Teleflex INCORPORATED

Quality Management

Failure Modes & Effects and Hazard Analysis

QUICK CONNECT HELM (CABLE TO HELM)

~~HIGH-RATIO NO FEEDBACK STEERER~~

MARINE DIVISION

MARCH 5, 1990

A. Product Definition

Cable-to-Helm Connection System (Quick-Connect)

1. Performance Requirements

a). ABYC (P 17 Standard)

1). 2000 lb. Minimum Ultimate Tension and Compression Loads

2). 750 lb. Minimum Loading with no Loss or Change in Steering

3). Quick Connect Integrity

4). 67ft-lb Minimum Wheel Torque

b). Teleflex

1). 1200 lb. Minimum Loading with no Loss or Change in Steering

2). 100ft-lb Minimum Wheel Torque

3). 50,000 Minimum Tension and Compression Cycle Test

4). Impact Test

5). Integrity After Cycle Test (10 Connections New) Using 3 Different Cables with the Same Helm

6). Ease of Installation (Pull out; Installation Force)

7). Minimum Endplay

2. Intended Use

a). Installation---Turn Shaft to Pull Cable in Place (Until Fitting Snaps in Place)

b). Disassembly---Release Ring and Pull Cable with Hand Force or by Turning Shaft

3. Product Features

a). Patented Snap-in Connection

b). Installation Time Savings

c). Reduces Potential for Incorrect Installation

d). Reduces Warranty Claims and Scrap

C. Nonconformance Definition

1. Won't Assemble
2. Won't Lock
3. Separates
4. Excessive Backlash
5. Won't Disassemble
6. Excessive Wear
7. Corrosion
8. Partial Lock (or no Lock)
9. Defects from Handling (Packaging, Contamination, Storage)
10. No Redundancy for Spring
11. Component Fracture

Teleflex

POTENTIAL FAILURE MODE AND EFFECTS ANALYSIS (PROCESS FMEA)

PROCESS _____ OUTSIDE SUPPLIERS AFFECTED _____ ENGINEER Rick TONY BERNARD

PRIMARY PROCESS RESPONSIBILITY _____ MODEL YEAR/VEHICLE(S) _____ SECTION SUPERVISOR L. McGRATH

OTHER BMD(S)/PEO(S) INVOLVED _____ SCHEDULED PRODUCTION RELEASE _____ FMEA DATE (ORIG) _____ (REV) _____

PART NAME/ PART NUMBER	Design FUNCTION	POTENTIAL FAILURE MODE	POTENTIAL EFFECT(S) OF FAILURE	S/C	POTENTIAL CAUSE(S) OF FAILURE	EXISTING CONDITIONS: CURRENT CONTROLS	O	S	D	(R.P.N.) RISK PRIORITY NUMBER	RECOMMENDED ACTION(S) AND STATUS	RESULTING: ACTION(S) TAKEN	O	S	D	(R.P.N.) RISK PRIORITY NUMBER	RESPONSIBLE ACTIVITY
Latch Ring 3923410	Retains the Quick-Connect Steering Cable Ass'y at the Quick-Connect Conduit Fitting	Cracking; Shearing	Cable separates from helm		Material out of specification	Test to simulate cracking											
					• Low Density		2	9	2	36	Determine vendor capability						
					• Brittleness		2	9	2	36	Run tests						
					• Oversized I.D.		1	9	1	9							
					• Bad Sintering		1	9	1	9							
		Cracking	Won't Assemble		Misassembled at Installation		5	5	6	150							
					Excessive force at Installation		1	9	1	9							
					Part mishandled		1	9	1	9	Run Tests						
		Binding	" No Connection		Ring too thick		1	5	1	5							
					Contamination (Flash, field, grease)		4	5	6	120	Run Tests						
					Ring Assembled Backawards		1	5	1	5	Verify ring assembled backwards can fit in hsgs. Redesign ring to avoid.	Ring assembled backwards leaves ¼" gap between housings. Control by providing short screws that will prevent ass'y if ring is backward.					
					Corrosion		1	5	1	5	Grease fixture to provide detection						
					Warped		1	5	1	5							
		Wears	Excessive Play		Vibration		3	3	1	9	L-Drive Test						
					Undersized ring		1	3	1	3							
					Oversized groove		1	3	1	3							
					Low hardness		1	3	1	3							

Teleflex

POTENTIAL FAILURE MODE AND EFFECTS ANALYSIS (PROCESS FMEA)

PROCESS _____ OUTSIDE SUPPLIERS AFFECTED _____ ENGINEER _____

PRIMARY PROCESS RESPONSIBILITY _____ MODEL YEAR/VEHICLE(s) _____ SECTION SUPERVISOR _____

OTHER BMD(s)/PEO(s) INVOLVED _____ SCHEDULED PRODUCTION RELEASE _____ FMEA DATE: (ORIG) _____ (REV) _____

PART NAME/ PART NUMBER	Design FUNCTION	POTENTIAL FAILURE MODE	POTENTIAL EFFECT(S) OF FAILURE	S / C	POTENTIAL CAUSE(S) OF FAILURE	EXISTING CONDITIONS: CURRENT CONTROLS	EXISTING CONDITIONS: OCCURRENCE	EXISTING CONDITIONS: SEVERITY	EXISTING CONDITIONS: DETECTION	EXISTING CONDITIONS: (R P N) RISK PRIORITY NUMBER	RECOMMENDED ACTION(S) AND STATUS	RESULTING: ACTION(S) TAKEN	RESULTING: OCCURRENCE	RESULTING: SEVERITY	RESULTING: DETECTION	RESULTING: (R P N) RISK PRIORITY NUMBER	RESPONSIBLE ACTIVITY
Conduit Fitting, Quick-Connect 3923513	Joins the Quick-Connect steering cable Ass'y to the Quick-Connect helm	Cracking	Conduit Fitting separates from conduit		Seam in bar stock		2	9	1	18							
			Cable separation from helm		Hydrogen Embrittlement		1	9	1	9							
					Dayco "hit" too hard		2	9	1	18							
		Shearing	"		Lack of or improper radius*	Form Tool	1	9	1	9	Verify						
					Undersized root diameter*		2	9	2	36							
					Oversized I.D.*		3	9	2	54	*Check on Comparator and with gauges						
					Drill depth too deep		3	9	2	54							
					Improper location of undercut*		1	9	1	9							
		Won't lock	Won't Assemble		.150" Dimension oversized*		1	6	1	6							
			Will not stay assembled (Separates under slight load)		Contamination		1	6	1	6	Design special pigtail						
					Handling		1	6	1	6							
					Form & Diameter incorrect*		1	6	1	6							
		Partial locking	Cable separation from helm under load		.150" Dimension oversized		1	9	2	18							
					contamination		1	9	2	18							
					Handling		1	9	2	18							
					Form & Diameter incorrect		1	9	2	18							

Teleflex

POTENTIAL FAILURE MODE AND EFFECTS ANALYSIS (PROCESS FMEA)

PROCESS _____ OUTSIDE SUPPLIERS AFFECTED _____ ENGINEER _____

PRIMARY PROCESS RESPONSIBILITY _____ MODEL YEAR/VEHICLE(s) _____ SECTION SUPERVISOR _____

OTHER BMD(s)/PEO(s) INVOLVED _____ SCHEDULED PRODUCTION RELEASE _____ FMEA DATE (ORIG) _____ (REV) _____

PART NAME/ PART NUMBER	Design FUNCTION	POTENTIAL FAILURE MODE	POTENTIAL EFFECT(S) OF FAILURE	S / C	POTENTIAL CAUSE(S) OF FAILURE	EXISTING CONDITIONS: CURRENT CONTROLS	OCCURRENCE	SEVERITY	DETECTION	(R P N) RISK PRIORITY NUMBER	RECOMMENDED ACTION(S) AND STATUS	RESULTING: ACTION(S) TAKEN	OCCURRENCE	SEVERITY	DETECTION	(R P N) RISK PRIORITY NUMBER	RESPONSIBLE ACTIVITY
Conduit Fitting, Quick-Connect 3923513 (Cont.)		Partial locking	Cable separation from helm under load		Improper installation	Redundancy Feature	1	9	2	18							
					Incorrect Dayco "hit"		2	9	1	18							
		Wear	Excessive Play		Vibration		3	3	1	9							
					Total # cycles	Cycle Test	3	3	1	9	L-Drive Test						
					Excessive load		3	3	1	9							
					Material hardness		1	3	1	3							
Spring	Activates Latch Ring	Won't lock	Will not stay assembled		Weak spring	Pin Provides Redundancy	1	7	1	7							
					Short spring		1	7	2	14							
					Corrosion	"	1	7	2	14							
					Fatigue	"	1	7	1	7	L-Drive Test						
					Vibration												
					Burrs		1	7	1	7							
			Will not assemble		Long spring		1	7	1	7							
					Large coil O.D.		1	7	1	7							
		Partial lock	Cable separation from helm under load		Weak spring		1	9	1	9							
					Short spring		1	9	2	18							

Teleflex

POTENTIAL FAILURE MODE AND EFFECTS ANALYSIS (PROCESS FMEA)

PROCESS _____ OUTSIDE SUPPLIERS AFFECTED _____ ENGINEER _____
PRIMARY PROCESS RESPONSIBILITY _____ MODEL YEAR/VEHICLE(S) _____ SECTION SUPERVISOR _____
OTHER BMD(S)/PEO(S) INVOLVED _____ SCHEDULED PRODUCTION RELEASE _____ FMEA DATE: (ORIG) _____ (REV) _____

PART NAME/ PART NUMBER	Design FUNCTION	POTENTIAL FAILURE MODE	POTENTIAL EFFECT(S) OF FAILURE	S E V	POTENTIAL CAUSE(S) OF FAILURE	EXISTING CONDITIONS: CURRENT CONTROLS	O C C	SEV	DET	(R P N) RISK PRIORITY NUMBER	RECOMMENDED ACTION(S) AND STATUS	RESULTING: ACTION(S) TAKEN	O C C	SEV	DET	(R P N) RISK PRIORITY NUMBER	RESPONSIBLE ACTIVITY
Helm Wheel Hsg 3862513 Helm Gear Hsg 3862413	Contains Latch Ring, Spring, and Conduit Fitting	Fracture	Cable separation		Defective casting •Porosity •Cold shot •Warpage		2	9	1	18							
					Handling		2	9	1	18							
					Wrong Material		2	9	1	18							
					Die-shifting		2	9	2	36							
					Wrong Dimensions		1	9	2	18							
		Wear	Excessive backlash		Vibration		1	3	1	3	L-Drive Test						
			Hard to Disassemble		Excessive load		1	3	1	3							
					Total # cycles		1	3	1	3							
					Sharp edges on conduit fitting		1	3	1	3							
					Mat'l porosity		1	3	1	3							
					Contamination		2	3	2	12							
		Won't lock	Will not assemble		Warped castings		2	7	1	14	Evaluate Bolt Locations						
			Will not stay assembled		Die-shifting		2	7	1	14							
					Handling "dings"		2	7	1	14							
		Partial lock	"		Flash		2	9	2	36							
			Cable separation under load		Wrong dimensions		1	9	1	9							
					•Drawings •Tolerances •Conformance		1	9	1	9							

Teleflex

POTENTIAL FAILURE MODE AND EFFECTS ANALYSIS (PROCESS FMEA)

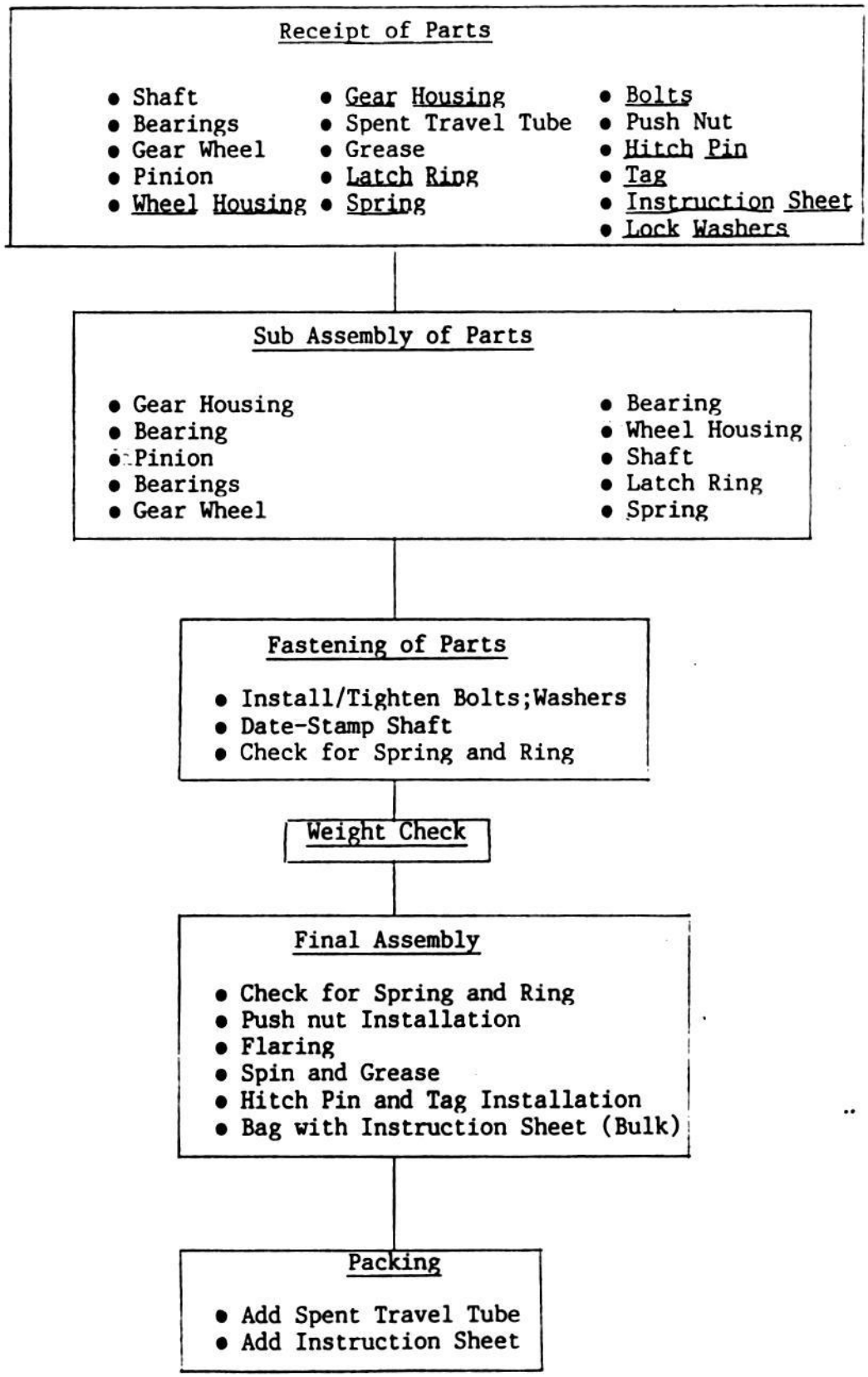
PROCESS _____ OUTSIDE SUPPLIERS AFFECTED _____ ENGINEER _____ Page ____ of ____

PRIMARY PROCESS RESPONSIBILITY _____ MODEL YEAR/VEHICLE(s) _____ SECTION SUPERVISOR _____

OTHER SMD(s)/PEO(s) INVOLVED _____ SCHEDULED PRODUCTION RELEASE _____ FMEA DATE: (ORIG) _____ (REV) _____

PART NAME/ PART NUMBER	Design FUNCTION	POTENTIAL FAILURE MODE	POTENTIAL EFFECT(S) OF FAILURE	S / C	POTENTIAL CAUSE(S) OF FAILURE	EXISTING CONDITIONS: CURRENT CONTROLS	EXISTING CONDITIONS: OCCURRENCE	EXISTING CONDITIONS: SEVERITY	EXISTING CONDITIONS: DETECTION	EXISTING CONDITIONS: (R P N) RISK PRIORITY NUMBER	RECOMMENDED ACTION(S) AND STATUS	RESULTING: ACTION(S) TAKEN	RESULTING: OCCURRENCE	RESULTING: SEVERITY	RESULTING: DETECTION	RESULTING: (R P N) RISK PRIORITY NUMBER	RESPONSIBLE ACTIVITY
Hitch Pin	•Confirms lock of Cable and Housing	Fracture	Pin comes out		Misuse		1	1	1	1							
			Pin stays in		"		1	1	1	1							
	•Disassembly Tool	Wear	Pin breaks		Vibration		1	7	1	7							
			•Stays in •Comes out				1	5	1	5							
		Deformed	Pin won't install		Handling		1	2	1	2							
					Wrong Part		2	2	1	4							
			Pin comes out		Handling		1	2	1	2							
					Wrong Part		1	2	1	2							
			Doesn't Confirm lock		Short length		1	2	1	2							
		Corrosion	Difficulty of insertion and removal		Service life		1	3	1	3							
					Severity of environment		1	3	1	3							
					Plating damage		1	3	1	3							

Helm Assembly Flow Chart



Teleflex

POTENTIAL FAILURE MODE AND EFFECTS ANALYSIS (PROCESS FMEA)

PROCESS HELM ASS'Y
PRIMARY PROCESS RESPONSIBILITY
OTHER BMO(s)/PEO(s) INVOLVED
OUTSIDE SUPPLIERS AFFECTED
MODEL YEAR/VEHICLE(s)
SCHEDULED PRODUCTION RELEASE
ENGINEER A. Bernard
SECTION SUPERVISOR
FMEA DATE (ORIG) (REV)

PART NAME/ PART NUMBER	PROCESS FUNCTION	POTENTIAL FAILURE MODE	POTENTIAL EFFECT(S) OF FAILURE	S/C	POTENTIAL CAUSE(S) OF FAILURE	EXISTING CONDITIONS: CURRENT CONTROLS	O	S	D	RPN	RECOMMENDED ACTION(S) AND STATUS	RESULTING: ACTION(S) TAKEN	O	S	D	RPN	RESPONSIBLE ACTIVITY
Sub Assy of Parts	Position Gear Hsg, Place in Components, Finish w/Wheel Hsg and Shaft	Latch Ring Omitted	Cable Won't Lock		•Operator Fails to Install		2	7	2	28	Provided 100% Inspection for Ring and Spring in Fixture	May be automated					
					•Part Falls Out		1	7	2	14							
		Spring Omitted	"		"		2	7	2	28	" "						
					"		2	7	2	28	" "						
		" . .	(Verified by Whether Hitch Pin Can be Installed)														
		Spring and Hitch Pin Omitted	Cable Separates From Helm		"		1	9	2	18							
					Customer Looses Hitch Pin		4	9	2	72							
		Latch Ring Installed Backwards	Cable Won't Assemble		Operator Installs Backwards		1	6	3	18							
		Two Springs Installed	"		Operator Doesn't Separate		2	6	3	36	Check if Possible						
Fastening of Parts	Installation and Tightening of Bolts/Lock washers And Date Stamp Shaft	Spigot Bolts Omitted	2 Bolts Separation Under Extreme Load (>1600 LB)		•Operator Fails to Install		1	9	4	36							
					•Customer Removes		2	9	8	144							
			1 Bolt Separation Under Extreme Load (>1900 LB)		"		2	9	4	72							
					"		3	9	8	216							
		Lock Washer Omitted	Possible Loosening by Vibration		"		1	7	4	28							
					"		3	7	8	168							

Teleflex

POTENTIAL FAILURE MODE AND EFFECTS ANALYSIS (PROCESS FMEA)

PROCESS HELM ASS'Y
PRIMARY PROCESS RESPONSIBILITY
OTHER SMD(s)/PEO(s) INVOLVED
OUTSIDE SUPPLIERS AFFECTED
MODEL YEAR/VEHICLE(s)
SCHEDULED PRODUCTION RELEASE
ENGINEER A BERNARD AUB
SECTION SUPERVISOR
FMEA DATE: (ORIG) (REV)

PART NAME/ PART NUMBER	PROCESS FUNCTION	POTENTIAL FAILURE MODE	POTENTIAL EFFECT(S) OF FAILURE	▼ ▽	POTENTIAL CAUSE(S) OF FAILURE	EXISTING CONDITIONS: CURRENT CONTROLS	OCCURRENCE	SEVERITY	DETECTION	(R P N) RISK PRIORITY NUMBER	RECOMMENDED ACTION(S) AND STATUS	RESULTING: ACTION(S) TAKEN	OCCURRENCE	SEVERITY	DETECTION	(R P N) RISK PRIORITY NUMBER	RESPONSIBLE ACTIVITY
Final Assembly	Installation of Push Nut, Flaring End of Shaft, Spin and Grease, Hitch Pin and Tag Installation, And Bagging the Assembly with Instruction Sheet	Hitch Pin Omitted	Loss of Redundancy		Operator Fails to Install		2	4	4	32							
			Loss of Instruct. Tag														
		Tag Omitted	Cable Won't Install		•Hitch Pin Omitted		2	6	4	48							
					•Operator Omission		2	3	8	48							
		"	Helm Damage		Customer Improper Installation		5	5	8	200							
		Hitch Pin Partially Installed	Loss of Redundancy		Assembler Fails to Insert all way		1	2	1	2							
		Hitch Pin Upside Down					1	2	1	2							
		Incorrect Instruction Sheet			•Operator Fails to Install Inst. Sht.		2	3	4	24							
		• w/Tag	None		•Inst. Sht. Not Delivered to Operator		1	3	4	12							
		• w/o Tag	Won't Dissassemble				1	4	4	16							

Teleflex Incorporated
Quality Management

Hazard Analysis

Project Description: High Ratio/No Feedback Steerer

Date: 2/27/90 | Page: 1 of 1

Revision Date:

Engineer: A.C. Bernard

Hazard	Cause	Effects	Severity	Occurence	Crit. Index	Remarks
Hand Slippage						
• Installation	• Poor Grip • Excessive Force	Cuts	5	2	10	
• Disconnection	• Poor Grip • Excessive Force	Cuts	5	2	10	
Loss of Steering	• Pin Not Removed Before Cable Installed	Property Damage and/or Personal Injury	9	2	18	Identification Ring on Conduit Fitting Will Show If Proper Connection is Made
	• Cable Not Locked In and Cable Inserts	Property Damage and/or Personal Injury	9	2	18	" " "
Helm Damage Due to Dismantling	Hitch Pin Missing	Extreme Inconvenience	4	2	8	
Contamination	• Customer Caused	Property Damage and/or Personal Injury	9	5	45	Protective Sleeve For Conduit Fitting/Tail
	• Environment Caused	Property Damage and/or Personal Injury	9	5	45	" " "

Printed in U.S.A.

9 STRONG CORRELATION

3 MEDIUM CORRELATION

1 SMALL CORRELATION

TELEFLEX MARINE

HIGH-RATIO/NO FEEDBACK STEERER

3-6-90

QUALITY CHARACTERISTICS

ITEM NUMBER

DEGREE OF IMPORTANCE

DESIGN REQUIREMENTS

		TARGETS	%	Cam Wedge: Dog 1 Dimensions	Dog 2 Surface Finish	Spng 3 Dimensions	Spng 4 Material	Roller 5 Dimensions	Roller 6 Material	Roller 7 Surface Finish	Rvt 8 Dimensions	Rvt 9 Material	Housings: Upper 10 Dimensions	Upper 11 Surface Finish	Upper 12 No Draft	Upper 13 Mating Fit	Lower 14 Dimensions	Lower 15 Surface Finish	Lower 16	Lower 17 Mating Fit	Center 18 Dimensions	Center 19 Surface Finish	Center 20	Center 21 Mating Fit	Back Ring 22 Dimensions	Back Ring 23 Material	Pinion 24 Dimensions	Pinion 25 Mating Fit	Pinion 26 Handling Damage
	Cam Wedge S/A	TFX:ABYC	23.8	3	3	1	9	9	3	3	3	3	3	3	9												3	9	3
	Gear Ratio	TFX S/C	3.0																								9		
	Optimum Fit	Rack Bklash	12.2	9	1	1		1			1		9			9	9			9	9			9	9		9	9	9
	Cable Connection	ABYC Mech.	9.8										9			9	9			9	9			9					
	2 Cable Hsg Adapt.	>Safe-T	1.0																		9			9					
	SSC 72 Adapter	Patent	3.6										9			9	9			9	9			9					
	Capt. Cable Mtg Nut	20 lb Pull	2.7										9			9													
	Non-Catast.Failure	ABYC/TFX	2.4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Cycle Life	50K Min.	1.6	1		1		1			1		1				1				1				3	3	1		
	System Strength	ABYC/TFX	2.3													3				3				3			3		
	Feedback Loads	300 lb/100	2.5	3	3	3	3	3	3	3	3	3	3	3	3												3	3	3
	Std Mfg Process	Exist Equip	4.2								1		3				3								3	3			
	Assy Tooling	QC Fixtures	5.2	9		9		9			9	9	9			3	9			3	9			3	9		9	3	

SKETCH

VALUE WEIGHTS																													
	ABSOLUTE																												
	RELATIVE	%	4	4.5	4.6	3.6	4.7	1.3	4.3	2.3	2.1	6.7	1.3	3.8	4.6	4.8	0.1	—	4	5	0.1	—	4.4	3	0.3	4.1	6	5.2	3
	RANKING		10	30	29	12	5	31	31	19	24	1	31	11	6	3	42	—	9	3	42	—	7	17	39	7	2	13	1

TARGET VALUES

U=Upper N=Nut H=Hsg. Bolt
L=Lower W=Washer W=Wheel Bolt
H=Helix S=Staking
I=Idler

ART # 2

Gears								Bearings				Shaft				FSTNR			Spent Travel Tube								
dler		Helm			Dual			U	L	H	I			N	W	H	W	S									
Mating Fit	Handling Damage	Dimensions	Mating Fit	Handling Damage	Dimensions	Mating Fit	Handling Damage	Dimensions	Dimensions	Dimensions	Dimensions	Dimensions	Material	Specifications	Specifications	Specifications	Specifications	Retention Force	Mating Fit								
28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
								1				1															
		9			9																						
9	9	9	9	9	9	9	9	3	3	3	3	9			1	3	3		1								
																9		3									
												9				1											
																9		3									
																3		9									
	1	1	1	1	1	1	1						1	1		1	1										
		1			1			3	3	3	3																
			3			3																					
		9	3		9	3												9									
[illegible]	3.1	2.2	1.8	3.1	2.2	1.8	1.1	0.7	0.7	0.7	2.5	0.1	0.1	0.2	2.8	1.6	1.8	0.2									
5	14	21	25	14	21	25	34	35	35	35	19	42	42	40	18	38	25	40									

MARR - 1 1990

NO FEEDBACK MECH. STEERING

COMPUTER FILE: HOUSE

PRODUCT PLANNING MATRIX

9 – ◎ STRONG RELATIONSHIP

3 – ○ MEDIUM RELATIONSHIP

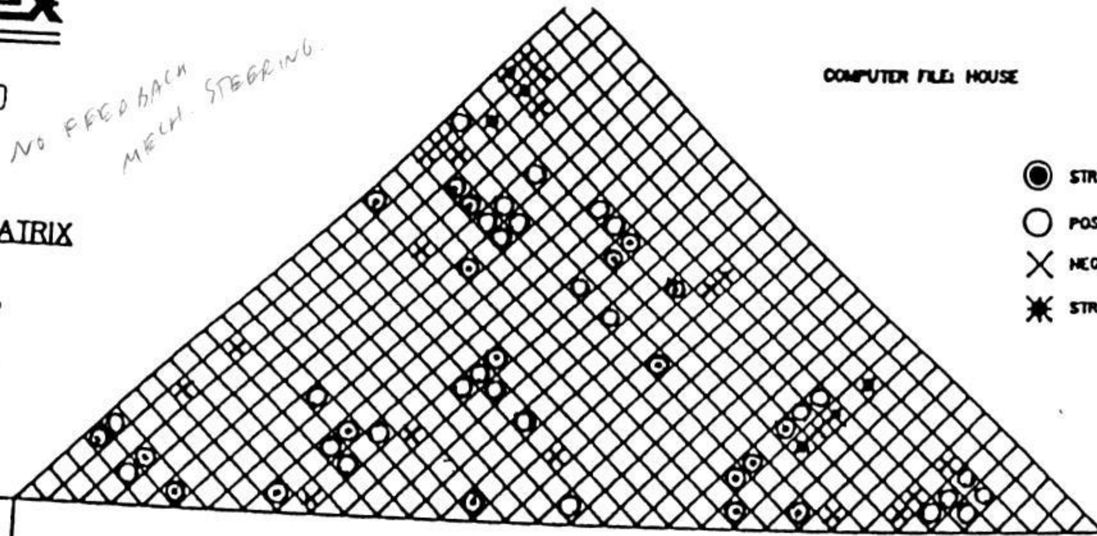
1 – △ SMALL RELATIONSHIP

◉ STRONG POSITIVE RELATIONSHIP

○ POSITIVE RELATIONSHIP

╳ NEGATIVE RELATIONSHIP

✱ STRONG NEGATIVE RELATIONSHIP



PRODUCT DESIGN REQUIREMENTS

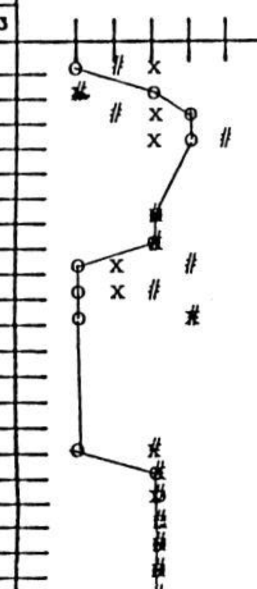
MARKET QUALITY REQUIREMENTS (PRIMARY / SECONDARY / TERTIARY)

DEGREE OF IMPORTANCE: 5=VERY IMPORTANT, 1=SLIGHT IMPORTANCE; ITEM NUMBER

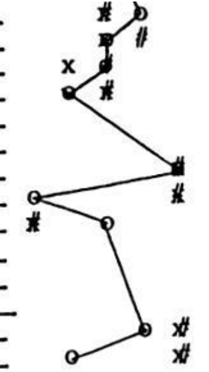
Primary	Tertiary	Importance	1 Cam Wedge S/A	2 Gear Ratio	3 Bearings	4 Lubrication	5 Optimum Fit	6 Shaft Support	7 Shaft Configuration	8 Safe-T Mounting	9 Safe-T Envelope Fit	10 Cable Connection	11 Easy Bolt Alignment	12 Size	13 Safe-T Bezel	14 2 Cable Hsg. Adapt.	15 Adapter for SSC 72	16 No Field Helm Conv.	17 No Adjustments	18 Instruction Sheets	19 Needs Nc Special Tools	20 Captive Cable Mtg.Nut	21 Materials	22 Redundant Shaft Ret.	23 Non-Catastrophic Fail	24 Cycle Life	25 System Strength	26 Feedback Loads	27 Std. Mfg. Process	28 Design Simplicity(MFG)	29 Ass'y Tooling	30 Line Flow Assembly	31 Modular Packaging	32	33
PERF.	Easy Steering	5		9	3	1													1									3							
	No Feedback	5	9				3	3																				9		3					
	Smooth Feel	3			3	1	9																						1	1	3				
	Minimum Slop	3		9			9	3				3							1							3			1	1	1				
INSTALL.	Easy Wheel Align.	1							9											3	3				3					1					
	Std. Mounting	3						1		9	9		1		9					3	3						1						1		
	Dash Size Compatab.	5								3	9			9	3																				
	Easy Installation	3								9		3	9	3	3	3				9	9	3													
	Light Weight	3	3	9										9		3							9												
	Fast Installation	3	3						3	3		3	3	1	3				3	3	9	3											1		
P...	Tilt Unit Compatab.	3							9	9																							3		
	Attractive Bezel	3								9					9								3						3	3					
	20/90° Units	5								9					9															3			1		
	2 Cable Capability	5										9				9					3	3								3					
	Cable Interchange.	1															9				3	3						1							
	Helm "	1								9		9					9																1		

o Okoboji
x TFX Rack
TFX'Rotary

1 WORSE | 2 | 3 SAME | 4 | 5 BETTER

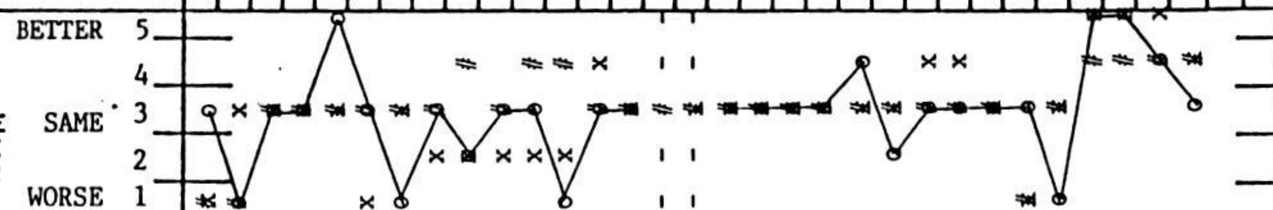


			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
L.	[illegible]viceability	3							3			9	3						9		9	3													
	Corrosion Resist.	1				1																	9		9										
	Reliability/Safety	5	9	1		3	3					9						9	9	3	3			9	9	9	9			1	3				
MRTG.	Availability	3								3							3												3	1	3	3	3		
	Competitive Low Cost	3	3	3																			9							3		9			
	Patentability	5	9														9																		
MFRG.	Ease of Ass'y	3	9	9		1	9																							9	9	9	9		
	Ease of Manufacture	3	3	3			9															3	3						9	9					
DEGREE OF TECHNICAL DIFFICULTY 1-5			5	1	1	1	5	1	1	1	1	3	1	1	1	1	3	1	1	1	1	3	1	1	1	1	1	1	5	1	5	1	1		
OBJECTIVE TARGET VALUES																																			



o=Okoboji
x =TFX Rack
# =TFX Rotary

TECHNICAL COMPETITIVE BENCHMARK EVALUATION



			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
NUMBER SERVICE REPAIRS																																			
COST OF SERVICE REPAIRS																																			
IMPORTANT CONTROL ITEMS	ABYC (MECH.)	5										9													9		9								
	ABYC (DIM.)	5							9						9																				
	TFX (STRENGTH)	5	9	3																			9		9		9	9							
	TFX (CYCLE)	5	9	3																						9		9							
VALUE WEIGHTS	ABSOLUTE		288	179	33	36	147	27	99	195	72	198	48	84	177	63	72	72	89	63	126	54	135	45	147	99	138	151	51	132	63	63	56		
	RELATIVE TO S/C		1440	179	33	36	735	27	99	195	72	594	48	84	177	63	216	72	89	63	126	162	135	45	147	99	138	151	255	132	315	63	56		
	RANKING		1	8	30	29	2	31	17	7	21	3	27	20	9	23	6	21	19	23	16	10	14	28	12	17	13	11	5	15	4	23	26		

X TECH DIFFICULTY

TELEFLEX/TFX MARINE
FMEA1 - TT Cylinder
Filename: FMEA\FMEA1_1.wk1

25-Feb-90

Options Described Below
Weighted Effect of Options on Customer Wants
+ = Favorable Effect; - = Unfav, thru 5.3 Only

Customer Wants	IMPORT	OPTION 1	OPTION 2	OPTION 3	OPTION 4	OPTION 5	OPTION 6	OPTION 7	OPTION 8	OPTION 9
5.1 Performance Related										
a.) Cycles	5	0	10	5	0	10	0	0	0	5
b.) Output load	5	0	10	5	0	5	0	0	0	5
c.) Environmental Res.	5	0	10	0	10	0	0	0	0	10
d.) No "red" fluid	5	0	10	10	10	10	0	0	5	5
e.) No leaks	5	0	10	5	0	0	0	0	5	5
f.) Long life	3	0	6	3	3	3	0	0	3	3
g.) Dependable	3	0	6	3	3	3	0	0	3	3
h.) Dependable sender	3	0	6	0	0	-6	6	6	0	0
i.) Simple service	1	0	-1	0	0	0	0	-1	0	0
j.) Accurate sender	3	0	6	0	0	-6	6	6	0	0
5.2 Design Features										
a.) Dual cylinder cap.	3	0	0	0	0	0	0	0	0	0
b.) Transom adapt.	3	0	0	0	0	6	0	0	0	0
c.) Connect ftg option	1	0	2	0	0	2	0	0	-2	0
d.) Interchangeable	1	0	0	0	0	0	0	0	0	0
e.) Simple/fast instal.	5	0	0	0	0	0	0	-5	0	0
f.) Sender option	5	0	-10	0	-5	0	0	-10	0	0
5.3 Marketing Features										
a.) Appearance	3	0	6	0	6	0	3	6	0	0
b.) Cost competitive	5	0	-10	-5	-5	10	5	10	0	-5
c.) Min. inventory	1	0	-2	0	0	1	0	-2	0	0
d.) Simple assembly	3	0	-6	-3	-6	0	3	-6	-3	0
e.) Incr. sales/profits	5	0	10	10	10	10	10	10	5	5
f.) Incr. mkt share	3	0	6	6	6	6	6	6	3	3
g.) Availability	3	0	0	0	0	0	0	0	0	0
h.) Longer warranty	1	0	0	0	0	0	0	0	0	0
			1	3	6	2	3	7	8	3 — RANKING NET
NET Total:		0	69	39	32	54	39	20	19	39
+			98	47	48	66	39	44	24	44
−			29	8	10	12	0	24	5	5
5.4 Impact (Costs, etc.)			8	4	6	5	1	7	2	2 — RANKING NEG.
a.) Capital outlay-max $K		0	140	15	30	70	50	60	2	10
b.) Payback time		0	?	?	?	?	?	?	?	?
c.) Lead time (months)		0	12	3	4	12	9	9	4	3
d.) Change in mtl cost $		0	1	0.3	1	0	-0.5	-0.5	0	1
e.) Change in ass'y cost		0	+aa	+a	+a	0	0	+a	+a	+a
f.) Change in labor var.		0	-b	-b	-b	-b	-b	-b	-b	-b
g.) Change in rework cost		0	-c	-c	-c	-c	-c	-c	-c	-c
h.) Change in warranty		0	-d	-d	-d	-d	-d	-d	-d	-d
i.) Change in profits		0	+ee	+ee	+ee	+ee	+e	+e	+e	+e

Note - $1.00 change in material unit cost for Option 2 based on $1.50 more w/o sender (80% of mix) and $3.50 less with sender (20%) of mix; times 2 cylinders per system. Also, +aa is more of an impact than +a, etc.

- o Option 1 - Do nothing
- o Option 2 - New cylinder per SK
- o Option 3 - Two "O" rings on existing cyl.
- o Option 4 - Add outer skirt/boot to exist.
- o Option 5 - Invert cylinder
- o Option 6 - Re-design external sender
- o Option 7 - Use int. sender with exist. cyl
- o Option 8 - Use compression ftgs on exist.
- o Option 9 - Change material on existing cyl.