

# FTA를 이용한 껌 자동포장기계 故障의 體系的 分析 - A Systemetic Analysis of Gum Electro Automatic Overwrapping Machine Using FTA -

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## ABSTRACT

This paper performs a systematic analysis for failures in gum electro automatic overwrapping machines using FTA technique. Data for failures which occurred from January, 1978 to June, 1983 are collected from machinery maintenance department at L. Confectionery Co. Ltd. In order to analyse them, COBOL computer program is performed because of a lot of time and effort. The minimal cut sets of the system failures are obtained from computer program. Through a set of analyses, the critical basic failures are found out.

### I. 序 論

本 研究의 目的은 FTA技法을 利用하여 껌 自動 包裝機械의 故障原因을 體系的으로 分析하여 主要 故障原因을 찾아 내고자 하는 데 있다.

FTA技法은 複雜하고 大型化 된 시스템의 信賴性 分析 및 安全性 分析에 널리 利用되고 있는 技法으로, 1961年 Bell 전화 研究所의 Watson이 Minuteman Launch Control System의 安全性을 評價 分析할 때 처음 사용하였다.<sup>(1)</sup> 그 후 Boeing社의 分析者들은 디지털 컴퓨터를 사용하여 分析이 가능한 定量的인 면에서 이 技法을 발 見시켰다.<sup>(3)</sup> 1965年 安全性 심포지움에서 Hassl<sup>(5)</sup>을 비롯한 많은 사람들이 FTA技法을 航空學, 原子力 工學 등 다른 여러 分野의 信賴性 分析과 安全性 分析에 適用하였으며, 이에 대한 研究가 활발히 進行되고 있다.<sup>(4)</sup> 또한 FT作成에 대한 一般의인 概念이 Hassl<sup>(5)</sup>에 의하여 論하여 졌고,

Fussell<sup>(3)(4)</sup>은 전기 시스템에 대해서, Powers<sup>(7)</sup>는 화학공정 시스템에 대한 규칙적이고 연역적인 기법을 공식화하였다.

FTA技法을 利用하여 複雜한 시스템을 分析한 으으로써 다음과 같은 效果를 얻을 수 있다.

- (1) 시스템의 故障을 연역적으로 추적해 감으로써 故障의 形態를 系統的으로 알 수 있다.
- (2) 시스템의 故障을 도해적으로 나타냄으로써 시스템의 構造를 잘 理解할 수 있다.
- (3) FTA技法을 전산화 함으로써 信賴性 分析에 필요한 많은 時間과 努力을 절약할 수 있다.
- (4) 全體 시스템에 영향을 미치는 要因을 쉽게 찾을 수 있고 그에 대한 措置를 取함으로써 效果的으로 信賴性을 向上시킬 수 있다.

本 研究에서는, 껌 自動包裝機械에서 발생하는 各種 故障形態를 조사 분류하여 FT를 作成하였다. 作成된 FT를 分析하기 위해 컴퓨터 프로그램으로

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전산처리 하였고, 그 결과를 분석하여 시스템 故障에 중요한 영향을 미치는 故障要因들을 찾아 내었다.

II. 컴 自動包裝機械의 故障 分析

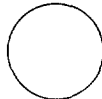
II-1. FTA의 事象 記號와 論理 게이트

(1) 事象 記號

① 직사각형 ( Rectangle ) : 시스템 分析에 있어서 좀 더 展開되어야 할 事象



Events to be developed further



Basic Events



Inconsequential Events, or, Insufficient Data to Develop



Triangle-in



Triangle-out

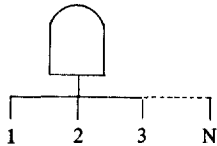
Fig. 1. Events Symbols for Fault Tree Analysis.

(2) 論理게이트

① AND Gate : 出力事象 F가 일어나기 위해서는 入力事象이 모두 일어나야 한다.

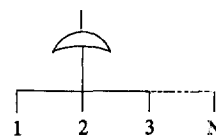
② OR Gate : 出力事象 F가 일어나기 위해서는 入力事象 中 적어도 하나가 일어나야 한다.

Output Event F



"AND" Gate

Output Event F



"OR" Gate

Fig. 2. Logic Gates for Fault Tree Analysis.

II-2. 껌自動包裝機械의 構造

껌 自動包裝機械는 一次 原料를 配合하여 製造한 片 모양의 껌을 한 枚씩 절단한 後 銀紙와 상표표 지로 內包裝을 하고, 소정의 枚數 ( 5, 6, 7, 8枚) 를 셀로 銀종이로 外包裝을 하여 芳香, 防濕을 위 한 왁스 沾착을 하는 高速 自動包裝機械로서 크게 7개 부문으로 分類된다.

- (1) Breaker Section
- (2) Silver Paper Flow Section
- (3) Inner Turret Section
- (4) Label Flow Section

- (5) Gear Box Section
- (6) Cellophane Silver Paper Flow Section
- (7) AMP and Electric Section

II-3. 껌自動包裝機械의 FT

L製菓株式會社의 기계 정비실의 故障 修理 現況 資料를 이용하여 모든 故障形態를 연역적으로 調查한 結果, 基本 故障은 171개였고, 이를 토대로 하여 作成한 껌 自動包裝機械의 FT를 Figure 3에 나타내었다. 또한 各 基本 故障에 대한 故障率과 分類코드는 Table 1에 나타나 있다.

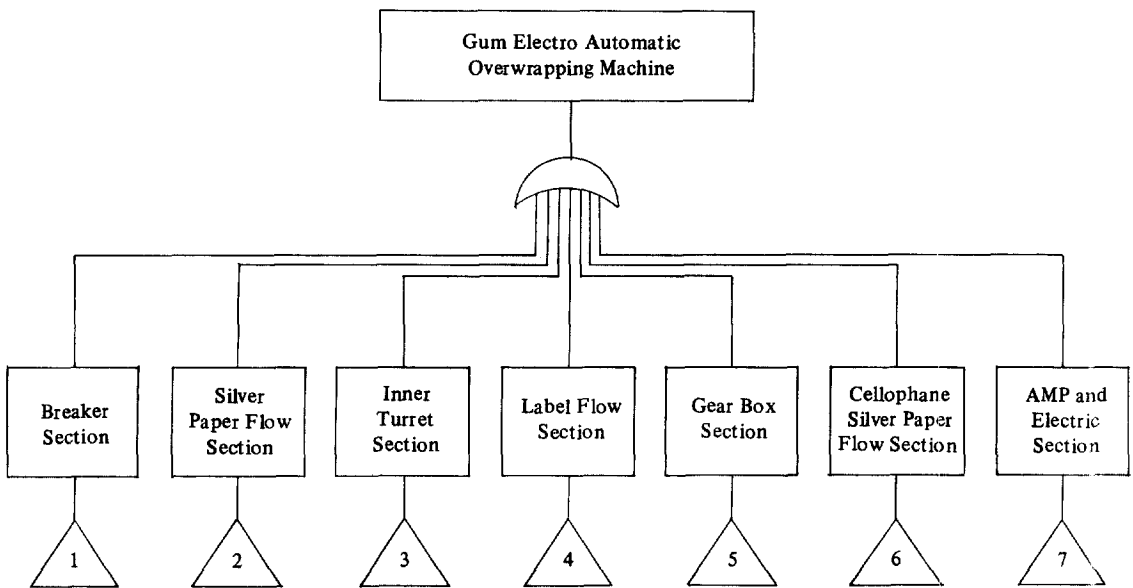
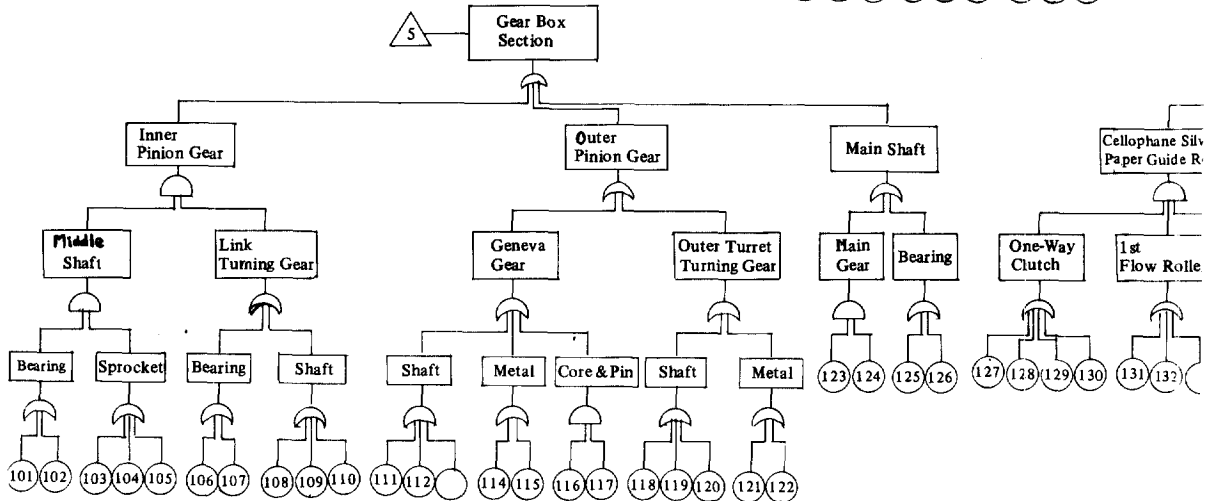
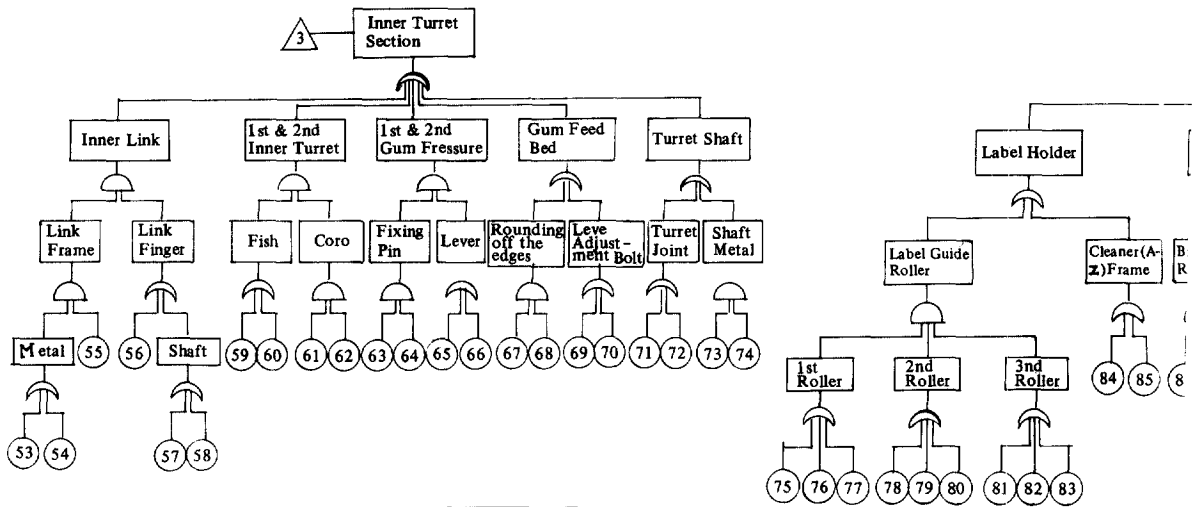
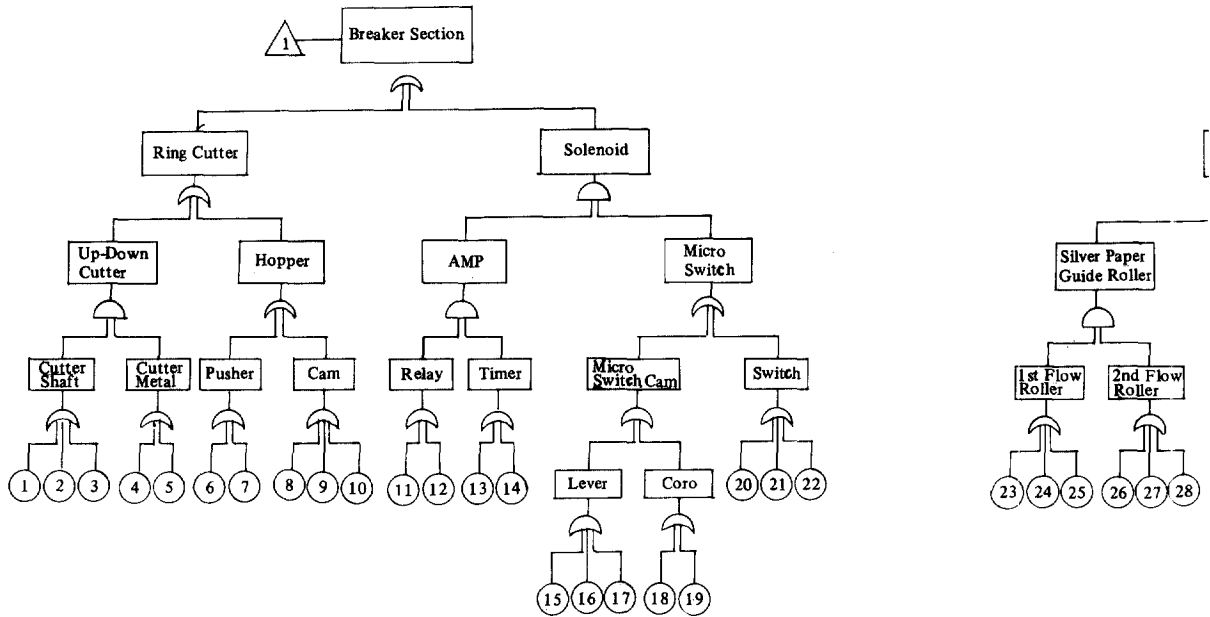
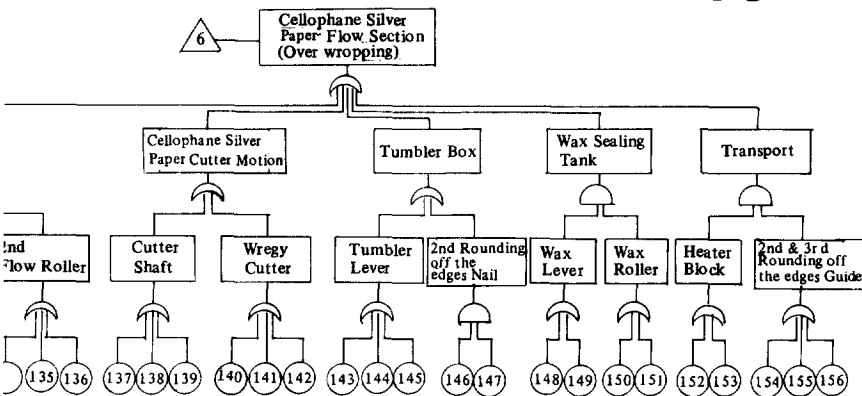
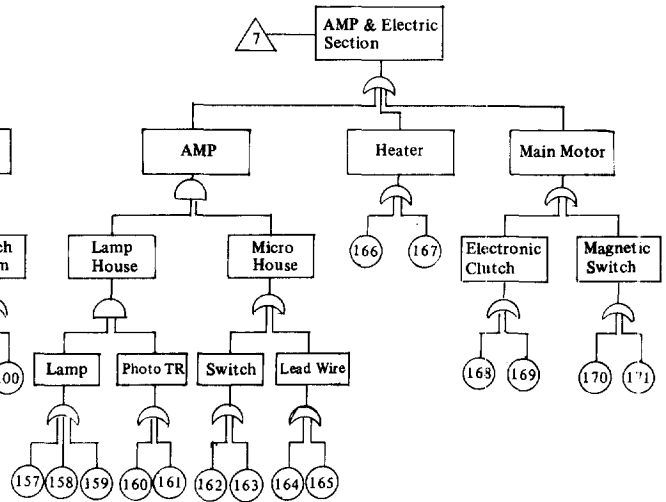
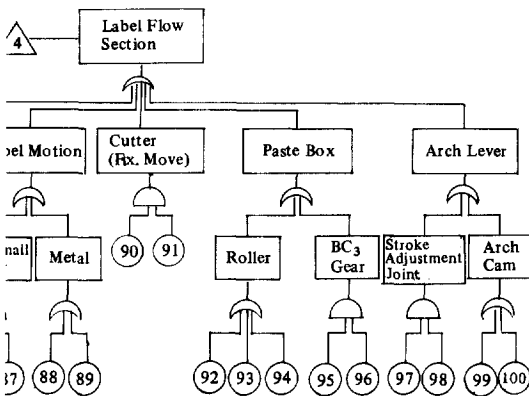
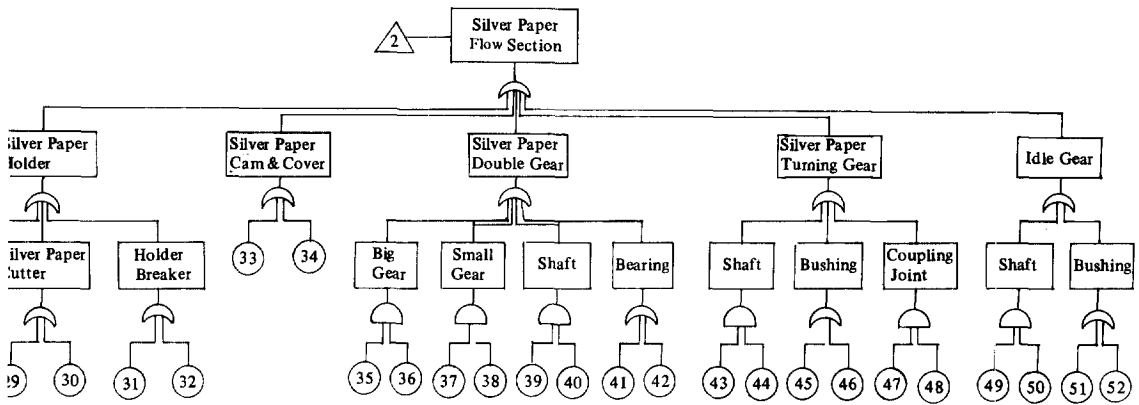


Fig. 3. Fault Tree of Gum Electro Automatic Overwrapping Machine





**[Table 1] Basic Events & Codes**

**(1) Breaker Section**

Subsystem	Code	Contents	Failure Rate ( $\lambda$ )
Breaker Cutter Shaft Failure	001	Wear	$2.0 \times 10^{-4}$
	002	Assembly Fault	$1.0 \times 10^{-4}$
	003	Oiling and Cleaning Fault	$1.1 \times 10^{-3}$
Cutter Shaft Metal Failure	004	Wear	$4.2 \times 10^{-5}$
	005	Oiling Fault	$6.6 \times 10^{-4}$
Hopper Pusher Failure	006	Bending	$1.1 \times 10^{-4}$
	007	Stroke Fault	$2.4 \times 10^{-3}$
Breaker Pusher Cam Failure	008	Wear	$2.8 \times 10^{-4}$
	009	Timing Fault	$3.5 \times 10^{-3}$
	010	Broken	$3.6 \times 10^{-4}$
Solenoid Relay Failure	011	Contact Point Broken	$1.6 \times 10^{-3}$
	012	Setting Fault	$2.7 \times 10^{-3}$
Solenoid Timer Failure	013	TR Out Fault	$4.8 \times 10^{-4}$
	014	Setting Fault	$2.1 \times 10^{-3}$
Micro Switch Cam Lever Failure	015	Broken and Wear	$6.0 \times 10^{-4}$
	016	Position Fault by Gap	$3.2 \times 10^{-3}$
	017	Cleaning Fault	$2.5 \times 10^{-3}$
Micro Switch Cam Coro Failure	018	Wear	$6.2 \times 10^{-4}$
	019	Position Fault by Gap	$1.6 \times 10^{-3}$
Micro Switch Failure	020	Lead Wire Fault	$2.9 \times 10^{-4}$
	021	Switch Broken	$6.5 \times 10^{-4}$
	022	Switch Contact Point Broken	$1.2 \times 10^{-3}$

**(2) Silver Paper Flow Section**

Silver Paper 1st Flow Roller Failure	023	Broken	$2.3 \times 10^{-3}$
	024	Roller Press Irregularity	$5.7 \times 10^{-3}$
	025	Wear	$1.3 \times 10^{-3}$
Silver Paper 2nd Flow Roller Failure	026	Broken	$2.9 \times 10^{-3}$
	027	Roller Press Irregularity	$4.6 \times 10^{-3}$
	028	Wear	$1.5 \times 10^{-3}$
Silver Paper Cutter Failure	029	Wear	$7.8 \times 10^{-4}$
	030	Broken	$2.3 \times 10^{-4}$
Holder Breaker Failure	031	Breaker Leather Wear	$3.1 \times 10^{-4}$
	032	Breaker Press Irregularity	$3.1 \times 10^{-3}$

**Table 1. Continued**

Subsystem	Code	Contents	Failure Rate
Silver Paper Cam and Cover Failure	033	Broken	$1.8 \times 10^{-4}$
	034	Cam Timing Fault	$1.5 \times 10^{-3}$
Silver Paper Double Big Gear Failure	035	Broken	$3.9 \times 10^{-3}$
	036	Wear	$3.6 \times 10^{-3}$
Silver Paper Double Small Gear Failure	037	Broken	$3.3 \times 10^{-3}$
	038	Wear	$2.7 \times 10^{-3}$
Silver Paper Double Gear Shaft Failure	039	Broken	$1.1 \times 10^{-3}$
	040	Wear	$1.3 \times 10^{-3}$
Silver Paper Double Gear Shaft Bearing Failure	041	Bearing Needle Broken	$2.4 \times 10^{-3}$
	042	Oiling Fault	$1.1 \times 10^{-3}$
Silver Paper Turning Gear Shaft Failure	043	Broken	$3.0 \times 10^{-3}$
	044	Wear	$2.7 \times 10^{-3}$
Shaft Bushing Failure	045	Oiling Fault	$3.5 \times 10^{-3}$
	046	Wear	$2.1 \times 10^{-3}$
Coupling Joint Failure	047	Broken	$1.5 \times 10^{-3}$
	048	Wear	$1.1 \times 10^{-3}$
Idle Gear Shaft Failure	049	Wear	$1.3 \times 10^{-3}$
	050	Broken	$2.3 \times 10^{-3}$
Idle Gear Shaft Bushing Failure	051	Wear	$3.9 \times 10^{-3}$
	052	Oiling Fault	$1.6 \times 10^{-3}$

(3) Inner Turret Section

Inner Link Metal Failure	053	Wear	$3.8 \times 10^{-4}$
	054	Oiling Fault	$4.9 \times 10^{-4}$
Link Frame Liner F.	055	Liner Broken	$5.2 \times 10^{-4}$
Link Finger Pin Bolt Failure	056	Broken	$1.1 \times 10^{-3}$
Link Finger Shaft Failure	057	Wear	$4.5 \times 10^{-4}$
	058	Assembly Fault	$2.9 \times 10^{-4}$
Turret Fish Failure	059	Press Irregularity	$4.5 \times 10^{-3}$
	060	Broken	$3.5 \times 10^{-3}$
Turret Fish Coro Failure	061	Coro Pin Broken	$2.0 \times 10^{-3}$
	062	Coro Pin Wear	$1.5 \times 10^{-3}$
Gum Pressure Fixing Pin Failure	063	Broken	$7.0 \times 10^{-4}$
	064	Wear	$6.3 \times 10^{-4}$

**Table 1. Continue**

Subsystem	Code	Contents	Failure Rate
Gum Pressure Lever Failure	065	Press Irregularity	$2.0 \times 10^{-3}$
	066	Broken	$1.8 \times 10^{-3}$
Rounding off the Edges Nail Failure	067	Wear	$1.8 \times 10^{-3}$
	068	Assembly Fault	$1.7 \times 10^{-3}$
Level Adjustment Bolt Failure	069	Assembly Fault	$1.2 \times 10^{-3}$
	070	Broken	$6.6 \times 10^{-4}$
Inner Turret Joint Failure	071	Assembly Fault	$5.9 \times 10^{-4}$
	072	Joint Broken	$3.1 \times 10^{-4}$
Turret Shaft Metal Failure	073	Wear	$7.8 \times 10^{-4}$
	074	Oiling Fault	$4.1 \times 10^{-4}$

**(4) Label Flow Section**

Label 1st Roller Failure	075	Press Irregularity	$2.2 \times 10^{-3}$
	076	Wear	$1.1 \times 10^{-4}$
	077	Broken	$4.4 \times 10^{-4}$
Label 2nd Roller Failure	078	Press Irregularity	$2.3 \times 10^{-3}$
	079	Wear	$1.0 \times 10^{-3}$
	080	Broken	$2.4 \times 10^{-4}$
Label 3rd Roller Failure	081	Press Irregularity	$1.6 \times 10^{-3}$
	082	Wear	$2.5 \times 10^{-3}$
	083	Broken	$1.1 \times 10^{-3}$
Label Cleaner (A-Z) Frame Failure	084	Wear	$2.7 \times 10^{-3}$
	085	Position Fault	$2.3 \times 10^{-3}$
Label Motion Big-Small Roller Failure	086	Wear	$2.0 \times 10^{-3}$
	087	Broken	$4.8 \times 10^{-4}$
Label Motion Metal Failure	088	Wear	$2.6 \times 10^{-3}$
	089	Oiling Fault	$1.4 \times 10^{-3}$
Label Cutter Failure	090	Broken	$3.0 \times 10^{-4}$
	091	Wear	$4.5 \times 10^{-3}$
Paste Box Roller Failure	092	Bending	$7.3 \times 10^{-4}$
	093	Cleaning Fault	$3.5 \times 10^{-3}$
	094	Wear	$2.7 \times 10^{-3}$
BC3 Gear Failure	095	Wear	$1.2 \times 10^{-3}$
	096	Broken	$6.1 \times 10^{-4}$
Arch Stroke Adjustment Joint Failure	097	Setting Fault	$3.3 \times 10^{-3}$
	098	Broken	$2.7 \times 10^{-4}$
Arch Cam Failure	099	Timing Fault	$2.3 \times 10^{-3}$
	100	Broken	$3.6 \times 10^{-4}$



**Table 1. Continued**

(5) Gear Box Section

Subsystem	Code	Contents	Failure Rate
Middle Shaft Bearing Failure	101	Oiling Fault	$4.5 \times 10^{-4}$
	102	Wear	$6.0 \times 10^{-4}$
Middle Shaft Sprocket Failure	103	Broken	$2.9 \times 10^{-4}$
	104	Wear	$1.1 \times 10^{-3}$
	105	Assembly Fault	$3.0 \times 10^{-4}$
Link Turning Gear Bearing Failure	106	Oiling/Fault	$1.1 \times 10^{-3}$
	107	Wear	$4.0 \times 10^{-4}$
Link Turning Shaft Failure	108	Broken	$2.7 \times 10^{-4}$
	109	Wear	$1.3 \times 10^{-4}$
	110	Oiling Fault	$4.0 \times 10^{-4}$
Geneva Gear Shaft Failure	111	Broken	$1.5 \times 10^{-4}$
	112	Wear	$1.1 \times 10^{-4}$
	113	Bending	$1.2 \times 10^{-4}$
Geneva Metal Failure	114	Wear	$2.3 \times 10^{-4}$
	115	Oiling Fault	$2.9 \times 10^{-4}$
Geneva Coro and Pin Failure	116	Wear	$2.6 \times 10^{-3}$
	117	Broken	$1.6 \times 10^{-3}$
Outer Turret Shaft Failure	118	Assembly Fault	$1.2 \times 10^{-4}$
	119	Wear	$6.7 \times 10^{-5}$
	120	Cutting	$3.3 \times 10^{-5}$
Outer Turret Metal Failure	121	Wear	$9.2 \times 10^{-5}$
	122	Oiling Fault	$1.3 \times 10^{-4}$
Main Gear Failure	123	Broken	$1.7 \times 10^{-4}$
	124	Wear	$9.2 \times 10^{-5}$
Main Shaft Bearing Failure	125	Oiling Fault	$7.8 \times 10^{-4}$
	126	Wear	$1.6 \times 10^{-3}$

(6) Cellophane Silver Paper Flow Section (Overwrapping)

One-way Clutch Failure	127	Assembly Fault	$6.1 \times 10^{-4}$
	128	Bending	$1.1 \times 10^{-4}$
	129	Wear	$5.0 \times 10^{-5}$
	130	Press Irregularity	$7.8 \times 10^{-4}$
Cellophane Silver Paper 1st Roller Flow Failure	131	Press Irregularity	$1.1 \times 10^{-3}$
	132	Wear	$1.8 \times 10^{-4}$
	133	Oiling Fault	$3.1 \times 10^{-4}$

**Table 1. Continued**

Subsystem	Code	Contents	Failure Rate
Cellophane Silver Paper 2nd Roller Flow Failure	134	Press Irregularity	$8.1 \times 10^{-4}$
	135	Wear	$3.6 \times 10^{-4}$
	136	Oiling Fault	$4.1 \times 10^{-4}$
Cellophane Silver Paper Cutter Shaft Failure	137	Assembly Fault	$1.6 \times 10^{-4}$
	138	Wear	$5.0 \times 10^{-5}$
	139	Bending	$1.2 \times 10^{-4}$
Wregly Cutter Failure	140	Wear	$1.6 \times 10^{-3}$
	141	Broken	$1.5 \times 10^{-4}$
	142	Assembly Fault	$3.6 \times 10^{-4}$
Tumbler Lever Failure	143	Assembly Fault	$6.8 \times 10^{-4}$
	144	Position Fault	$2.0 \times 10^{-3}$
	145	Wear	$1.8 \times 10^{-4}$
2nd Rounding off the Edges Nail Failure	146	Broken	$1.0 \times 10^{-4}$
	147	Wear	$1.6 \times 10^{-4}$
Wax Lever Failure	148	Position Fault	$1.5 \times 10^{-3}$
	149	Wear	$3.2 \times 10^{-4}$
Wax Roller Failure	150	Timing Fault	$1.8 \times 10^{-3}$
	151	Wear	$3.6 \times 10^{-4}$
Heater Block Failure	152	Assembly Fault	$2.2 \times 10^{-3}$
	153	Wear	$6.3 \times 10^{-4}$
2nd and 3rd Rounding off the Edges Guide Failure	154	Position Fault by Gap	$2.4 \times 10^{-3}$
	155	Wear	$7.2 \times 10^{-4}$
	156	Broken	$1.1 \times 10^{-3}$

(7) AMP and Electric Section

Lamp House Lamp Failure	157	Lamp Out	$2.5 \times 10^{-3}$
	158	Position Fault	$3.0 \times 10^{-3}$
	159	Cleaning Fault	$2.7 \times 10^{-3}$
Photo TR Failure	160	Position Fault	$1.1 \times 10^{-3}$
	161	Breaking of a Wire	$3.9 \times 10^{-4}$
Micro Switch Failure	162	Breaking of a Wire	$4.8 \times 10^{-4}$
	163	Broken	$6.8 \times 10^{-4}$
Lead Wire Failure	164	Breaking of a Wire	$6.2 \times 10^{-4}$
	165	Insulation Fault	$5.1 \times 10^{-4}$
Heater Failure	166	Breaking of a Wire at Control Switch	$4.1 \times 10^{-4}$
	167	Breaking of a Wire at Thermostat	$4.9 \times 10^{-4}$
Electronic Clutch Failure	168	Wear	$5.3 \times 10^{-4}$
	169	Breaking of Lead Wire	$2.3 \times 10^{-4}$
Magnetic Switch Failure	170	Contact Point Wear	$4.8 \times 10^{-4}$
	171	Breaking of Lead Wire	$1.4 \times 10^{-4}$

II-4. 컴퓨터 出力 結果

作成된 FT에 基本 故障과 論理게이트의 숫자가 많아지면 Minimal Cut Sets (2),(6)을 구하고 分析하는데 많은 시간과 노력이 필요하게 된다. 이에 따라 컴퓨터 프로그램을 作成하고 處理한 결과,

Minimal Cut Sets 은 256개였다. 이들 Minimal Cut Sets 中 基本 故障 하나로 이루어진 것은 57개, 두개로 이루어진 것은 40개, 세개로 이루어진 것은 159개였다.

Table 2. Minimal cut sets to cause system failure occurrence.  
(The number of minimal cut sets is 256.)

1st Basic Event	2nd Basic Event	3rd Basic Event	1st Basic Event	2nd Basic Event	3rd Basic Event	1st Basic Event	2nd Basic Event	3rd Basic Event
001	004		011	014	015	012	014	018
001	005		011	014	016	012	014	019
002	004		011	014	017	012	014	020
002	005		011	014	018	012	014	021
003	004		011	014	019	012	014	022
003	005		011	014	020	023	026	
006			011	014	021	023	027	
007			011	014	022	023	028	
008			012	013	015	024	026	
009			012	013	016	024	027	
010			012	013	017	024	028	
011	013	015	012	013	018	025	026	
011	013	016	012	013	019	025	027	
011	013	017	012	013	020	025	028	
011	013	018	012	013	021	029		
011	013	019	012	013	022	030		
011	013	020	012	014	015	031		
011	013	021	012	014	016	032		
011	013	022	012	014	017	033		
034			075	079	083	100		
035	036		075	080	081	101	103	106
037	038		075	080	082	101	103	107
039	040		075	080	083	101	103	108
041			076	078	081	101	103	109
042			076	078	082	101	103	110
043	044		076	078	083	101	104	106
045			076	079	081	101	104	107
046			076	079	082	101	104	108
047	048		076	079	083	101	104	109
049	050		076	080	081	101	104	110
051			076	080	082	101	105	106
052			076	080	083	101	105	107
053	055	056	077	078	081	101	105	108
053	055	057	077	078	082	101	105	109

1st Basic Event	2nd Basic Event	3rd Basic Event	1st Basic Event	2nd Basic Event	3rd Basic Event	1st Basic Event	2nd Basic Event	3rd Basic Event
053	055	058	077	078	083	101	105	110
054	055	056	077	079	081	102	103	106
054	055	057	077	079	082	102	103	107
054	055	058	077	079	083	102	103	108
059	061	062	077	080	081	102	103	109
060	061	062	077	080	082	102	103	110
063	064	065	077	080	083	102	104	106
063	064	066	084			102	104	107
067	068		085			102	104	108
069			086	087		102	104	109
070			088			102	104	110
071			089			102	105	106
072			090	091		102	105	107
073	074		092			102	105	108
075	078	081	093			102	105	109
075	078	082	094			102	105	110
075	078	083	095	096		111		
075	079	081	097	098		112		
075	079	082	099			113		
114			129	132	136	157	160	163
115			129	133	134	157	160	164
116	117		129	133	135	157	160	165
118			129	133	136	157	161	162
119			130	131	134	157	161	163
120			130	131	135	157	161	164
121			130	131	136	157	161	165
122			130	132	134	158	160	162
123	124		130	132	135	158	160	163
125			130	132	136	158	160	164
126			130	133	134	158	160	165
127	131	134	130	133	135	158	161	162
127	131	135	130	133	136	158	161	163
127	131	136	137			158	161	164
127	132	134	138			158	161	165
127	132	135	139			159	160	162
127	132	136	140			159	160	163
127	133	134	141			159	160	164
127	133	135	142			159	160	165
127	133	136	143			159	161	162
128	131	134	144			159	161	163
128	131	135	145			159	161	164
128	131	136	146	147		159	161	165
128	132	134	148	150		166		
128	132	135	148	151		167		
128	132	136	149	150		168		
128	133	134	149	151		169		

1st Basic Event	2nd Basic Event	3rd Basic Event	1st Basic Event	2nd Basic Event	3rd Basic Event	1st Basic Event	2nd Basic Event	3rd Basic Event
128	133	135	152	154		170		
128	133	136	152	155		171		
129	131	134	152	156				
129	131	135	153	154				
129	131	136	153	155				
129	132	134	153	156				
129	132	135	157	160	162			

### II-5. 分析結果

基本故障들의 Minimal Cut Sets에 출현하는 횟수와故障率을 利用하여 컴퓨터 出力結果를 分析한 결과, 검自動包裝機械故障에 중요한 영향을 미치는 基本故障들은 Table 3 과 같다.

Table 3. Basic Events to affect system failure greatly

Code Number	Contents
009	Timing Fault in Breaker Pusher Cam
045	Oiling Fault in Shaft Bushing
051	Wear Fault in Idle Gear Shaft Bushing
093	Cleaning Fault in Paste Box Roller
032	Pressure Fault in Holder Breaker
007	Stroke Fault in Hopper Pusher
041	Bearing Needle Broken
084	Wear Fault in Label Cleaner Frame
088	Wear Fault in Label Motion Metal
094	Wear Fault in Paste Box Roller
099	Timing Fault in Arch Cam

따라서 위에 적힌 基本故障들에 대해 적절한 措置를 取함으로써 檢自動包裝機械의 信賴性을 向上시킬 수 있다.

171개의 基本故障들을 故障形態別로 分析해 본 결과는 Table 4 와 같으며 이중 마모에 의한 故障形態가 가장 많았다. 마모는 材料의 強度에 관계가 있으므로, 적절한 재료.선택과 아울러 알맞은 主油 공급을 해주므로써 마모에 의한 고장을 줄일 수 있을 것이다.

Table 4. Rate of Failure Modes

Failure Mode	Rate (%)
Wear	33
Broken	29
Assembly Fault	11
Oiling Fault	10
Pressure Fault	6
Bending	3
The others	8

### III. 結 論

本 研究에서는 FTA 技法을 利用하여 檢自動包裝機械故障에 대해 體系의인 分析을 하였다. 이 機械에서 발생하는 各種故障形態를 調査分類하여 FT를 작성하였다. 作成된 FT를 分析하기 위해 컴퓨터 처리를 하여 Minimal Cut Sets을 구하고, 이를 分析하여 檢自動包裝機械의 故障에 중요한 영향을 미치는 基本故障들을 찾아 내었다. 그 결과, 009, 041, 051, 093, 032 ... 등의 基本故障들이 이 機械의 信賴性 向上에 크게 作用함을 알 수 있었다. 즉, 이들에 대한 적절한 조치를 취함으로써 檢自動包裝機械의 信賴性을 높일 수 있을 것이다.

本 연구에서는 資料의 난이성때문에 機械의 하드웨어에 발생하는 故障形態만을 分析하였는데, 인간의 실수, 자재의 결함 등으로 인해 발생하는 여러 故障形態에 대한 分析을 함께 함으로써 보다 철저한 故障分析이 가능하리라 생각된다. 또한 故障形態에 대한 經濟性 分析을 함으로써 信賴性 向上을 위한 經濟的인 對策들을 강구할 수 있을 것이다.

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