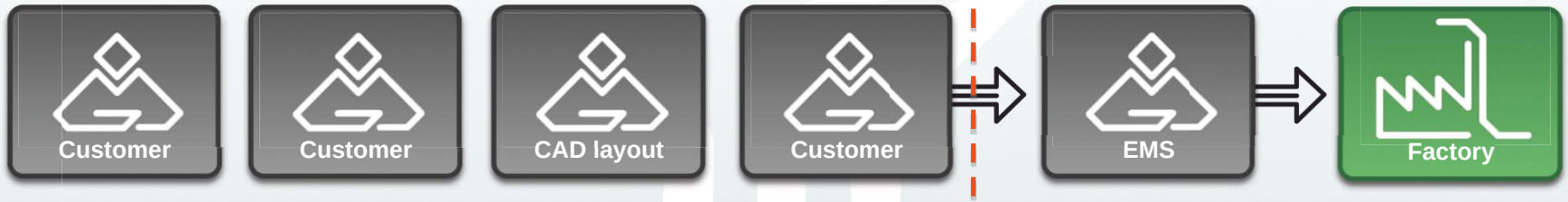
NCAB Group | Seminar no. 4

Cost drivers in PCB production

NCAB GROUP

INTRODUCTION

Where does the basic costs originate?



Concept / Idea

Mechanical Engineer

CAD layout Bureau

Electrical Engineer

EMS company

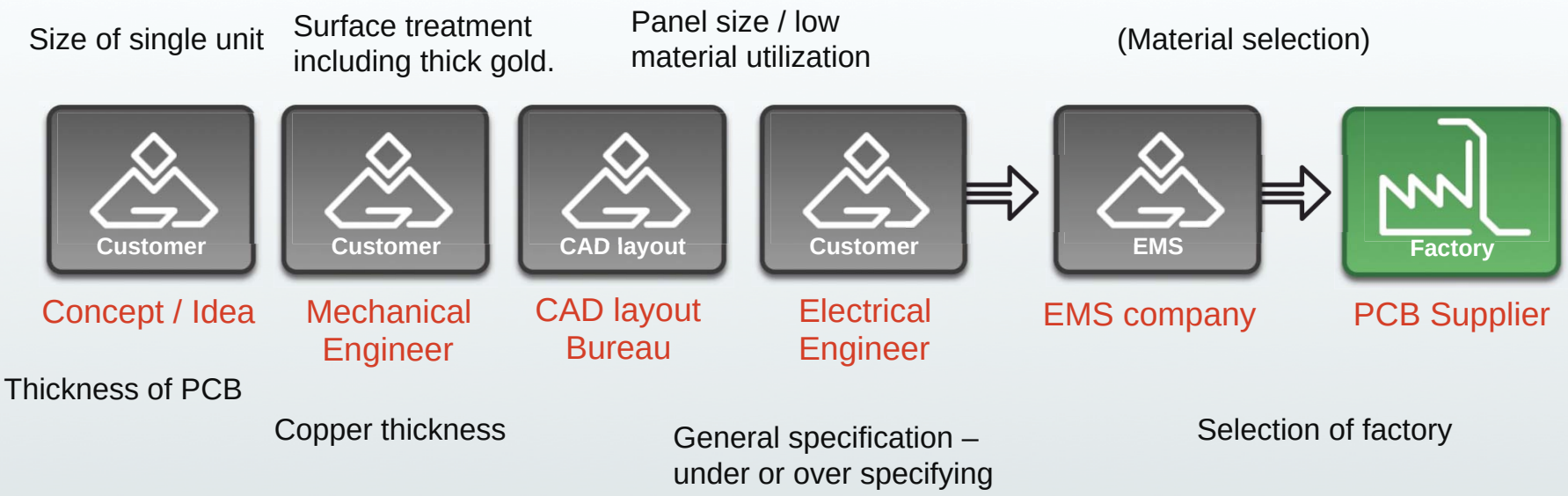
PCB Supplier

80-90%
of cost

10-20%
of cost

INTRODUCTION

PCB basic cost – contributing factors



INTRODUCTION

Cost Drivers

Hard Cost

Soft Cost

Hard Cost Drivers

HARD COST DRIVERS

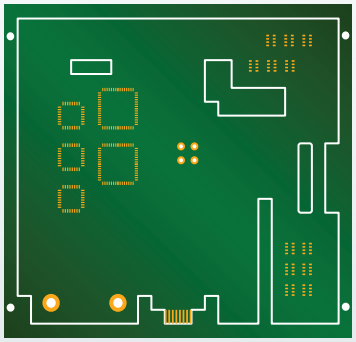
Size of PCB

This is of course one of the very simplest drivers to understand, just as with real estate - the larger it is, the more it costs.

Size 150*150mm

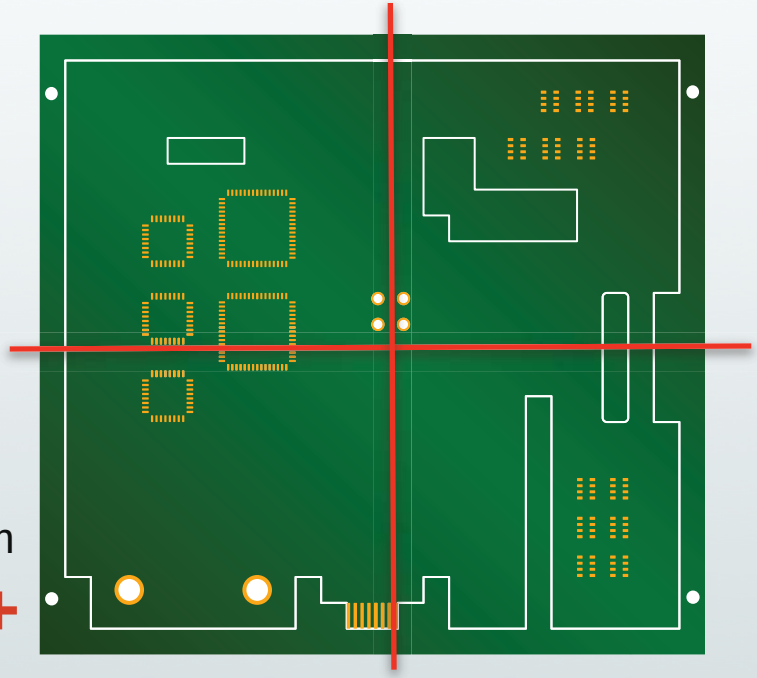
Price x1

(base price)



Size 300*300mm

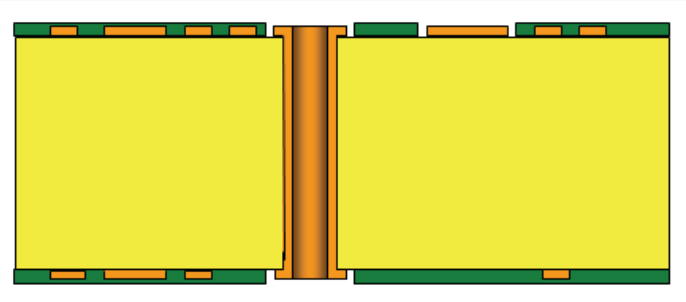
Price x4+

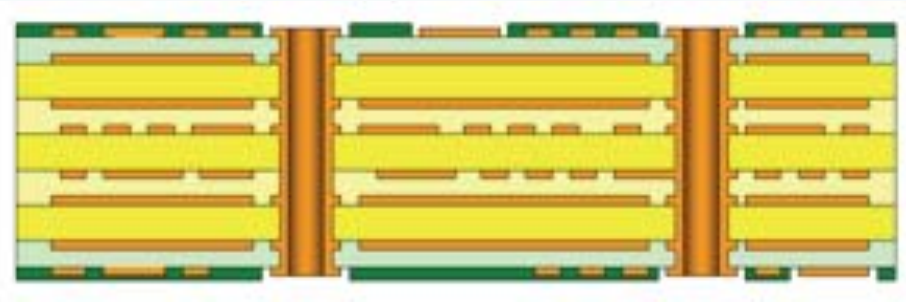


HARD COST DRIVERS

Layer count

Layer count is another easy way to understand driver given the following ‘equation’ – *more layers = (more production steps + more individual ‘pieces’ of material*).





- Cost for each inner layers / dry film
- More layers = increased processing through the same processes
- Developing / Etching / AOI inspection for each inner layer
- Black / brown oxide for each inner layer
- Cost for each piece of pre-preg used between layers
- Pressing / bonding cycles necessary

HARD COST DRIVERS

Layer count

1 ► 2 layer + 40%

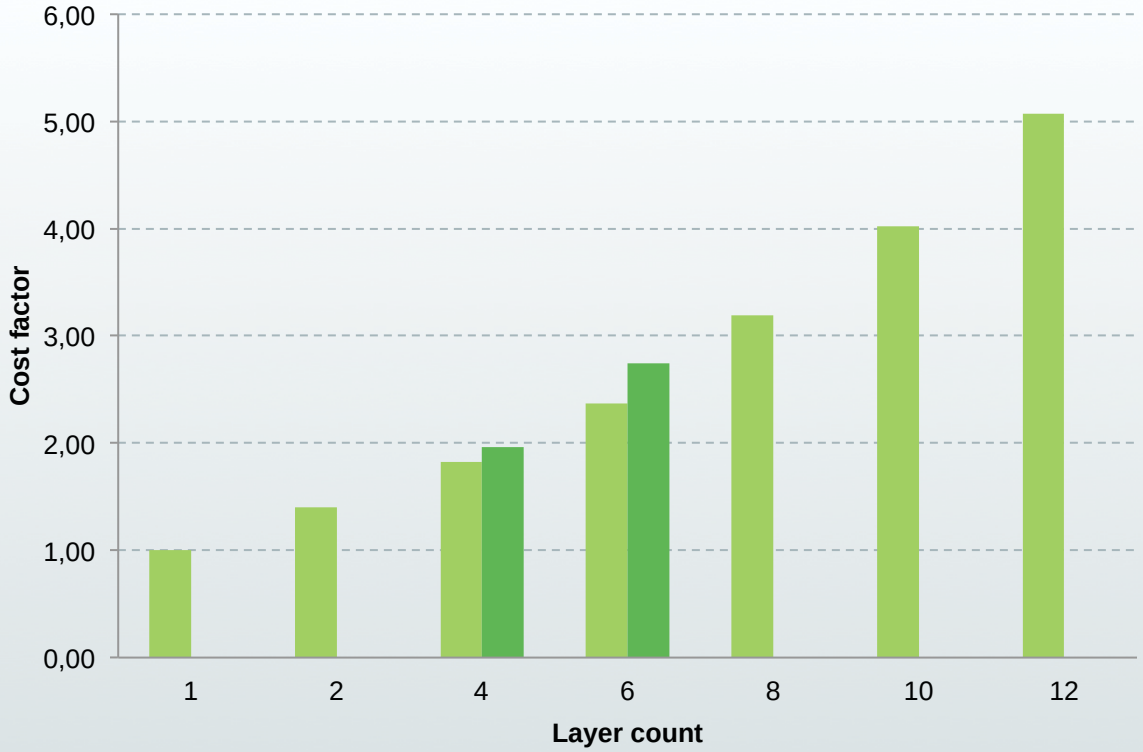
2 ► 4 layer + 30-40%

4 ► 6 layer + 30-40%

6 ► 8 layer + 35%

8 ►10 layer + 26%

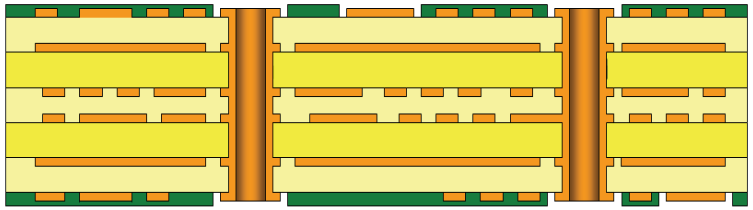
10 ►12 layer + 26%



HARD COST DRIVERS

Build / Complexity

Without doubt, this is one of the largest ‘hard cost’ drivers due to increased processing steps.

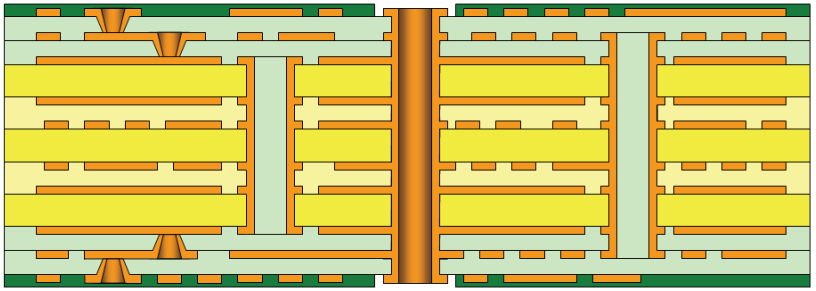


✓ 1 Drilling operation

✓ 1 Plating cycle

✓ 1 Bond cycle

= Copper = Core = Prepreg = Build-up layer = Soldermask



✓ 3 Mech. + 4 Laser Drilling operation

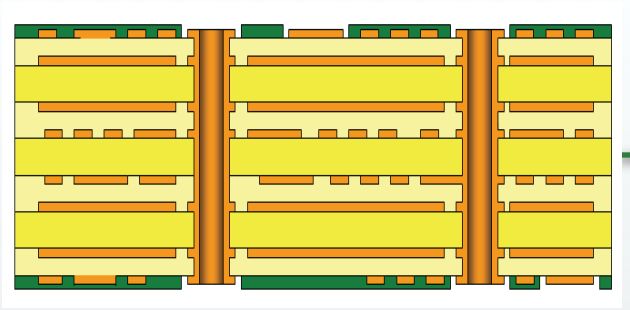
✓ 3 Plating cycle

✓ 3 Bond cycles

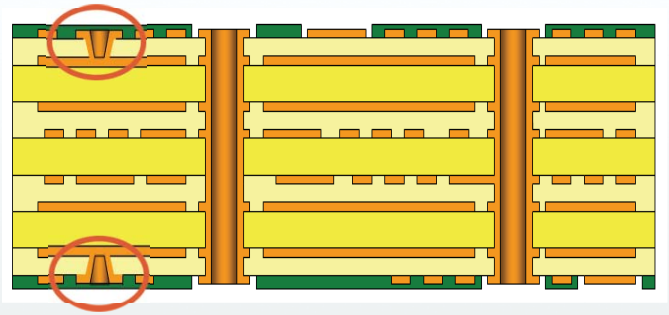
= Copper = Core = Prepreg = Build-up layer = Soldermask

HARD COST DRIVERS

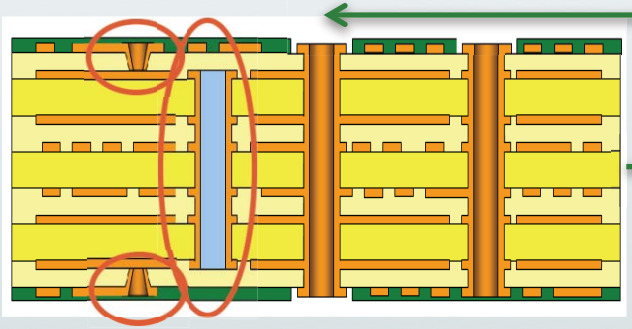
Build / Complexity



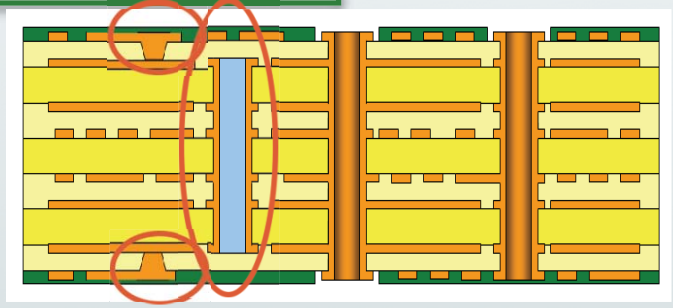
8L= base level



1+6+1 = +40-60%



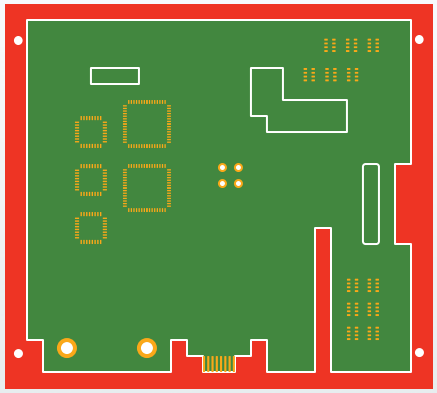
1+6b+1 = +80-100%



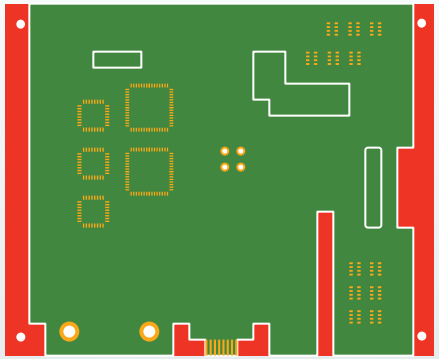
1+6b+1 + Cu fill = +100-120%

HARD COST DRIVERS

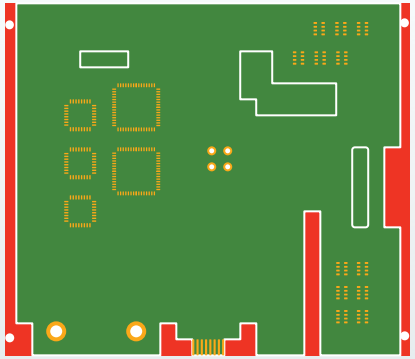
Material utilisation, example 1



Panelisation 1



Panelisation 2

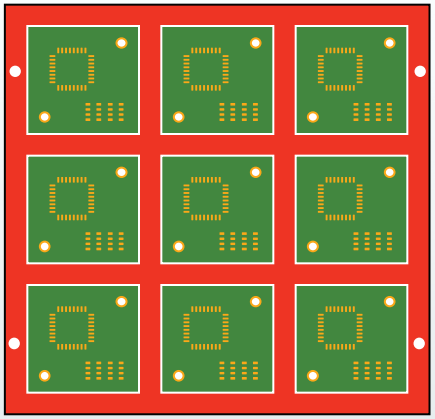


Panelisation 3

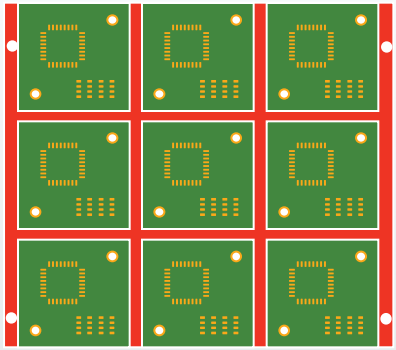
Consider the 3 panel options above. **RED** is the carrier rail.
It has the same cost structure as the circuit itself. It ends up in the bin after assembly.

HARD COST DRIVERS

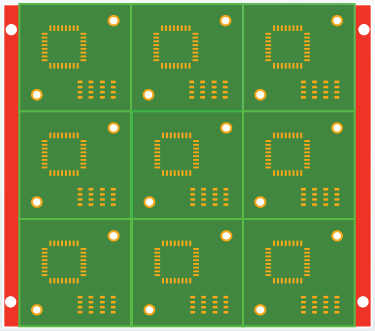
Material utilisation, example 2



Panelisation 1



Panelisation 2

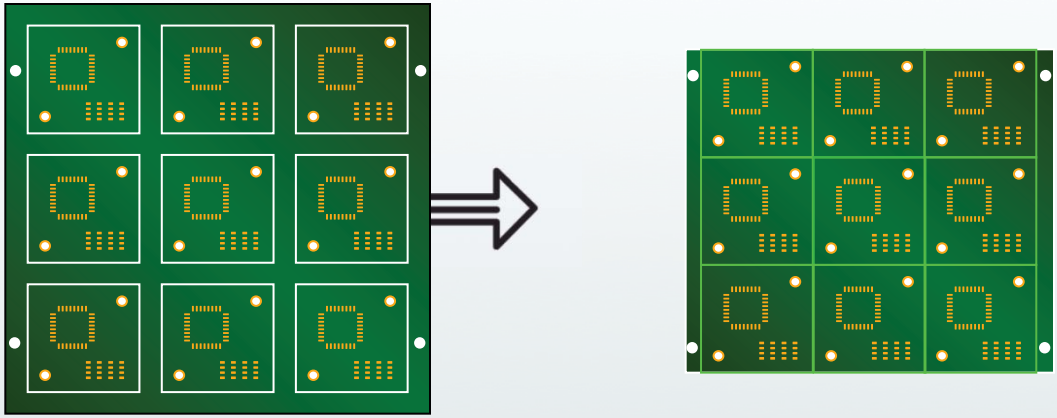


Panelisation 3

As before, **RED** is the waste that goes in the bin once assembled.
In this example (panelisation 3), note how scoring further reduces waste.

HARD COST DRIVERS

Utilisation summary



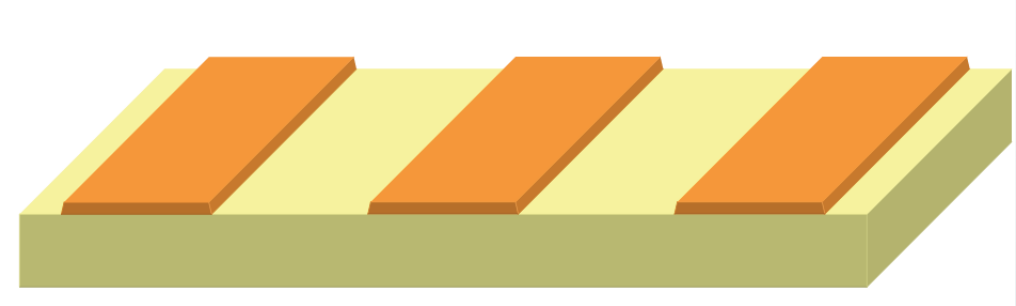
Key point - the bigger the panel, the more it costs

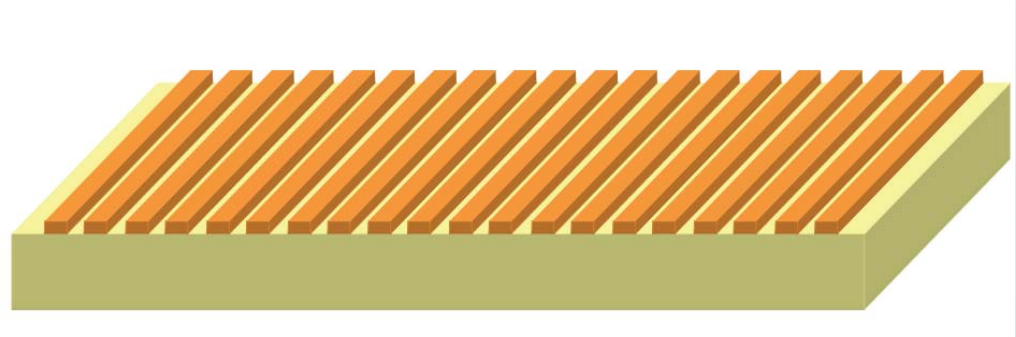
HARD COST DRIVERS

Track and gap

How does this influence?

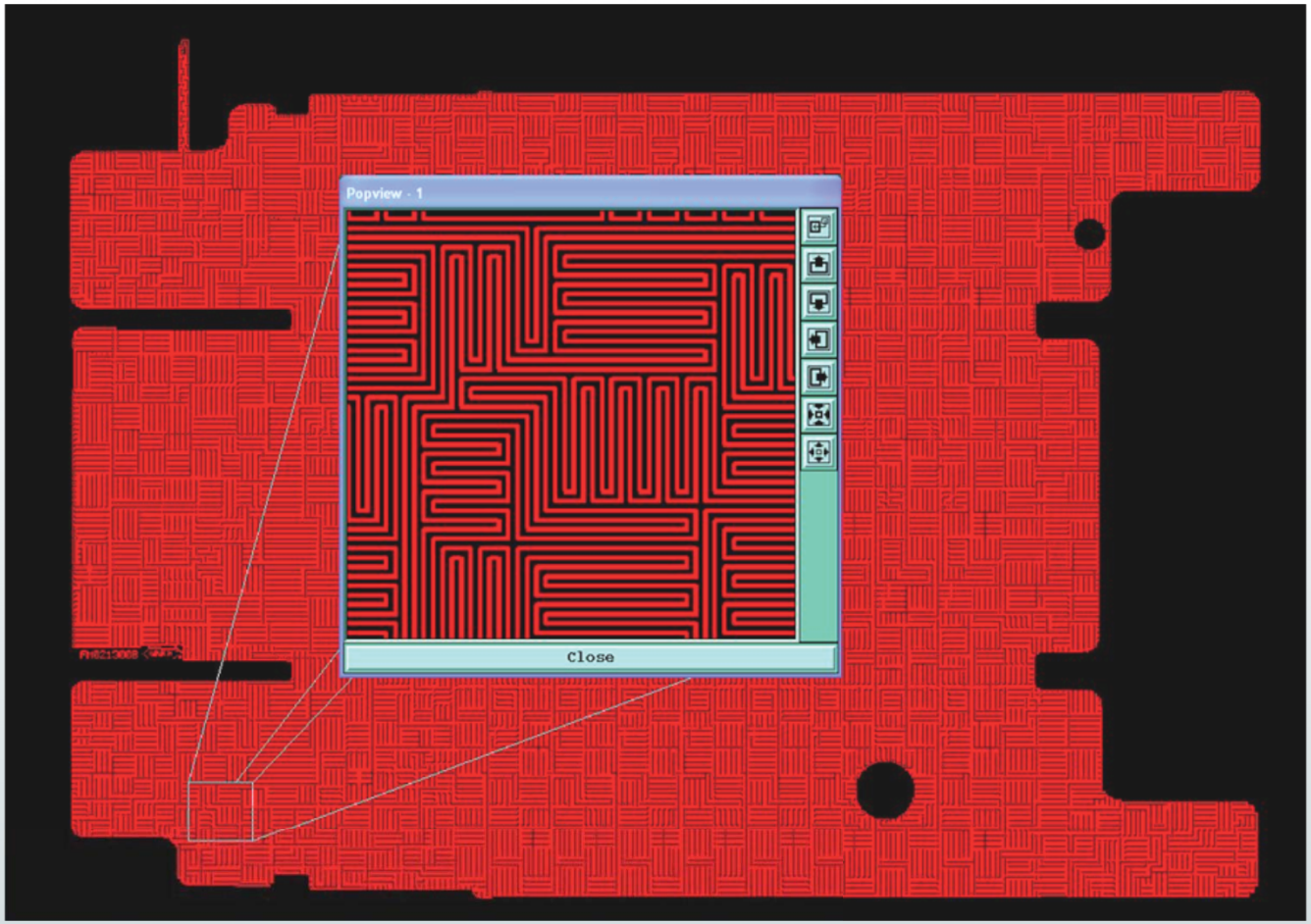
- **Length of fine line tracks**
- **Copper weight / base foil**
- **Exposure units**
- **Etching methods**
- **Handling methods**
- **Type of clean room**





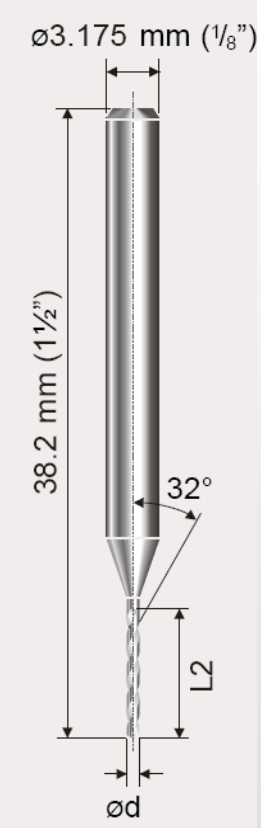
HARD COST DRIVERS

Track and gap

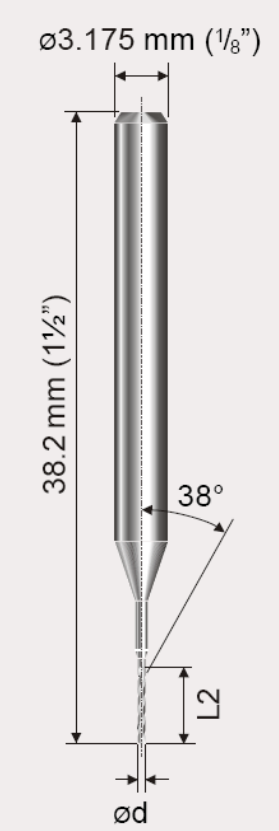


HARD COST DRIVERS

Hole (size & quantity)



3.10 – 0.50mm



< 0.50mm

Drilling of small holes is a cost driver.

The standard today is typically based upon a 0.30mm finished hole, with a density of approximately 50-60k holes per sqm.

Smaller drill bits have shorter flute length which limits the number of boards that can be drilled in one stack (increasing cycle time greatly).

HARD COST DRIVERS

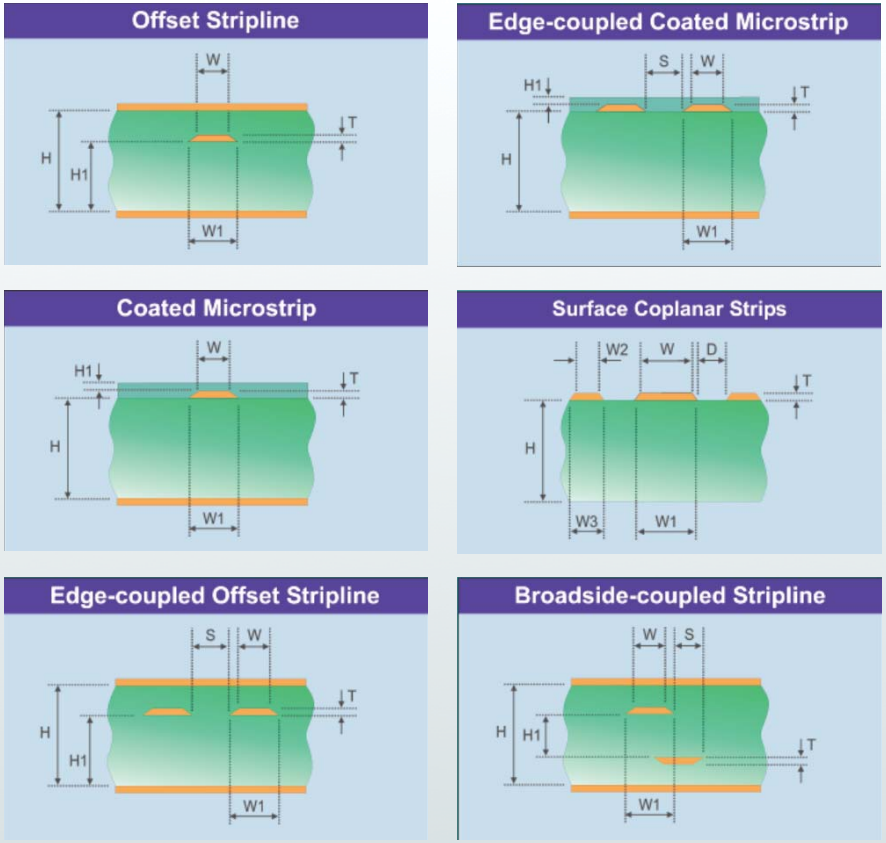
Hard gold / thick gold

- Gold price – moving in 1 direction!
- Extra dry film process
- Additional space necessary for tracks to connect necessary areas
- Less panel utilization with boards with slot-in contacts

HARD COST DRIVERS

Impedance

- Very specific track widths necessary
- Better controlled / specified builds are necessary
- Material with specific dielectric properties may be necessary
- Additional space needed within the panel for impedance test coupons (real estate!)
- Additional process step necessary relating to measurement of test coupons



HARD COST DRIVERS

Excessive tolerances

- **Annular rings below 150µm**
- **Outline dimensions tighter than +/- 0.10mm**
- **Tracks smaller than 100µm**
- **Gaps below 100µm**
- **All hole sizes +/- 0.05mm**
- **Aspect ratio above 1:8**
- **Impedance tighter than +/-10%**

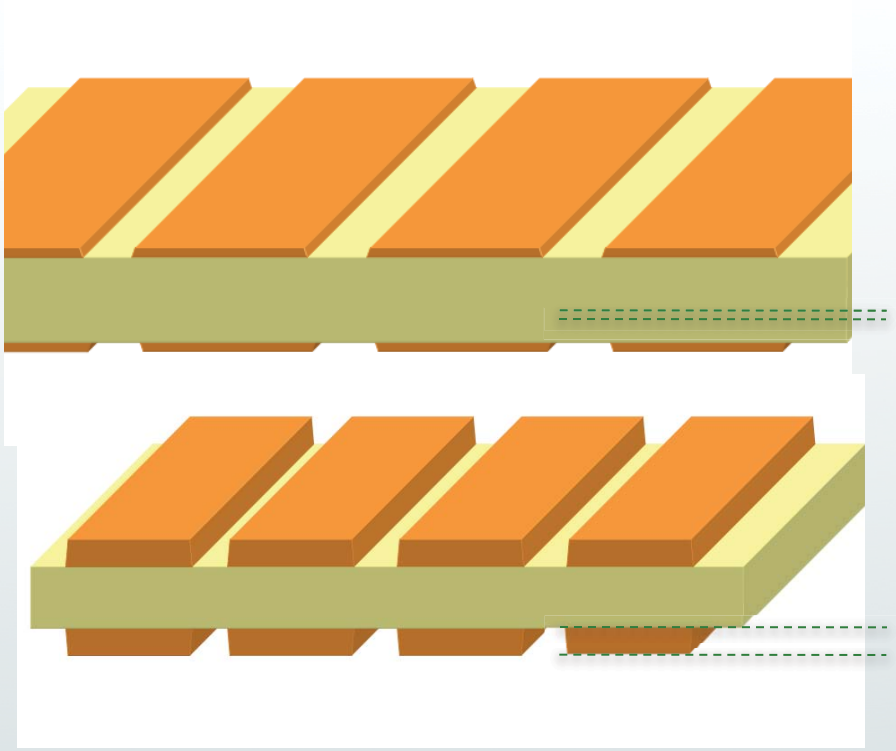
Tight tolerances can result in single source of PCB - never a good situation and also turns a basic / standard PCB into an unnecessarily complex one.

If such tolerances are not critical to the fit/form/function of the PCB, then are they really necessary?

HARD COST DRIVERS

Copper foil weights

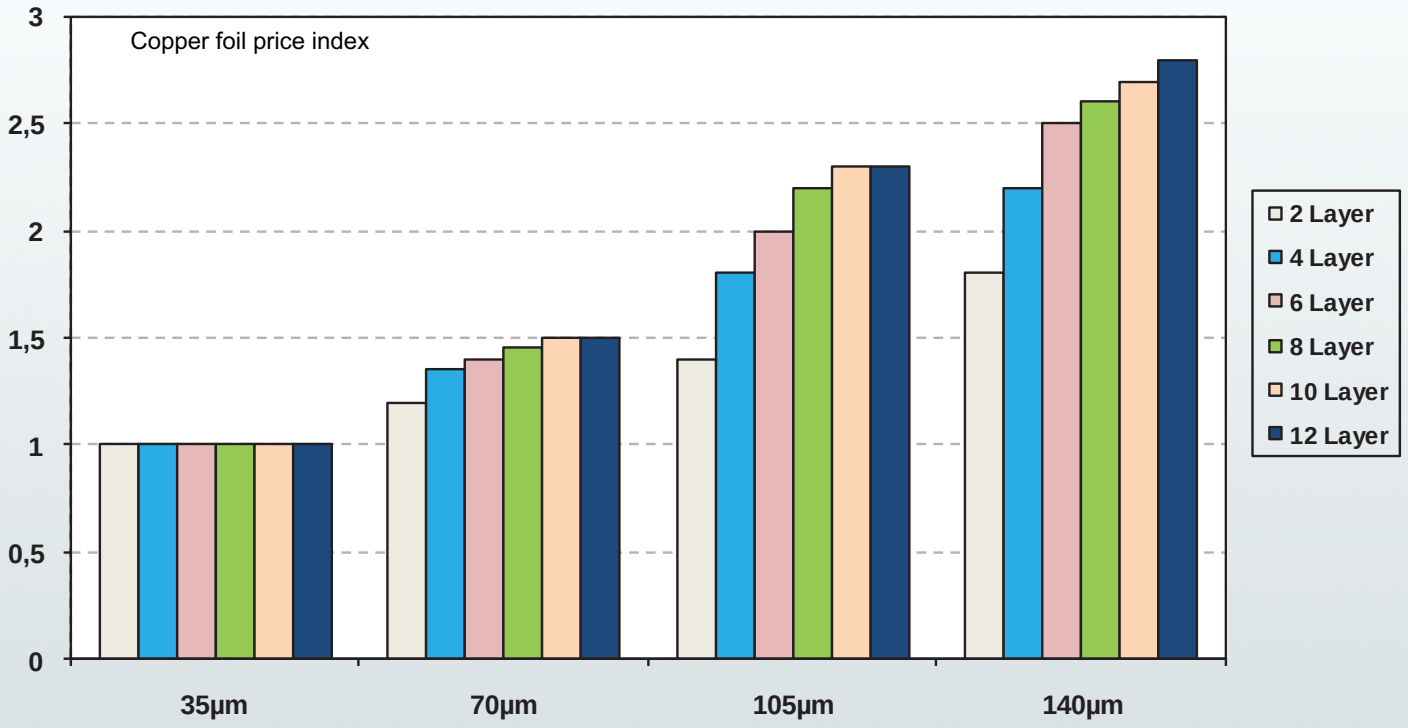
- As with most things in life, copper costs money, so the thicker the copper then the higher the cost.
- Thick copper on inner layers requires more prepreg during pressing to fill up all cavities between copper features.
- Track and gap is more difficult to control on heavy copper – as the copper weight increases so does the track and gap requirement.
- May also need additional soldermask application to coat knee of tracks.
- Heavy copper = heavier PCBs = higher transportation cost.



Ref copper weights IPC-6012!

HARD COST DRIVERS

Copper foil weights



HARD COST DRIVERS

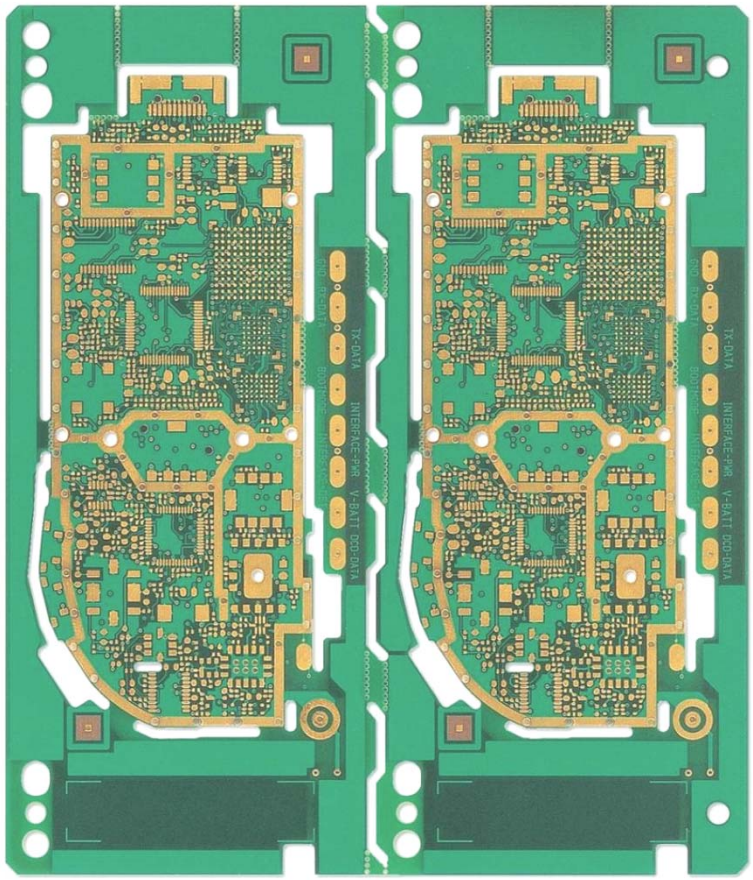
Soldermask, legend / silkscreen, carbon print

- **Each one is a separate screen print / cure operation**
- **Cost can be in the region of 2-5% extra dependant upon technology**
- **‘High end’ or specific soldermask types (high chemical resistance for example) can also add more to the price**
- **Thick soldermask requirements = double coat = additional cost**

HARD COST DRIVERS

Surface finishes

Type	2-Layer	12-Layer
OSP	0%	0%
HASL	0%	0%
LF HASL	3%	0,8%
Imm Ag	18%	4.5%
Imm Sn	18%	4.5%
ENIG	22%	5.5%
ENEPIG	By quote	By quote




Soft Cost Drivers

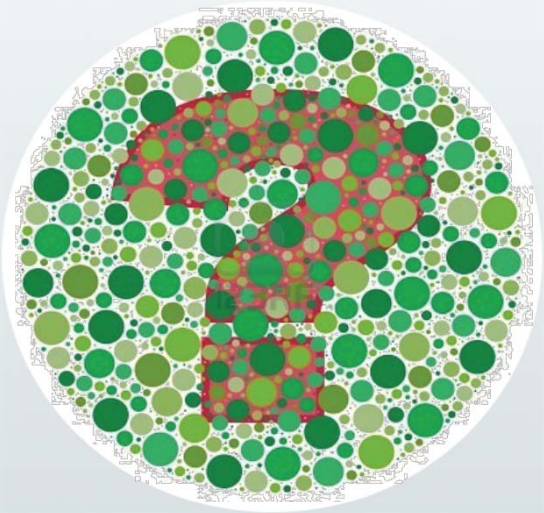
SOFT COST DRIVERS

Under specification

NCAB Group often experiences examples of under-specification (lack of vital information) resulting in time consuming review / investigation, which often causes costly delays or confusion, and also prevents acceptance expectations being fully understand at the very start.

Some typical examples of missing information:

- Contour detail
- Lack of detail regarding PTH vs. NPTH designations
- Surface finish not specified
- Copper thickness
- Base material information not provided
- Soldermask colour
- Thickness of finished board
- Missing Gerber files
- Etc…



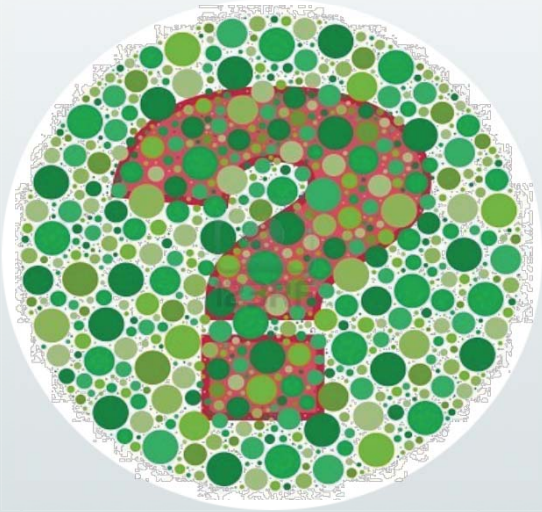
SOFT COST DRIVERS

Over specification

NCAB Group also experiences cases / examples of over-specification (too much information) and whilst with under specification the time is spent searching for missing information, here the time and effort is spent of reviewing every single piece of information and determining what parts are critical for the PCB. As may be imagined this can cause delays.

Examples of over-specification:

- Long specification, takes time to understand
- References to specifications not widely used, such as DIN, BS, IEC etc.
- Over specification can lead to contradictory information
- Over specification can lead to excessively high demands / reliability classification despite purpose



SOFT COST DRIVERS

Reliability

NCAB Group does not often experience demands for high reliability (normally IPC class 3) that are not borne out of end product usage demands.

It’s easy to specify the highest demand without real or full knowledge of the consequences – in both commercial and supply chain terms.

The cost increase involved in achieving such high reliability demands will be extremely high.

SOFT COST DRIVERS

Reliability

To be able to fulfill all demands in accordance IPC class 3, the following three major points must be controlled:

- Design: a tight design might drive the cost or even make it impossible to fulfil the demands.
- Process control: a ‘serious’ factory will have very stable and well controlled processes.
- Verification: the verification on a product level for IPC class 3 is extremely time consuming and should really only be applied for the most demanding of products.

SOFT COST DRIVERS

Reliability

Sampling plan (verification) according to IPC6012, 6013, yellow marking for structural integrity which requires micro section analysis.

Table 4-2 C=0 Sampling Plan (Sample Size for Specific Index Value*)

Lot Size	Class 1			Class 2			Class 3		
	2.5*	4.0*	6.5*	1.5*	2.5*	4.0*	0.10*	2.5*	4.0*
1-8	5	3	2	**	5	3	**	5	3
9-15	5	3	2	8	5	3	**	5	3
16-25	5	3	3	8	5	3	**	5	3
26-50	5	5	5	8	5	5	**	5	5
51-90	7	6	5	8	7	6	**	7	6
91-150	11	7	6	12	11	7	125	11	7
151-280	13	10	7	19	13	10	125	13	10
281-500	16	11	9	21	16	11	125	16	11
501-1200	19	15	11	27	19	15	125	19	15
1201-3200	23	18	13	35	23	18	125	23	18
3201-10,000	29	22	15	38	29	22	192	29	22
10,001-35,000	35	29	15	46	35	29	294	35	29

SOFT COST DRIVERS

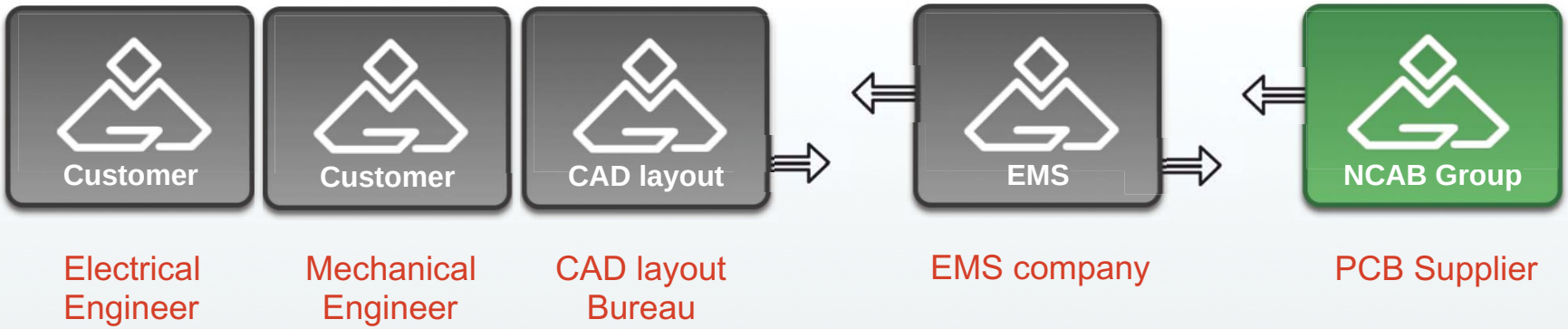
Lack of knowledge, communication, willingness

It is very common that bad design, unsuitable material, wasteful panel layouts, etc. is built in at an early stage due to a lack of knowledge, communication with the volume provider or willingness to challenge ‘the’ current way’.

When faced with critical time to market situations, it is all to easy to say:
“*it doesn’t matter, this is just the prototype, we can look at / fix this later*” …

Often this leads to no change being implemented as once the prototypes are approved, the design stays ‘firm’.

Summary

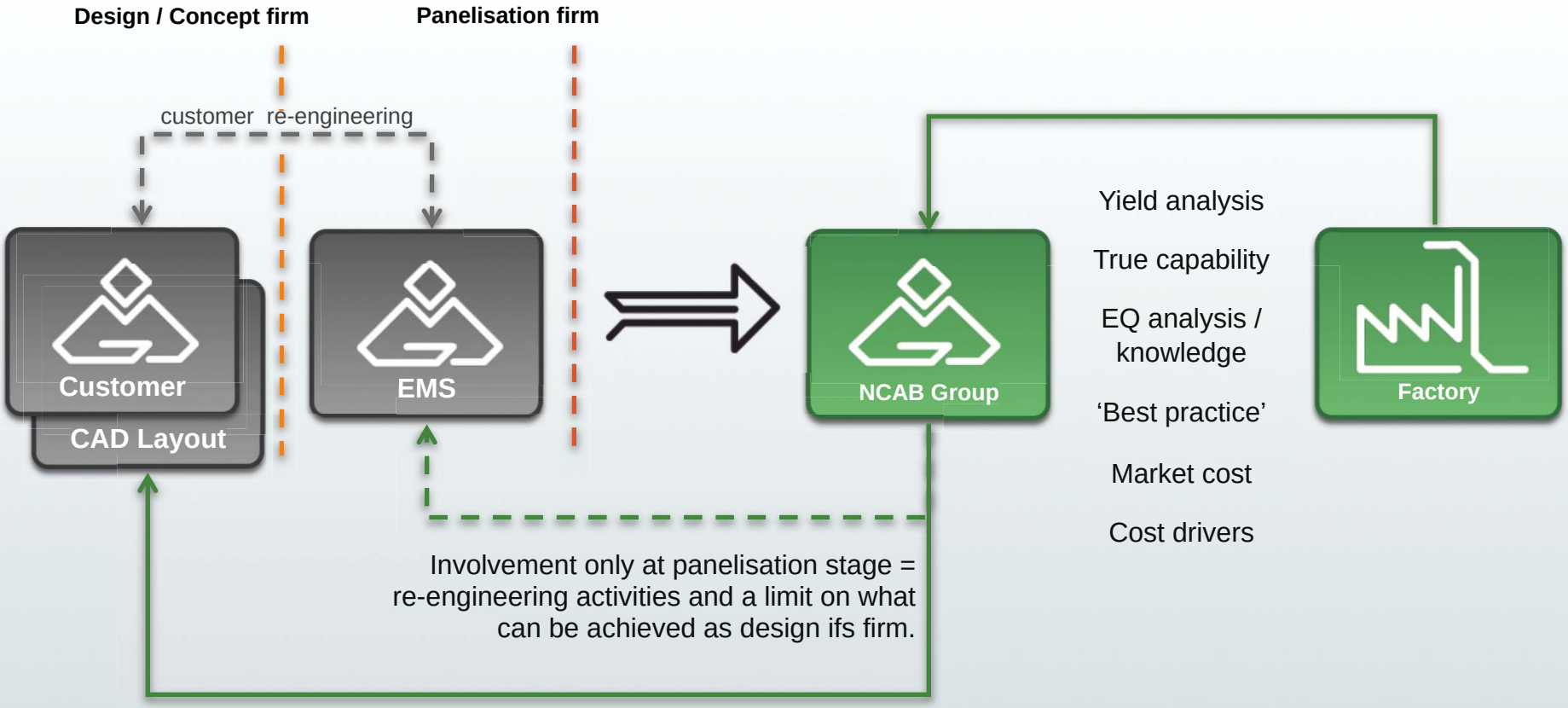


We are <u>all</u> involved in the supply chain for each and every unique PCB, and we have the expertise that can bring your products to market as quick and as well engineered as possible.

But this has to be considered as early as possible within the supply chain.

PCB COST DRIVERS

When to initiate



Seamless involvement at concept stage = building in cost effective designs for volume supply & allows real time DFM input with design teams.

Questions?

NCAB GROUP SEMINARS

Improve your knowledge about PCBs – participate in our seminars

- Technical trends in the global PCB industry
- How to produce a printed circuit boards
- New technologies
- Cost drivers in PCB production
- Surface finishes
- HDI - High Density Interconnect
- IMS - Insulated Metal Substrate
- Rigid-flex
- NCAB Group PCB Specification
- Impedance controlled boards
- DFM – Design For Manufacturing
- IPC vs. Perfag
- Reliability, IPC & NCAB
- Material for lead-free production
- Technical advice
- NCAB Group Laboratory