

MANUFACTURING INSIGHTS:

Failure Mode Effects Analysis (FMEA)

SCENE 1.

CG: FBI warning  
white text centered on black to  
blue gradient

WARNING

federal law provides severe civil and  
criminal penalties for the unauthorized  
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of copyrighted videotapes.

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SCENE 2.

**tape 40, 01:00:00-01:00:12**  
SME logo, with music

SCENE 3.

MI opening

MUSIC UP AND UNDER

NARRATION (VO):

MANUFACTURING INSIGHTS, MANUFACTURING ENGINEERING  
MAGAZINE'S VIDEO SERIES FOR PROCESS IMPROVEMENT.

SCENE 4.

04.14.03

NARRATION (VO):

04.05.20

high speed driving 00.04.48-53

THIS PROGRAM EXAMINES THE DISCIPLINED QUALITY  
PROCEDURE "FAILURE MODE EFFECTS ANALYSIS", AND HOW  
PROACTIVE "F.M.E.A." DOCUMENTATION IS BEING USED  
TO REDUCE PRODUCT AND PROCESS RISKS.

SCENE 5.

04.14.28

04.04.18

Braking in action-00.05.21

NARRATION (VO):

THIS PROGRAM TRACKS AN FAILURE MODE EFFECTS  
ANALYSIS DOCUMENT FROM AN AUTOMOTIVE ANTILOCK BASE  
BRAKING SYSTEM DESIGNED, TESTED, AND MANUFACTURED  
BY ROBERT BOSCH CORPORATION.

fade to black

FADE TO BLACK

SCENE 6.

NARRATION (VO):

Document being looked at-  
04.10.00

People in meeting room-04.08.55

Brake in cad- 03.06.30

Designing of brake system-  
03.06.00

COMPANIES CONDUCT FMEAs TO PROACTIVELY IDENTIFY ALL KNOWN AND POTENTIAL FAILURE MODES SO THEY CAN BE PRIORITIZED AND USED AS PART OF A CORPORATE RISK REDUCTION PROCESS. THESE POTENTIAL FAILURES CAN BE PART OF THE PHYSICAL *PRODUCT*, OR THE PROCESSES USED TO ENGINEER AND MANUFACTURE IT.

SCENE 7.

test track hummer-00.05.44-55

**NARRATION (VO):**

THE RISK MANAGEMENT FOCUS AT BOSCH HAS ONE GOAL:  
**DEFECT FREE PRODUCTS.**

SCENE 8.

blue background, still of  
meeting- 04.10.45 still

Text: Internal Risks: Potential risks created in the design phase by a potentially deficient design process

NARRATION (VO):

TWO MAIN TYPES OF POTENTIAL FAILURE MODES ARE RECOGNIZED AT BOSCH:

1. INTERNAL RISKS: THESE ARE POTENTIAL RISKS CREATED IN THE DESIGN PHASE BY A POTENTIALLY DEFICIENT DESIGN PROCESS.. AND . . .

SCENE 9.

blue background, still of people  
in shop test area.-03.09.30still

Text: Potential risks created by the interface between the corporation's components and those of different departments, customers or suppliers.

**NARRATION (VO):**

2. INTERFACE RISKS: THESE ARE POTENTIAL RISKS CREATED BY THE INTERFACE BETWEEN THE CORPORATION'S COMPONENTS AND THOSE OF DIFFERENT DEPARTMENTS, CUSTOMERS OR SUPPLIERS.

SCENE 10.

NASA Footage mars mission.  
Jpl labs: 20.02.17thru 25

engineer at PC 20.02.41-45

flight path 20.00.01-06

mars planet 20.00.38-54

A WELL-KNOWN EXAMPLE OF AN INTERFACE DEFECT OCCURRED WHEN ENGINEERS AT NASA INADVERTENTLY MIXED METRIC AND ENGLISH MEASUREMENT UNITS WHILE CALCULATING THE FLIGHT PATH OF THE MARS CLIMATE OBSERVER. THIS MISCALCULATION CAUSED THE ORBITER

Mars planet 20.02.02-15

FADE TO SOLID RED

SCENE 11.

Design brakes-03.07.13

Testing brake components-  
04.00.35

tech working on brakes at BOSCH-  
03.19.10

TO ENTER THE PLANET'S ATMOSPHERE TOO LOW AND BURN  
UP.

**NARRATION (VO) :**

COMPANIES DO AN FMEA BECAUSE ALL POTENTIAL RISKS  
INVOLVED IN DESIGNING, TESTING AND MANUFACTURING  
PRODUCTS CAN BE MANAGED WITH THIS DISCIPLINED  
APPROACH TO ENGINEERING DOCUMENTATION BEFORE THE  
PRODUCT IS PRODUCED.

SCENE 12.

CAD workstation with base brake-  
03.04.00

Same brake on Hummer in shop-  
03.16.26

SCENE 13.

FMEA document-04.06.12  
FMEA meeting- 04.10.30

**NARRATION (VO) :**

THE FMEA CAN QUICKLY DIRECT ENGINEERING TOWARD THE  
HIGHEST RANKED POTENTIAL RISKS EARLY IN THE DESIGN  
PROCESS.

**NARRATION (VO) :**

EACH NEW PRODUCT FMEA DOCUMENT IS CREATED &  
DISTRIBUTED EARLY IN THE DESIGN AND PROTOTYPE  
PHASE OF PRODUCT DEVELOPMENT AND THEN MADE  
AVAILABLE WHERE EVER BOSCH NEEDS IT.

SCENE 14.

meeting with document on screen-  
04.08.00

Design resources 03.29.00

Cad 03.02.00

EARLY FEEDBACK FROM ORIGINAL EQUIPMENT  
MANUFACTURER CUSTOMERS IS THEN COMMUNICATED  
QUICKLY TO CONTROL DESIGN RISKS. AT THIS STAGE,  
AN OBJECTIVE OF THE FMEA PROCESS IS TO BALANCE THE  
ENGINEERING RESOURCES WITH THE POTENTIAL PRODUCT  
DESIGN AND MANUFACTURING RISKS.

SCENE 15.

Paul interview

Paul in shop-03.21.58

**NARRATION (VO) :**

PAUL BAIRD, IS THE FMEA METHODOLOGY AND PROCESS  
EXPERT AT ROBERT BOSCH CORPORATION IN FARMINGTON  
HILLS MICHIGAN. PAUL EXPLAINS WHY AN FMEA IS USED

AT BOSCH.

SCENE 16.

CG text:

Paul Baird, P.E.

Robert Bosch Corporation

**(ON-CAM): 02.07.53 - 02.08.11**

THE FMEA ANALYSIS IS USEFUL FOR FINDING AND IDENTIFYING PRODUCT RISKS AND PROCESS RISKS. THE REASON FOR THIS IS THAT A DISCIPLINED PROCESS WILL BRING OUT ISSUES THAT ARE NOT NORMALLY FOUND IN A RANDOM ENGINEERING DEVELOPMENT OPERATIONAL STATUS.

SCENE 17.

testing-04.03.20

BOSCH HAS FOUND EFFORTS PUT INTO THIS ANALYSIS WILL PAY OTHER BENEFITS AS WELL.

SCENE 18.

**(ON-CAM): 01.07.40 - 01.08.25**

Cut away- new product-03.05.30

Car turning fast-00.07.33-47

The FMEA process can significantly shorten the development time of risk containment and risk identification. Through the disciplined process very early in the development process timing, we will be analyzing the functional failures first, which are known even before the product is identified down to a component if it's a new product. If it's a readily identifiable product, then we'll continually go into the FMEA risk priorities and go further deeper into the risk priority structure to bring out additional preventions or detective controls that will better the product.

SCENE 19.

tech testing 00.04.25-40

EVEN THOUGH QUALITY DEPARTMENTS HAVE BEEN DOING FAILURE ANALYSIS FOR YEARS, RECENT INDUSTRY STANDARDS LIKE QS 9000, ISO 9000 AND THE SAE STANDARDS PROVIDE GUIDELINES THAT GREATLY IMPROVE

THEIR FUNCTIONALITY.

SCENE 20.

Paul baird- 02.10.28--02.11.24

Text: Quality Audits

The FMEA documents are used in one of four ways in the organization. We have internal auditors that audit us for the QS9000 standardization. We have external auditors that do the same thing. We have internal QA's, and these internal QA's are project-specific, and they go through the process monitoring the progress and the risks associated at a point in time. We call those our QA assessments. Lastly we have the FMEA documents reviewed by our customers, and they have their own assessment practices and timing. The documents are well used a number of times for every project.

SCENE 21.

Text: over blue background  
Product Risk  
Process Risk

**NARRATION (VO) :**

TWO SEPARATE TYPES OF RISKS ARE RECOGNIZED WITHIN AN FMEA.

SCENE 22.

PAUL BAIRD 02.12.54 - 02.13.26

When we talk about risks, we're not only talking about product risks. We're talking about the process risks that are also evident in a process. When I define the two, if an individual can contribute, through his actions, a product-defined risk, that belongs in an FMEA. If that individual through process risks, not directly but indirectly associated with the product, have risks that also

must be identified in the FMEA.

SCENE 23.  
person looking at document-  
04.14.28

**NARRATION (VO) :**

ONE OF THE PRIMARY USES OF THE FMEA DOCUMENT IS TO SHOW WHO IS RESPONSIBLE FOR WHAT. IN OUR EXAMPLE OF A BASE ANTILOCK BRAKE SYSTEM FMEA, THEY HAVE WELL DEFINED RESPONSIBILITIES WITH THEIR CUSTOMERS BECAUSE THESE ARE COMPLEX PRODUCTS THAT REQUIRE INTENSE PLANNING.

Cu of rotor-03.18.00

Test equip inside truck-03.26.20

SCENE 24.  
document pan-04.15.02

**NARRATION (VO) :**

THESE RESPONSIBILITIES MUST BE DOCUMENTED TO ASSURE ALL COMMUNICATIONS HAVE BEEN SENT AND RECEIVED BOTH DURING THE NEW PRODUCT PLANNING CYCLE, AND FOR THE ENGINEERING CHANGES MADE AFTER PRODUCT LAUNCH.

document pan-04.15.21

cu of rotors-03.17.35

SCENE 25.  
cu of cad rotor-03.07.40

**NARRATION (VO) :**

ITS DURING THIS DEVELOPMENT TIME WHEN THE DISCIPLINE OF AN FMEA CAN MINIMIZE ENGINEERING RESOURCES.

SCENE 26.  
Carry video from last scene into  
this one.

Paul Baird 01.25.48 - 01.26.13

Cut away- cad file being opened  
03.01.26

OK, Here's a new product, they get all energetic and lose focus of where they're coming from, they forget they've already done some of the work and they start with a new sheet of paper. That is not an efficient process. We, on the other hand, effectively go through and try to springboard off of past projects to try to bring this knowledge forward, and then we go deeper into the product

with every evolutionary product cycle.

SCENE 27.

**NARRATION (VO) :**

Pan of Test area- 04.04.51

SOME PEOPLE HAVE REFERRED TO AN FMEA AS "GOLD MINING". BOSCH FEELS "GOLD MINING" MAY BE INTERPRETED AS AN UNDISCIPLINED APPROACH, UNLESS YOU KNOW EXACTLY WHERE TO DIG.

SCENE 28.

carry last video over this scene as a cut away

(ON-CAM) :

Paul Baird 02.06.41---02.06.31

From Bosch's point of view, we have minimal surprises on where and how the risks are found. The process is fully identified. We will occasionally find areas that have higher sensitivities than we may have thought, and from those we will then go dig further in those areas and look for those additional causal relationships that we may have underrated earlier.

SCENE 29.

cad of brake 03.07.00

NARRATION (VO) :

WHEN IMPROVEMENTS ARE MADE TO NEW OR EXISTING PRODUCTS, THE FMEA DOCUMENT IS THE REPOSITORY OF THIS CRITICAL INFORMATION.

SCENE 30.

Paul Baird- 02.11.50-02.12.15

Cut away: Test track footage- 00.05.55-00.06.05

The engineering change in this case would come from an internal or external condition. External to me would be to go into the field again, or development problem. We look into the FMEA to find does it exist in fact. If it does exist then we look at the preventative detective controls to

see if they were followed. If not, then we would amend the process, update the FMEA, and go forward.

SCENE 31.  
cad adding components 03.03.00

AT BOSCH, THE FMEA IS INTEGRATED INTO THE NEW PRODUCT DEVELOPMENT PROCESS AND CONTINUES ON FOR THE LIFE OF THE PRODUCT. WITH THE BOSCH ANTILOCK BRAKE SYSTEM FOR EXAMPLE, THE FMEA DOCUMENT INCLUDES DETAILED INFORMATION ON ITS THREE MAIN COMPONENTS:

TEXT: over blue background  
\*hydraulic control unit  
  
\*electronic control unit  
  
\*wheel speed sensors

THE HYDRAULIC CONTROL UNIT,  
  
AN ELECTRONIC CONTROL UNIT,  
  
AND THE WHEEL SPEED SENSORS.

SCENE 32.  
Paul on camera to start

PAUL BAIRD 01.13.40 - 01.14.01

CUT AWAY TO HYDRAULIC MODULATOR-  
03.28.12

within the bosch antilock brake system there are major components that we concentrate our efforts on. One is the hydraulic modulator, which interrupts the flow of hydraulic pressure to and from the wheel cylinders. We have an electronic control unit, which is the electronic brain of the system. Then we have wheel speed sensors. These sensors feed back to the electronic control unit the various wheel speeds attained during a stop.

CUT AWAY TO ELECTRONIC CONTROL  
UNIT-03.28.29

TEST TRACK FOOTAGE OF WHEELS  
DURING A STOP-00.05.21-29

SCENE 33.  
close up of test gear-04.03.36

**NARRATION (VO):**

TO OPERATE CORRECTLY, ALL THREE OF THESE MAIN COMPONENTS MUST COMMUNICATE IN MILLISECOND CYCLE TIMES.

SCENE 34.  
test gear- 00.03.46-00.04.03

TESTING THIS TYPE OF "WHAT IF" DATA MOVEMENT IS A  
COMPLEX TASK. BUT BY USING THE DISCIPLINED FMEA  
APPROACH, EACH POSSIBLE CONDITION CAN BE SIMULATED  
AND TESTED.

SCENE 35.  
testing footage- 00.06.10-18

AND JUST TO MAKE SURE, BOSCH ALSO RUNS SEVERAL  
FIELD TESTS TO VERIFY SIMULATIONS BEFORE CUSTOMER  
ACCEPTANCE.

SCENE 36.  
Car coming to a standstill on  
test track 00.04.52-00.04.55

IF A PROBLEM IS FOUND, THE DOCUMENTED PROCEDURE  
MAKES SURE THEY FIX IT RIGHT.

SCENE 37.  
paul on camera

PAUL BAIRD 02.04.25 - 02.04.56  
We were doing an FMEA analysis on communications,  
and focusing on the barometric pressure sensor and  
its message sent to the ECU. From this we  
determined that at high altitudes we could have  
engines stall through a communications problem.  
In the field a month or two later we verified in  
fact that the engine was stalling, and we took the  
information from the FMEA and utilized the  
preventative controls. In this case we were using  
some message protocol changes, which then resolved  
the issue in the field.

SCENE 38.  
people viewing document on data  
projector in conference room-  
04.07.12 (dark)

**NARRATION (VO) :**

WITH MANY NEW PROJECTS UNDERWAY AT ONCE, IT IS  
OBVIOUS EACH BOSCH PRODUCT BENEFITS FROM A SINGLE  
CONTROLLED DOCUMENT THAT CAN ORGANIZE ALL KNOWN  
RISKS.

SCENE 39.  
people in conf room looking at  
FMEA on screen-04.06.27

FMEA book close-up-04.16.00

**NARRATION (VO) :**

THE FMEA DOCUMENT AT BOSCH EXISTS BOTH AS  
ELECTRONIC DOCUMENTS AND CONTROLLED BOOKS USED AS  
REFERENCE MATERIAL.

SCENE 40.  
carry over video from scene 39

**NARRATION (VO) :**

BOTH VERSIONS OF THE INFORMATION FOLLOW THE SAME  
FORMAT

SCENE 41.

PAUL BAIRD 01.17.20 - 01.17.56

Cut away to index tree- 04.11.18

The Bosch FMEA document, when it's fully prepared  
for distribution, contains a number of sections.  
We have an section that has an index tree, and the  
index tree is to contribute to those that are not  
familiar with the FMEA to indicate where and what  
specific page a specific failure mode may fall  
into. We have a section that has the full  
document, that contains it in an organized fashion  
for easy reference. Then we have a number of  
sections within the document that contain  
specialized sorts. These sorts would be for  
various high risk screens so that they're easily  
found and understood.

Cut away to person looking at  
document- 04.12.53

SCENE 42.  
video of software from FMEA PRO  
and FMEA Facilitator

**NARRATION (VO) :**

SEVERAL DIFFERENT COMPANIES SELL COMPUTER SOFTWARE  
THAT CAN BE USED TO CREATE AND CONTROL AN FMEA  
DOCUMENT IN A LARGE COMPLEX COMPANY. SMALLER  
FMEAS ARE DOCUMENTED USING SIMPLE SPREADSHEET  
PROGRAMS.

SCENE 43.  
cad design area- 03.04.45

SINCE THE ULTIMATE GOAL OF AN FMEA IS HIGHER  
QUALITY PARTS, HERE ARE SEVERAL DESIGN  
IMPROVEMENTS THAT HAVE RESULTED FROM THE  
INFORMATION GATHERED IN AN FMEA.

SCENE 44.  
destroyed rotor close up-  
04.17.46

TO AVOID DAMAGE LIKE THIS BRAKE ROTOR HAS, A  
DRIVER WARNING LIGHT IS NOW USED TO INFORM THE  
DRIVER THAT THE PARKING BRAKE IS APPLIED.

SCENE 45.  
color coded springs inside brake  
assembly-04.21.08

OTHER IMPROVEMENTS INCLUDE COLOR CODING TO ALL  
SPRINGS TO AVOID INSTALLING THE WRONG SIZE SPRING.

SCENE 46.  
broken steel spring, new  
unbroken stainless spring.-  
04.20.28

TO INSURE LONG-TERM QUALITY, THE STEEL WIRE USED  
TO MAKE THIS SPRING WAS CHANGED TO STAINLESS  
STEEL. THESE ARE JUST A FEW OF THE MANY  
IMPROVEMENTS BEING MADE TO BOSCH PRODUCTS AND  
PROCESSES EVERYDAY.

Cad of brake-03.05.08

SCENE 47.  
man looking at FMEA-04.13.15  
Test equipment in car-04.23.06

THE MOST IMPORTANT REASON COMPANIES HAVE USED FMEA  
DOCUMENTS IS TO COMMUNICATE TO MANAGEMENT THE  
RISKS OF DESIGNING AND MANUFACTURING PRODUCTS, AND  
WHAT IS BEING DONE TO MINIMIZE THOSE RISKS.

SCENE 48. testing area-04.01.50  
Truck on Test track-00.10.00-17

THE DISCIPLINED FMEA PROCEDURES MAXIMIZES DESIGN  
RESOURCES, MAKES FOR BETTER PRODUCTS AND MOST OF  
ALL HELPS PROVIDES BETTER CUSTOMER SATISFACTION.

SCENE 49.  
CG: credit roll  
white text on black, fade up  
mid-screen

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SCENE 50.

**tape 40, 01:00:00-01:00:12**

SME logo