL SECTION IN GENERAL ENGINEERING
LOCATED IN JUNO BEACH**

**5 ARCHITECTS****6 CIVIL/STRUCTURAL
ENGINEERS****RESPONSIBILITIES**

**STRUCTURAL AND CIVIL ENGINEERING FOR TRANSMISSION LINE
AND SUBSTATION PROJECTS AND STANDARDS.
ENGINEERING EXPERTISE PROVIDED FOR DEPARTMENTS OUTSIDE
GENERAL ENGINEERING UPON REQUEST.**

GENERAL ENGINEERING CUSTOMERS:

**Transmission Engineering
Substation Engineering
Substation & Transmission Design
Architectural**

OUTSIDE DEPARTMENT CUSTOMERS:

**Construction Services
Divisions
Distribution Engineering**

1

**DATE 3/1/88
BY B. JAND**

1

REASON
FOR IMPROVEMENT

THEME WAS SELECTED BY REVIEWING THE SECTION'S PRODUCTS,
THE CUSTOMER'S VALID REQUIREMENTS, AND DEPARTMENTAL INDICATORS.

STRUCTURAL PRODUCTS	VALID REQUIREMENTS
ENGINEERING CALCULATIONS	ERROR FREE
CIVIL & STRUCTURAL DESIGNS	COST EFFECTIVE DESIGNS
DESIGN DRAWINGS	PRACTICAL DESIGNS
TECHNICAL SPECIFICATIONS	COMPLETE PROJECT
REPORTS & RECOMMENDATIONS	ON TIME COMPLETION

CUSTOMER SURVEY
INDICATED THIS AREA
NEEDED IMPROVEMENT!
HOW IS IT TRACKED ?

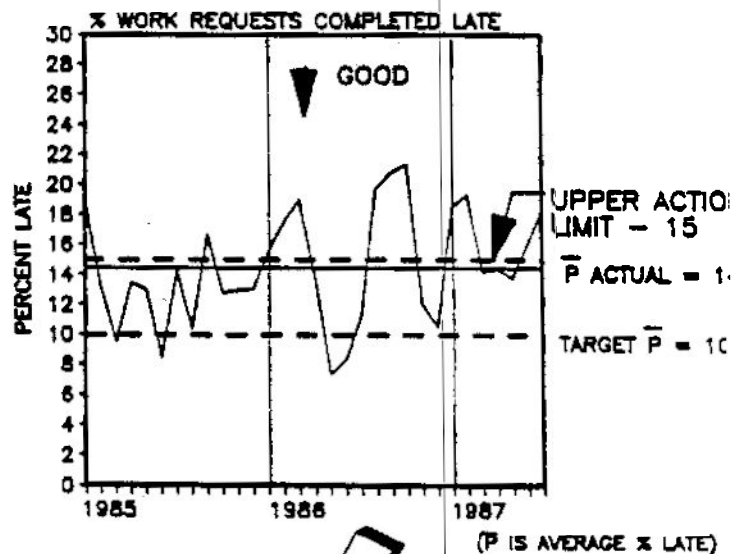
JGE - WORK REQUEST SYSTEM

ALL PROJECTS AND ASSIGNMENTS
IN GENERAL ENGINEERING ARE
GENERATED WITH A WORK REQUEST

A WORK REQUEST NUMBER IS
USED TO TRACK JOB PROGRESS.

ON-TIME PERFORMANCE ON WORK
REQUESTS IS A DEPARTMENT INDICATOR.

HOW IS THE DEPARTMENT'S
ON-TIME PERFORMANCE?

GENERAL ENGINEERING INDICATOR

DEPARTMENT'S PERFORMANCE IS EXCEEDING
SET TARGET AND UPPER LIMIT.

!! ?

HOW DOES STRUCTURAL SECTION COMPARE ?

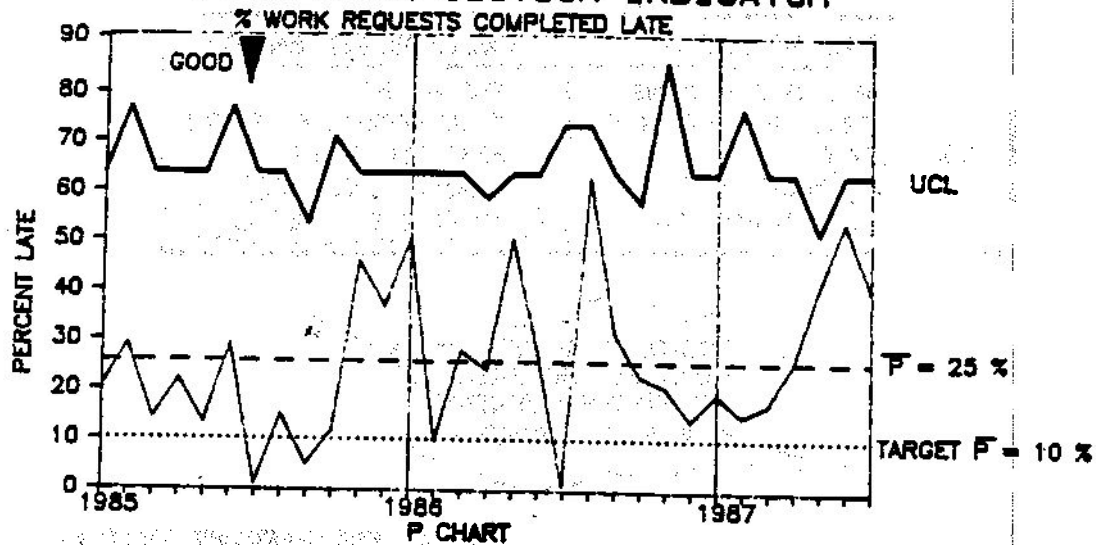
2

DATE 3/3/88
BY B. JAINDL

1

REASON
FOR IMPROVEMENT

STRUCTURAL SECTION INDICATOR



$$UCL = \bar{P} + 3\sqrt{\bar{P}(1-\bar{P})/n}$$

$\bar{n}$ USED FOR n WITHIN $\pm 25\%$ OF $\bar{n}$

$\bar{P}$ = AVERAGE % LATE

ALTHOUGH THE SYSTEM IS WITHIN STATISTICAL CONTROL LIMITS, THE STRUCTURAL SECTION IS EXCEEDING BOTH THE DEPARTMENT'S TARGET $\bar{P}$ (10%) AND UPPER CONTROL LIMIT (15%) FOR WORK REQUESTS COMPLETED LATE.

THEME: REDUCE PERCENT OF STRUCTURAL WORK REQUESTS COMPLETED LATE WHILE MAINTAINING QUALITY.

MO. & YR.	8/87	9/87	10/87	11/87	12/87	1/88	2/88	3/88	4/88	5/88	6/88	7/88
REASON FOR IMPROVEMENT												
CURRENT SITUATION												
ANALYSIS												
COUNTER-MEASURES												
RESULTS												
STANDARDIZATION												
FUTURE PLANS												

SCHEDULE (PROJECTED ACTUAL)

3

DATE 3/7/88
BY B. JAINDL

THE STRUCTURAL CONTROL CHART INDICATED THAT WE ARE RUNNING 25% LATE ON THE AVERAGE.

CONTINGENCY TABLES WERE USED FOR STRATIFYING DATA TO DETERMINE IF THERE WAS ANY PARTICULAR AREA THAT WAS CAUSING THE HIGH % OF LATE WORK REQUEST.

TEST IF % LATE FOR ALL WORK TASKS IS THE SAME ($\alpha = 0.05$)

ACTUAL DATA					
WORK TASK	DESIGN	ANALYSIS	INSPECTION	OTHER	TOTAL
ON TIME	100	125	23	45	293
LATE	43	37	6	8	94
TOTAL	143	162	29	53	387

EXPECTED VALUE AT 25 % LATE					
ON TIME	108.3	122.7	22.0	40.1	293
LATE	34.7	39.3	7.0	12.9	94
TOTAL	143	162	29	53	387

H_0 : NO RELATIONSHIP BETWEEN % LATE & WORK TASK.

H_A : THERE IS A RELATIONSHIP BETWEEN % LATE & WORK TASK.

SINCE $\chi_o^2 < \chi^2(3, 0.05)$, $5.4 < 7.8$

DO NOT REJECT H_0 - THERE IS NO RELATIONSHIP BETWEEN % LATE AND WORK TASK.

DO NOT REJECT H_0 - THERE IS NO RELATIONSHIP BETWEEN % LATE AND JOB SIZE / COMPLEXITY (ESTIMATED HOURS).

DO NOT REJECT H_0 - THERE IS NO RELATIONSHIP BETWEEN % LATE AND WORK TYPE (STRUCTURES, FOUNDATIONS, ETC.).

DO NOT REJECT H_0 - THERE IS NO RELATIONSHIP BETWEEN % LATE AND CUSTOMER.

DO NOT REJECT H_0 - THERE IS NO RELATIONSHIP BETWEEN % LATE AND JOB TYPE (EXPANSION, IMPROVEMENT).

CONCLUSION:

NO ONE AREA STANDS OUT
WE ARE AVERAGING 25 %
LATE ON EVERYTHING.

BUT ARE THERE ANY DIFFERENCES WHEN THE DATA IS STRATIFIED BY THE NUMBER OF DAYS LATE?

DATA ON THE NUMBER OF DAYS LATE WAS STRATIFIED BY WORK TASK AND WORK TYPE WITH MINIMAL DIFFERENCES FOUND IN THE AVERAGE NUMBER OF DAYS LATE. ALL WORK TASK AND WORK TYPES AVERAGED ABOUT 1.5 MONTHS LATE.

DATE 3/7/88
BY B. JAINDL

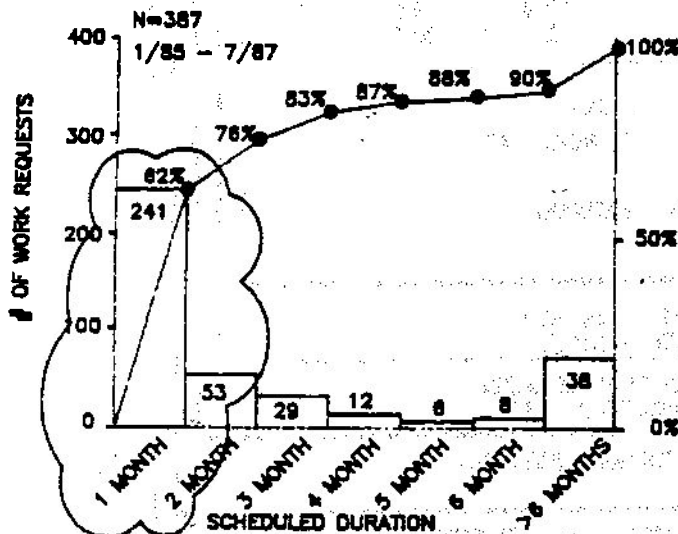
SINCE THERE ARE NO DIFFERENCES IN % OF LATE JOBS WHEN DATA IS STRATIFIED, LET'S GO FOR VOLUME! - WHERE ARE THE LARGEST NUMBER OF LATE JOBS OCCURRING?

SCHEDULED DURATION IS THE NUMBER OF CALENDER DAYS BETWEEN THE DATE RECEIVED AND THE DATE DUE.

SCHEDULED DURATION SHOWED THE LARGEST VOLUMES WHEN STRATIFYING THE DATA BOTH BY TOTAL JOBS AND LATE JOBS.

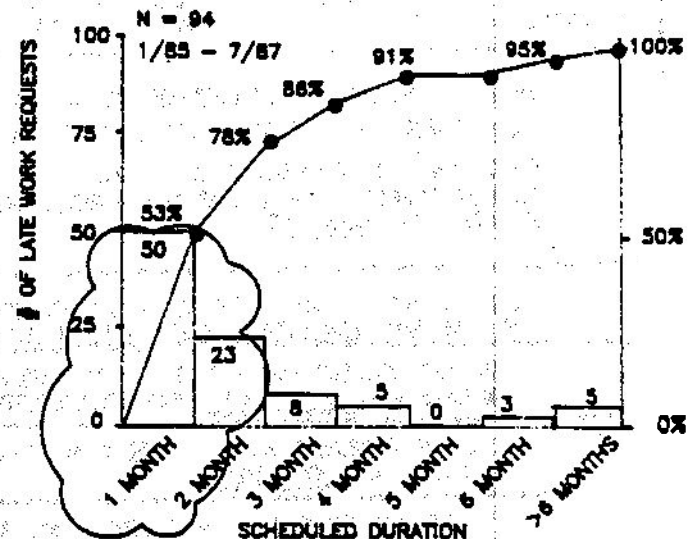


**TOTAL WORK REQUESTS-
BY SCHEDULED DURATION**



1 AND 2 MONTH
DURATION WORK
ACCOUNT FOR 76%
OF TOTAL JOBS

**LATE WORK REQUESTS
BY SCHEDULED DURATION**



1 AND 2 MONTH
DURATION WORK
ACCOUNT FOR 78%
OF LATE JOBS

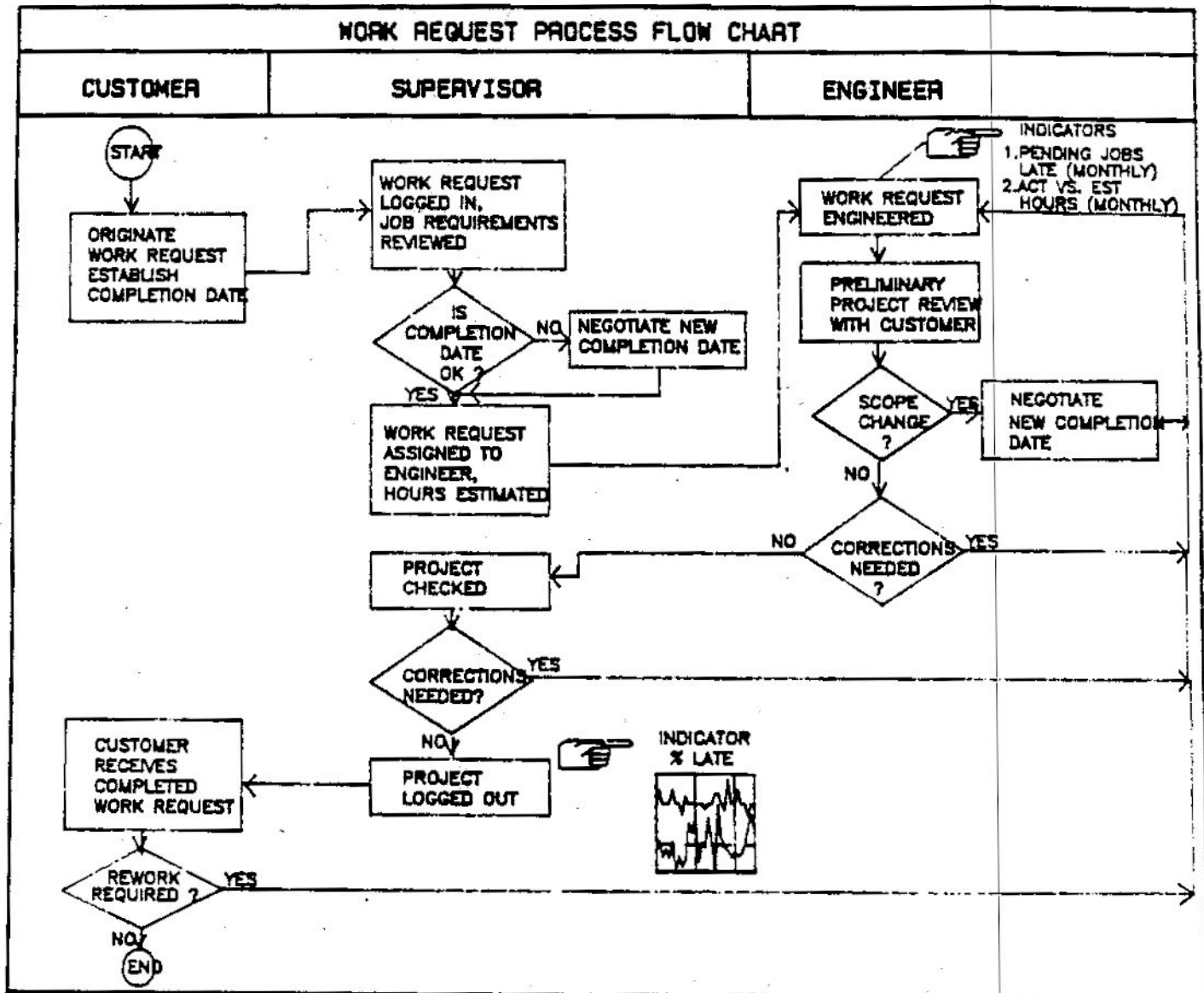
LET'S USE SHORT (1 AND 2 MONTH) DURATION
WORK REQUESTS FOR ANALYSIS.
SHORT DURATION % LATE
(73 LATE/ 294 TOTAL)X 100%= 25%

PROBLEM STATEMENT: 25% OF 1 AND 2 MONTH DURATION WORK REQUESTS ARE COMPLETED LATE WHICH EXCEEDS THE DEPARTMENT TARGET OF 10%.

TARGET: REDUCE THE AVERAGE PERCENT OF SHORT DURATION WORK REQUESTS COMPLETED LATE FROM 25% TO 10%.

STRUCTURAL SECTION ON-TIME PERFORMANCE IS WITHIN STATISTICAL CONTROL LIMITS WHICH POINTS TO A POSSIBLE PROCESS PROBLEM.

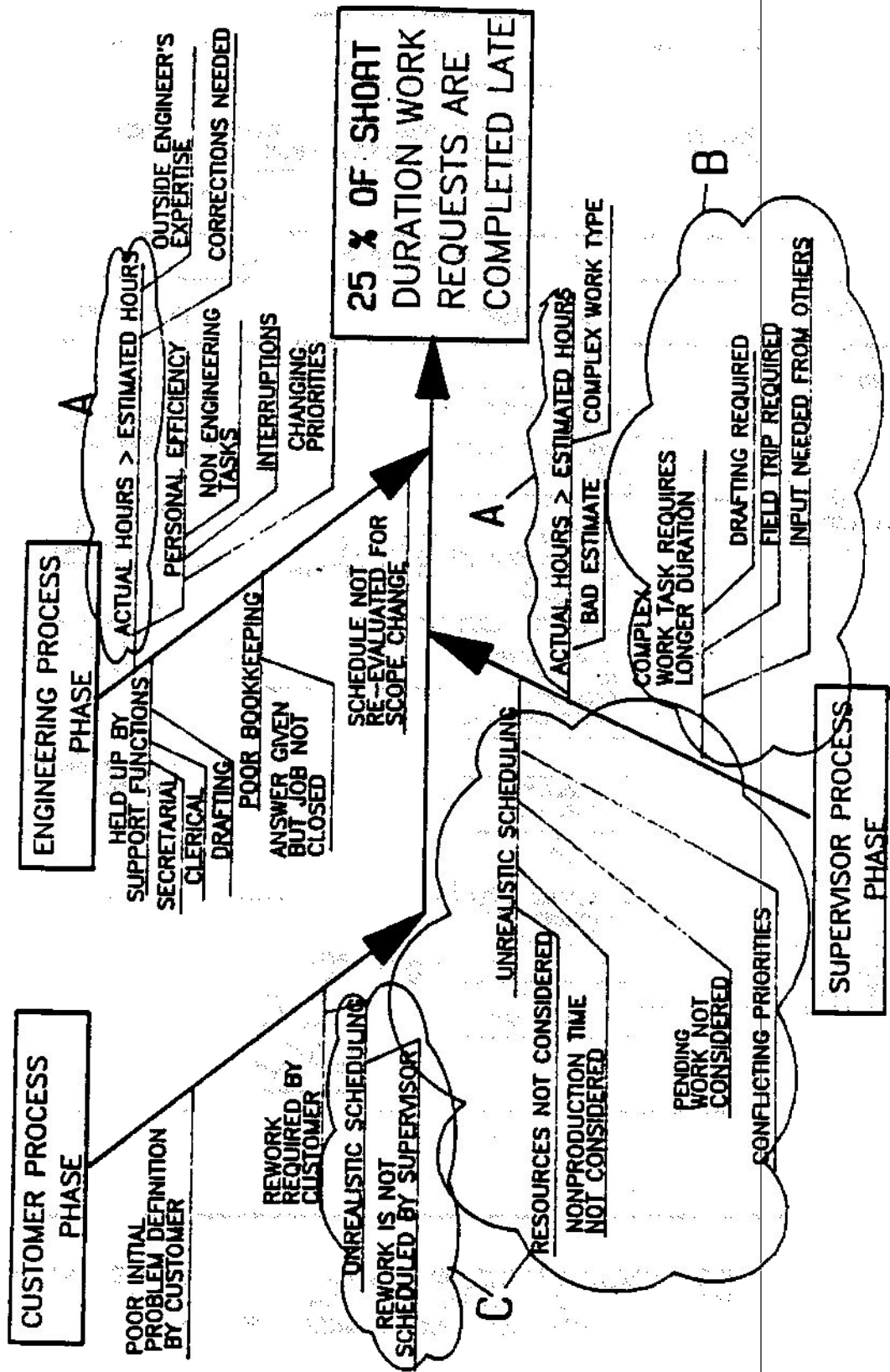
A FLOW CHART WAS DEVELOPED TO AID IN ANALYZING THE PROCESS.



THE CAUSE AND EFFECT DIAGRAM WAS GENERATED BY BRAINSTORMING POTENTIAL PROBLEM AREAS FOR EACH ACTIVITY IN THE CUSTOMER, SUPERVISOR, AND ENGINEER PROCESS PHASE.

3

ANALYSIS



DATE 3/8/88

BY B. JAINDL

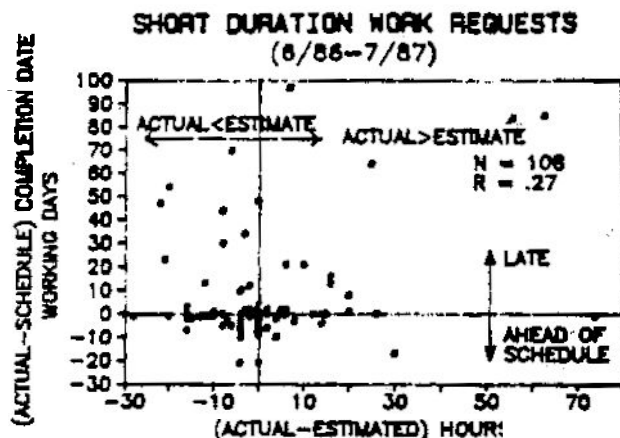
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ANALYSIS

A

INVESTIGATE IF ACTUAL HOURS > ESTIMATED HOURS IS CAUSING WORK REQUESTS TO BE COMPLETED LATE.

LET'S SEE IF THERE IS A DIRECT CORRELATION BETWEEN #DAYS LATE AND # HOURS UNDER ESTIMATED?



DATA SHOWS NO DIRECT CORRELATION.

HOWEVER, IF ESTIMATES ARE CONSISTENTLY LOW, SCHEDULED WORK WILL BE AFFECTED.

LET'S INVESTIGATE IF SHORT DURATION WORK REQUESTS ARE TAKING SIGNIFICANTLY LONGER THAN ESTIMATE



AT 5% LEVEL OF SIGNIFICANCE TEST IF ACTUAL HOURS ARE GREATER THAN ESTIMATED HOURS.

RUN TEST OF POPULATION MEAN FOR PAIRED SAMPLES:

$d = \text{ACTUAL HOURS} - \text{ESTIMATED HOURS}$

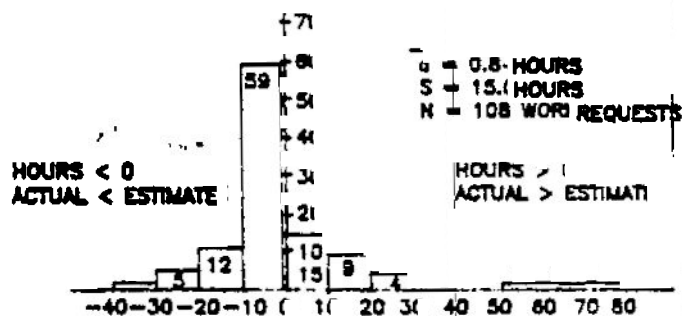
$H_0: \mu = 0$; ACTUAL HOURS = ESTIMATED HOURS

$H_A: \mu > 0$; ACTUAL HOURS > ESTIMATED HOURS

SINCE $t_c < t(107, .10)$ (ONE SIDE) TEST
.061 < 1.86

DO NOT REJECT H_0 THAT ESTIMATE HOURS ARE EQUAL TO ACTUAL HOURS

SHORT DURATION WORK REQUESTS
(ACTUAL MINUS ESTIMATED) HOURS:
(6/86-7/87)



CONCLUSION:

SINCE ACTUAL HOURS ARE NOT SIGNIFICANTLY GREATER THAN ESTIMATED HOURS, WE CONCLUDED THAT THIS FACTOR IS NOT CONTRIBUTING SIGNIFICANTLY TO THE HIGH % OF JOBS COMPLETED LATE.

② DO SPECIFIC WORK TASKS REQUIRE LONGER DURATIONS?

TEST IF THERE IS A RELATIONSHIP BETWEEN % LATE AND WORK TASKS FOR SHORT DURATION WORK REQUESTS. ($\alpha = 0.05$)

WORK TASK	DESIGN	ACTUAL DATA			
		ANALYSIS	INSPECTION	OTHER	TOTAL
ON TIME	59	120	16	13	208
LATE	37	28	5	3	73
TOTAL	96	148	21	16	281
38 % LATE		EXPECTED VALUE AT 25 % LATE			
ON TIME	71.1	109.6	15.5	11.8	208
LATE	24.9	38.4	5.5	4.2	73
TOTAL	96	148	21	16	281

H_0 : NO RELATIONSHIP BETWEEN % LATE & WORK TASK ON SHORT DURATION WORK REQUESTS.

H_A : THERE IS A RELATIONSHIP BETWEEN % LATE & WORK TASK ON SHORT DURATION WORK REQUESTS.

SINCE $\chi^2_{obs} > \chi^2_{(3,0.05)}$, $12.2 > 7.8$

REJECT H_0 IN FAVOR OF H_A THAT THERE IS A RELATIONSHIP BETWEEN % LATE AND WORK TASK ON SHORT DURATION WORK REQUESTS.

DESIGN TASKS LATE
TOTAL LATE

$$\frac{37}{73} \Rightarrow 51\%$$

CONCLUSION:



NATURE OF DESIGN WORK TASK IS SUCH THAT IT CANNOT NORMALLY BE DONE AS A SHORT DURATION PROJECT.

THIS IS A ROOT CAUSE OF THE PROBLEM AND DESIGN PROJECTS ACCOUNT FOR 51% OF THE LATE SHORT DURATION WORK REQUESTS.

③ IS SCHEDULING UNREALISTIC?

INVESTIGATE SCHEDULING METHODOLOGY

CURRENT WORK REQUEST SCHEDULING IS BASED UPON THE FOLLOWING:

1. COMPLETION DATES ARE AGREED UPON BASED ON THE SIZE AND URGENCY OF THE JOB, AND THE SECTIONS BACKLOG.
2. WORK REQUESTS ARE ASSIGNED BY THE SUPERVISOR AFTER A REVIEW OF AN ENGINEERS EXISTING WORK LOAD AND PRIORITIES.
3. ENGINEERS WORK LOAD AND PRIORITIES ARE DISCUSSED WITH THE SUPERVISOR MONTHLY OR MORE FREQUENTLY IF NECESSARY.

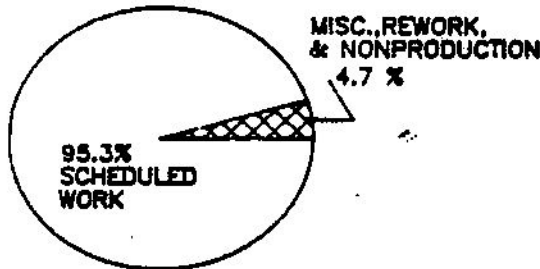
HAS THIS SCHEDULING METHOD BEEN WORKING?



DATE 3/7/88
BY B. JAINDL

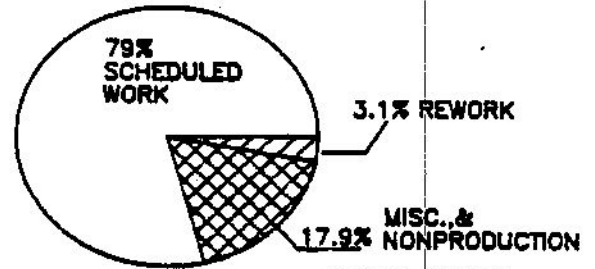
COMPARE SCHEDULED TIME TO ACTUAL TIME TO DETERMINE IF THERE IS A SIGNIFICANT DIFFERENCE.

SCHEDULED
AVERAGE TIME NECESSARY
TO COMPLETE WORK ON SCHEDULE
EACH MONTH



SCHEDULED HOURS:
 $\bar{X}_s = 160.5$ HOURS
 $S_s = 32.3$ HOURS
 $n = 12$

ACTUAL
HOW WAS TIME ACTUALLY SPENT ?



ACTUAL HOURS
ON SCHEDULED WORK
 $\bar{X}_a = 132.8$ HOURS
 $S_a = 23.4$ HOURS
 $n = 80$

TEST OF TWO POPULATION MEANS INDICATED THAT THERE WAS A SIGNIFICANT DIFFERENCE BETWEEN SCHEDULING ASSUMPTIONS AND ACTUAL PERFORMANCE.

IS ACTUAL TIME SPENT ON MISC., AND NONPRODUCTION EXCESSIVE?

TEST OF POPULATION
VARIANCE $\alpha = 0.05$

$H_0: \sigma_s^2 = \sigma_a^2$

$H_A: \sigma_s^2 \neq \sigma_a^2$

DO NOT REJECT H_0
SINCE $F_0 < F(11, 59, .05)$

TEST OF POPULATION MEAN

$H_0: \mu_s = \mu_a$

$H_A: \mu_s > \mu_a$

REJECT H_0 IN FAVOR OF H_A
SINCE $t_0 > t(70, .10): 3.5 > 1.67$

REVIEW OF AREAS CLASSIFIED AS MISC., AND NONPRODUCTION AND DISCUSSIONS WITH OTHER DEPARTMENTS INDICATE THAT 79% AVAILABILITY FOR SCHEDULED WORK IS REASONABLE.

THEREFORE, WE CONCLUDE THAT THE ENGINEERS ARE BEING OVERSCHEDULED.

WHAT WAS THE IMPACT OF THE DIFFERENCE BETWEEN SCHEDULED AND ACTUAL HOURS EACH MONTH?

$168.4 \text{ HRS/MTH} \times 4 \text{ ENGR} \times (95.3 - 79)\% =$

110 HOURS/MONTH

CONCLUSION:



UNREALISTIC SCHEDULING IS A ROOT CAUSE AND RESULTS IN OVERSCHEDULING THE SECTION BY 110 HOURS/MONTH.

PROBLEM STATEMENT: 25% OF 1 AND 2 MONTH DURATION WORK REQUESTS ARE COMPLETED LATE WHICH EXCEEDS THE DEPARTMENT TARGET OF 10 %.

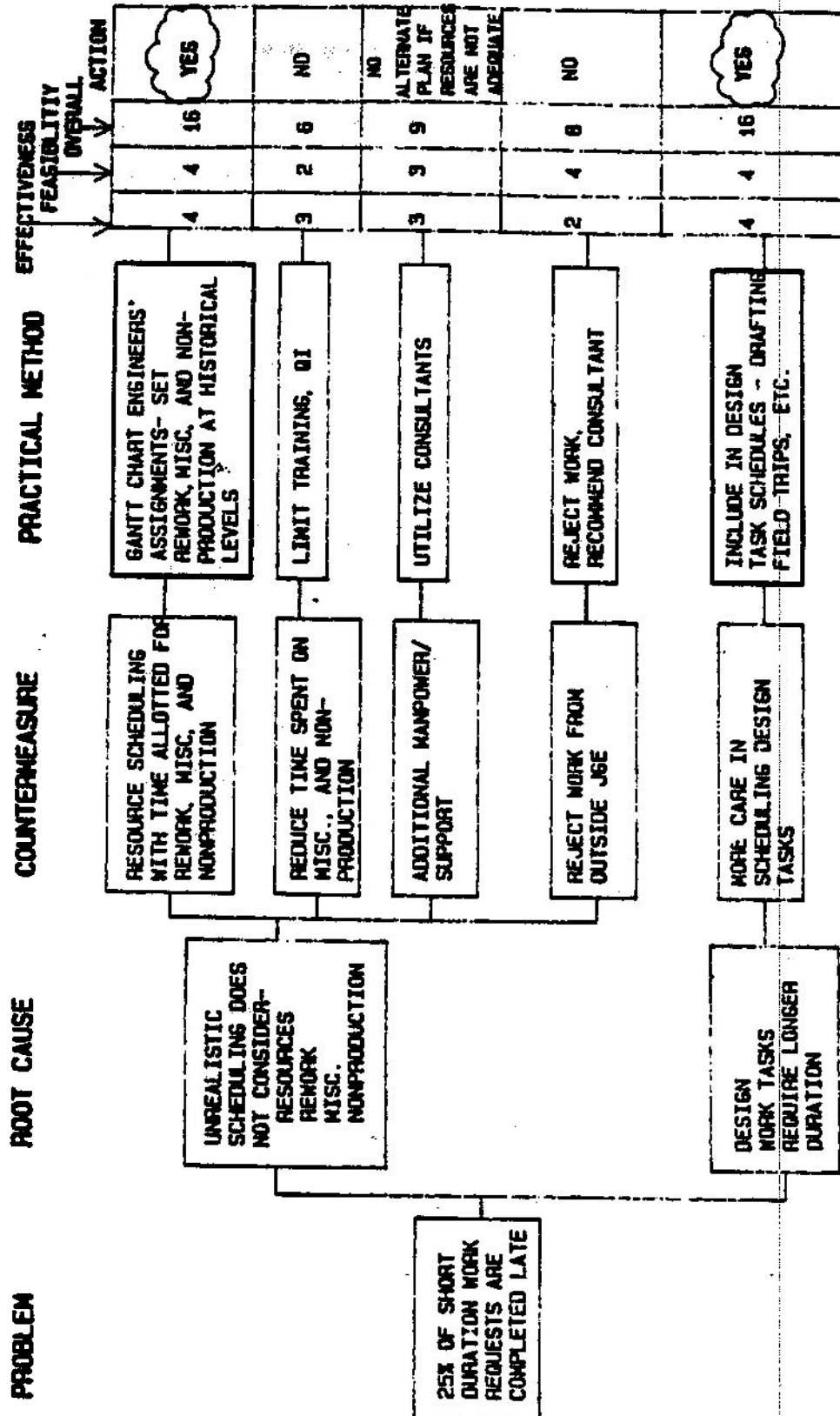
ROOT CAUSE EVALUATION SUMMARY

ROOT CAUSE	IMPACT
(A) ACTUAL HOURS > ESTIMATED HOURS	0 HOURS/MONTH
(B) COMPLEX WORK TASKS REQUIRE LONGER DURATIONS	DESIGN TASKS ACCOUNT FOR 51% OF LATE SHORT DURATION PROJECTS
(C) UNREALISTIC SCHEDULING - RESOURCES, NONPRODUCTION, MISC. AND REWORK NOT CONSIDERED	110 HOURS/MONTH



**MOST SIGNIFICANT
ROOT CAUSES**

4 COUNTERMEASURES



SCALE:
1 NONE
2 SOMEWHAT
3 MODERATE
4 VERY
5 EXTREME

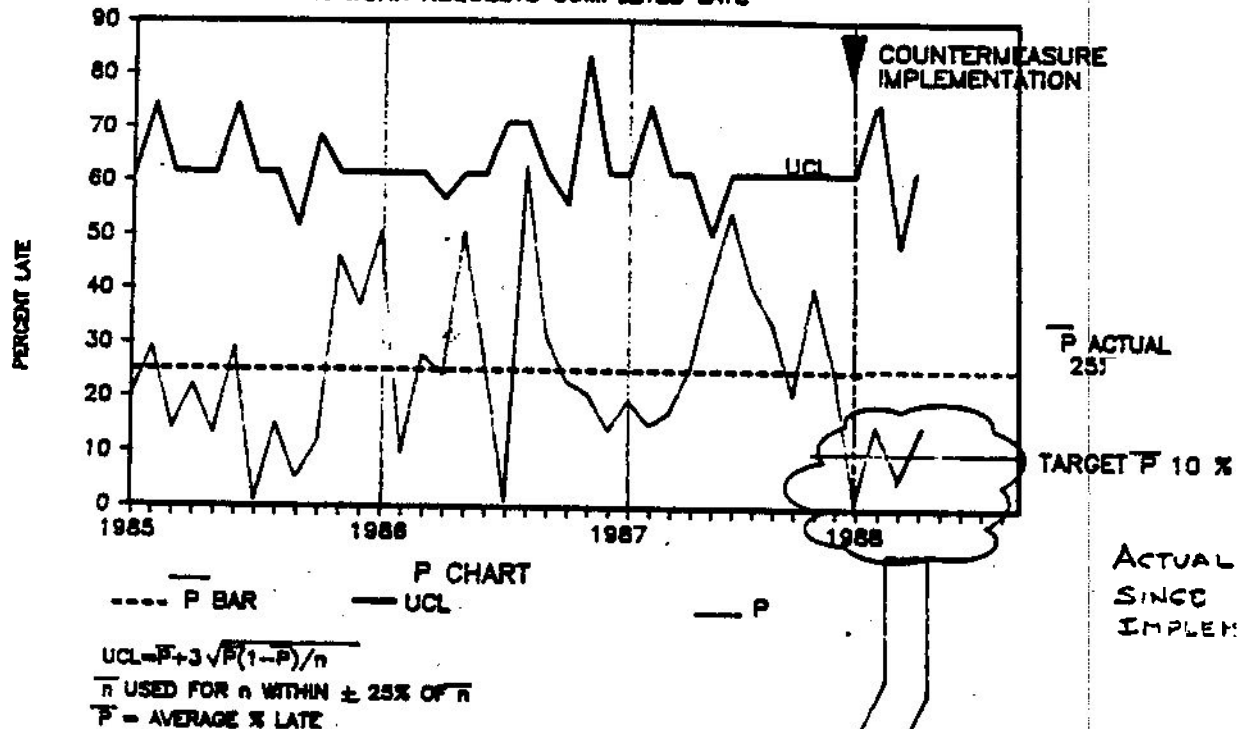
4 COUNTERMEASURES

COUNTERMEASURES	BARRIERS	AIDS
RESOURCE SCHEDULING WITH TIME ALLOTTED FOR REWORK, MISC, AND NONPRODUCTION	TIME CONSUMING FOR SUPERVISOR	MORE EFFECTIVE USE OF SUPERVISOR TIME
	ENGINEERS RESPOND TO CUSTOMER PRESSURE IN SETTING PRIORITIES	SCHEDULE TO BE VISIBLE TO BOTH SUPERVISOR AND ENGINEERS AND SHOW BOTH SCHEDULED AND ACTUAL
	SUPERVISOR UNAWARE OF CUSTOMER IDENTIFIED REWORK	ALL REWORK TO BE LOGGED THROUGH SUPERVISOR
	SUPERVISOR LOSES TRACK OF ACTUAL VS. SCHEDULED WHEN REPORTING ON A MONTHLY BASIS	SCHEDULE TO BE POSTED WITH ENGINEERS' ACTUAL HOURS ON A WEEKLY BASIS
MORE CARE IN SCHEDULING DESIGN TASKS	SCHEDULE DOES NOT MEET CUSTOMERS' REQUIREMENTS	ALLOWS CUSTOMER TO CONSIDER ALTERNATIVE PATHS IF WE ARE REALISTIC IN COMMITTING TO DUE DATES

ACTION PLAN

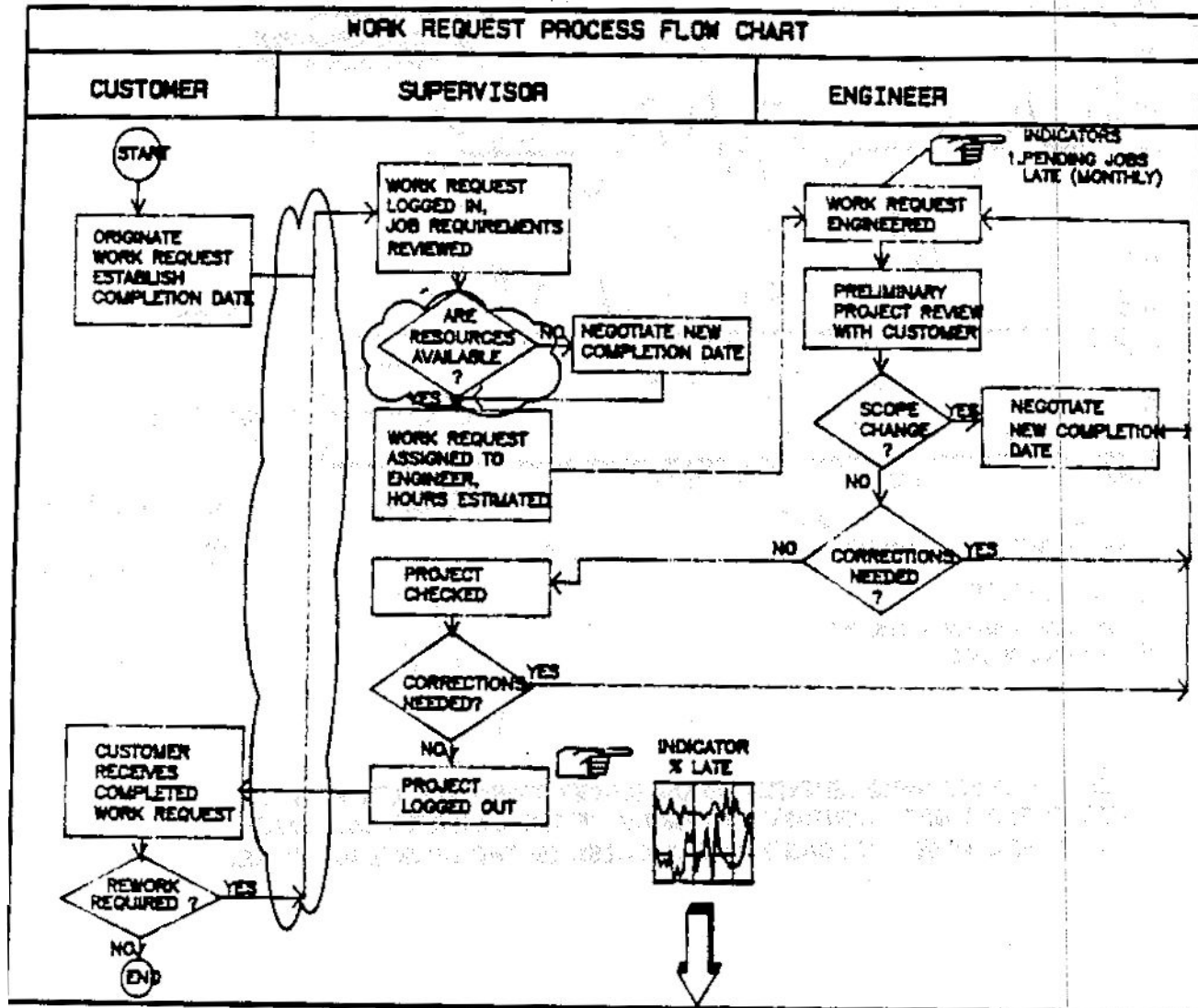
NO.	TASK/PROJECT	DUE DATE	ASSIGNEE	STATUS
1	A. DEVELOP RESOURCE SCHEDULE PROCEDURE	1/15/88	DB/BJ	COMPLETED 1/15/88
	B. IMPLEMENT RESOURCE SCHEDULING	1/1/88	DB	IMPLEMENTATION BEGAN 12/1/87
2	REVISE PROCESS FLOWCHART	2/1/88	BJ	COMPLETED 2/1/88
3	DEVELOP INDICATORS	2/1/88	DB/BJ	COMPLETED 1/18/88
4	EVALUATE CONSULTANTS	6/1/88	DB	

STRUCTURAL SECTION INDICATOR % WORK REQUESTS COMPLETED LATE



RESULTS SINCE IMPLEMENTATION SHOW SATISFACTORY RESULTS WITH THE TARGET BEING MET. CONTINUAL TRACKING OF THE INDICATOR WILL ALLOW US TO DETERMINE THE LONG RANGE SUCCESS OF THE COUNTERMEASURES.

WORK REQUEST PROCESS FLOW WAS MODIFIED TO INCLUDE RESOURCE SCHEDULING AND REWORK SCHEDULING.



TO BETTER MONITOR PERFORMANCE THE FOLLOWING DATA WILL BE TRACKED IN ADDITION TO PRIMARY INDICATOR ON % LATE:

DATA	FREQUENCY	RESPONSIBILITY
% NON PRODUCTION HOURS	MONTHLY	SUPERVISOR
ACTUAL HOURS VS. ESTIMATED	SEMI -ANNUALLY	" "
# DAYS EARLY/LATE	QUARTERLY	" "
DESIGN TASK DURATION	SEMI-ANNUALLY	" "

REMAINING PROBLEMS

1. SINCE COUNTERMEASURES COVERED NOT ONLY SHORT DURATION WORK REQUESTS BUT ALSO LONG DURATION, SCHEDULING PROBLEMS WITH ALL WORK REQUESTS WERE ADDRESSED.
3. INVESTIGATE LONG DURATION WORK REQUESTS TO DETERMINE IF THERE ARE OTHER ROOT CAUSES BESIDES SCHEDULING CAUSING THE HIGH % OF WORK REQUESTS COMPLETED LATE.
3. INVESTIGATE SETTING UP MORE INTERMEDIATE MILESTONES ON DESIGN TASKS TO AID IN TRACKING STATUS.

POCA TO LESSONS LEARNED

1. WHERE LARGE AMOUNTS OF DATA ARE AVAILABLE, AND MUCH SORTING AND DATA MANIPULATION IS REQUIRED DATA BASIS SHOULD BE COMPUTERIZED.
2. THE TECHNIQUES USED IN APPLICATION EXPERT COURSE ARE EXTREMELY HELPFUL IN ANALYZING DATA.