Risk Management
for Printed Circuit Boards

Why is it so Important, What is involved, and Who should do it?

Definitions: ***What is Risk Management?***

- **Risk management,** in general, is the process of *identifying, assessing and controlling threats* to an organization's capital and earnings.

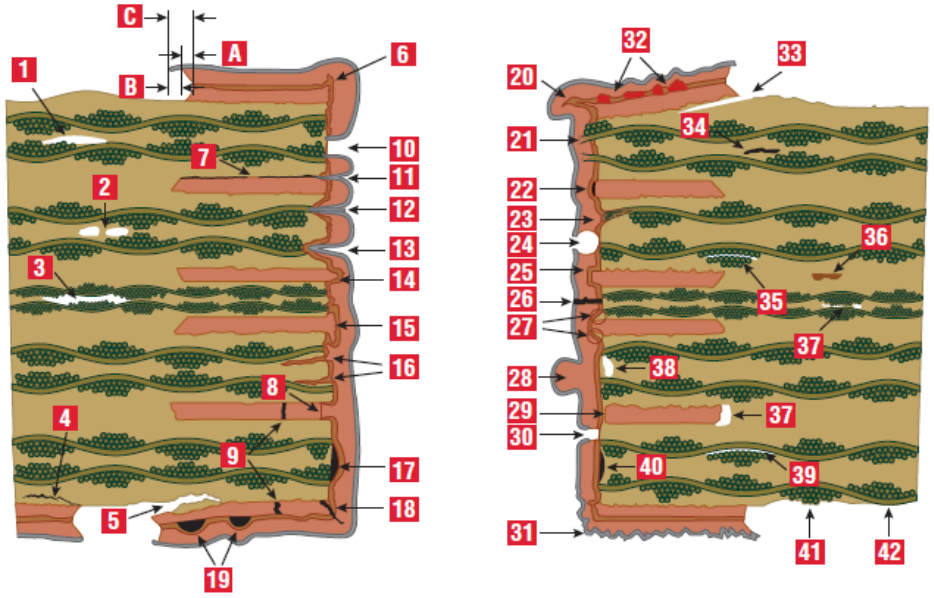
  These stem from a variety of sources including financial uncertainties, legal liabilities, technology issues, and strategic management errors.

- **New Product Risk**, comes from either being differentiated from existing products in its category, or it must create an entirely new category. In either case, the product offers *something new* to the market. It is a design that's never been done before. And if it's never been done before, *it's inherently risky.*

  At *the heart* of most new products *is the* ***Printed Circuit Board***. Its success is dependent upon the entire product team from the top down.

Why is it so Important?

- Theoretically, there are **42×10^{18}** different ways that a PCB can manifest a *failure* during the manufacturing phase.



The root cause of many of these failures can be sourced back to early decisions made during the planning stages of the product.

Successful solutions, implemented early in the development phase of a product, have been found when everyone has a solid understanding of

DFX.

DFX

Design for Manufacturing, Fabrication, Assembly, Testability, Cost, Reliability, Environment, and Reuse.

Goals, Methods, Techniques

Goal

"Produce a PCB quick, with highest quality, at the lowest cost and risk."

What is involved?

Methods start with the initial planning and concept phase of every product.

Good planning takes **TEAMWORK!**

Mechanical Design

PCB Design Engineering

Procurement

Project Management

Electrical Design

Testing / Programing

Each TEAM represents a "**Group or Category of Responsibility**".

The **RISK** is in the processes:
Manufacturing Assembly & Fabrication

Who should do it?

Quantifying the Risks

Technique: *Defining the Risk/Cost Ratio*

Categories of Responsibility:

- Project Management
- Mechanical Design
- PCB Design Engineering
- Electrical Design
- Testing / Programing
- Purchasing

Each Group influences an **"Area of Concern"** in the PCB development process.

***Areas of Concern*:**

- Component Development
- Test Plan
- Design & Material Selection
- Layout Density
- Panel Utilization
- Layer Count & Structure
- Hole Count & Sizes
- Finish Types & Surface Treatments

And each **"Area of Concern"** can be Quantified with a Risk / Cost Factor.

Let's look at a few basic ways that each Group's Responsibility influences the **Risk / Cost Ratio**:

Technique

Identify, *Quantify, and Prioritize*

➢ Project Management

Many cost defining items are affected by management decisions. PM's **set the level** of design criteria for the finished product.

- What is the CLASS of the product?
- Will fallouts be repaired, recycled, or thrown away?
- Is the product to be RoHS certified? ITAR?
- Do we have reliable resources for doing the job? (Software, Hardware, Personnel, etc.)

➢ Mechanical Design

Mechanical Design can impact the overall Producibility level of the project in multiple ways. Variables selected in the beginning will impact the overall "Price Factor" for both the Board Fabrication & the Assembly.

- Board thickness will define the maximum possible layer count.
- Board size will define the Panel sizes usage.
- Any mechanical height constraints above & below the board.
- Connector Interface locations affect layout & assembly processes.

Technique

Identify, *Quantify, and Prioritize*

➢Electrical Design Engineering

Many Electrical Engineers are being tasked with doing all the PCB design work. While this has the appearance of being "efficient" it really is NOT.

- The EE's should play an important part in the development of the PCB design specifications, schematic development, and preliminary circuit simulations.
  - By including information in the schematic, it can be captured and communicated to the PCB-DE.
- Close coordination between the PCB-DE and the EE team will utilize both their strengths effectively.
- The EE team can also coordinate other features of the electrical design with the Component, Test, and Software engineers.
  - Selection of components and level of testing requirements has a *HUGE* impact on all the risk factors.

Technique

Identify, Quantify, and Prioritize

➢PCB Design Engineering

- The PCB Design Engineer (PCB-DE) has the responsibility to coordinate the requirements from the PM, EE, ME, TE, Fabrication, Assembly, and Purchasing.
- When the designer coordinates their efforts with the team (and vice versa), cost saving features can be implemented in a timely manor.
- Implementation of the product requirements with close attention to the all ***"Areas of Concern"*** becomes the primary responsibility of the Design Engineer.

Technique

Identify, *Quantify, and Prioritize*

➢ Testing / Programing

- Testing should be coordinated with the EE & DE.
- Maturity of the design can determine the level of testing needed.
  - Number, size, and location of test points for each test.
  - Tooling features needed for Assembly & Fabrication.
  - Documentation for test procedures included in Schematic, BOM, and Assembly drawings as needed.
- Software Eng., EE, & Designer coordination:
  - Programing documents noted in Assembly drawing and Schematic.
  - Net Names and programing pins should be clearly identified, tests created for successful programing, and method of implementation.

Technique

Identify, *Quantify, and Prioritize*

➢Purchasing

The last link to Fabrication & Assembly! They are mostly at the effect of the decisions that have already been made. However:

- Decisions made here can **undo** many of the cost saving efforts that have been implemented. Close communication with EE & DE are important.
- Component Engineers can be part of the purchasing team or the EE team or the Librarian team. Main emphasis should be on component interchangeability -
    - FORM, FIT, & FUNCTION compatibility!
- IT support for database structures to interlink all the departments is an investment that has proven to save many hours and $$'s in the long run!

Technique

Identify, Quantify, and Prioritize

A study group by IPC created the **PCBA Checklist17**, to help us make some BASIC smarter choices, reduce risks, and trim some of the costs.

In this Checklist17, they **defined 32 parameters and 212 variables** that depend on each other. The number of potential combinations is as high as **42^{18}**

More than will ever actually happen all at once.

This document is available on the IPC web site *(FREE)* and holds a plethora of information on processes, standards, terminology, and **Risk / Cost comparisons.**

From the 32 parameters contained in in this publication, we can apply 27 of them to our "Areas of Concern" (or DFX) and ***Quantify them*** with a

Risk & Cost Factor (RF):

Technique

Identify, Quantify, and Prioritize

Areas of Concern:

A. Component Development
B. Test Plan
C. Design & Material Selection
D. Layout Density
E. Panel Utilization
F. Layer Count & Structure
G. Hole Count & Sizes
H. Finish Types & Surface Treatments

Risk Factor Score

A. 6- RF
   - ✓ Consistency
   - ✓ Size
   - ✓ Spacing
   - ✓ Complexity
   - ✓ EOL
   - ✓ CTE

B. 2- RF
   - ✓ # of Strategies
   - ✓ Implementation

C. 3- RF
   - ✓ CTE
   - ✓ Producibility
   - ✓ Environment

D. 5- RF
   - ✓ Orientation
   - ✓ Space/Trace
   - ✓ EE Functions
   - ✓ ME Features
   - ✓ Density

RF Score (cont)

E. 3- RF
   - ✓ Normal
   - ✓ Extended
   - ✓ Development

F. 2- RF
   - ✓ Strategy
   - ✓ Implementation

G. 3- RF
   - ✓ Registration
   - ✓ Bow & Twist
   - ✓ Symmetry

H. 3- RF
   - ✓ Availability
   - ✓ EE Functions
   - ✓ Compatibility

Technique

Identify, Quantify, and Prioritize

The Project Manager has the greatest impact on Risk Management. They often don't realize how many specific items listed in the checklist are directly affected by the priorities they set.

Many cost defining items are defined by the decisions made by management. Awareness of how each decision affects the overall progress can be critical.

- PM's set the level of design criteria for the finished product.
  - ✓ What is the CLASS of the product? Are there any exceptions?
  - ✓ Will fallouts be repaired, recycled, or thrown away?
  - ✓ Does it need to be RoHS certified?
  - ✓ What environmental considerations are there?
  - ✓ Where will we build prototypes & finished products?

(See pages 4 & 10 of PCBA Checklist)

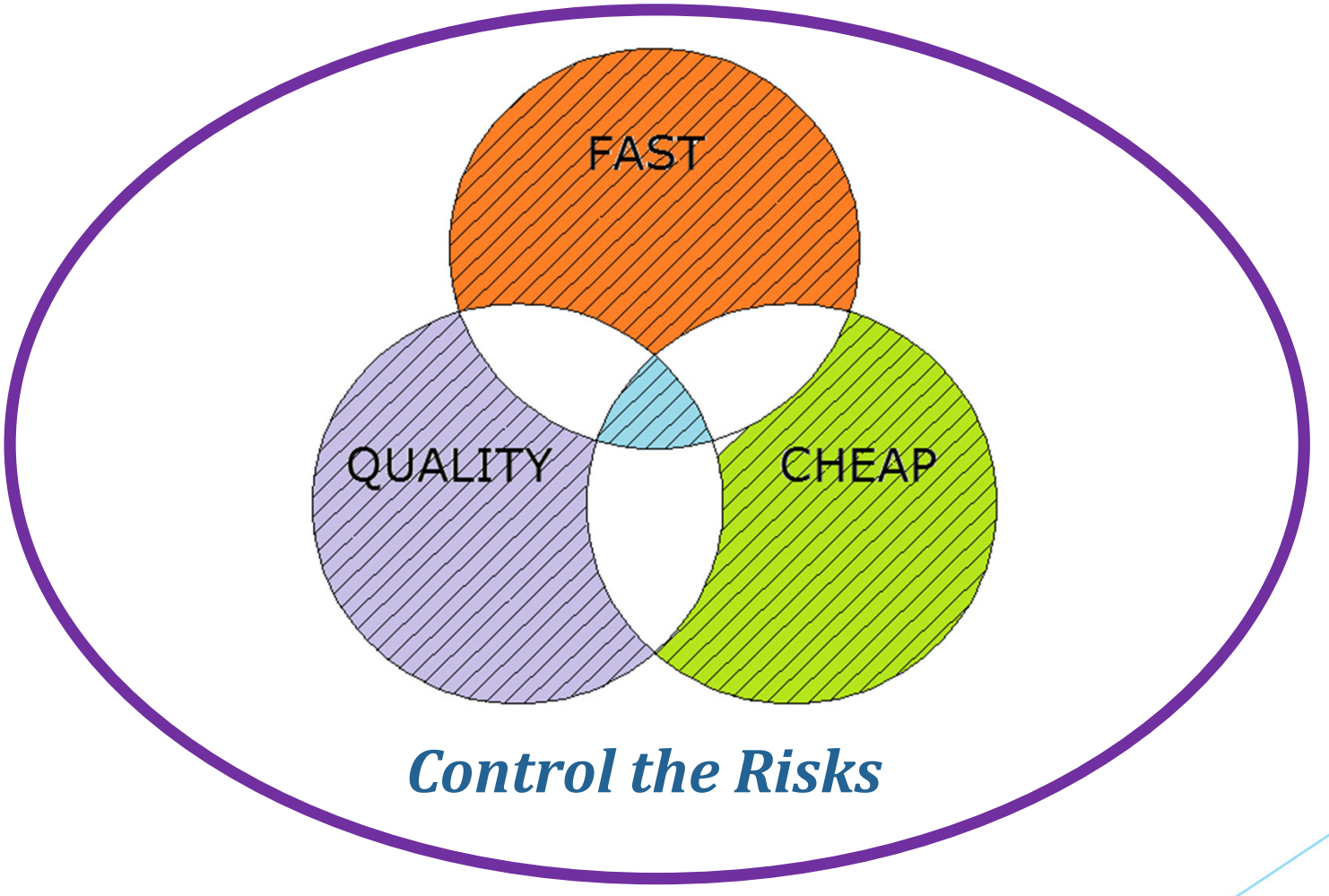
Technique

Identify, Quantify, and Prioritize

- Do we have reliable resources for doing the job?
  - ✓ Software and Database structures (MCAD, ECAD, EOL, Documentation, IT, etc)
  - ✓ Hardware
  - ✓ Trained Personnel
  - ✓ Availability of Standards
  - ✓ Up to date Company procedures on Documentation, Design Reviews, Purchasing, and Test.
- Know what can be done concurrently and what cannot.
  - ✓ Map phases and timelines with input from the team for critical items.
  - ✓ Don't rush hard builds before doing Design Reviews with everyone responsible!
  - ✓ Be willing to adjust the plan.

Summary

Manage PCBD Risk Factors with DFX



The PCB Design Process has many trade offs.

There is so much more that could be discussed!

Reliability factors into design choices as well …

(another time).

For a more detailed presentation or tailored DFX training, contact:

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