PCB Cost drivers

What drives the cost of a circuit board?

80-90% of cost

10-20% of cost

The ‘hard costs’ and the ‘soft costs’.

Hard cost drivers

- PCB size
- Layer count
- Build/complexity
- Via treatments
- Material / panel utilization
- Track and gap
- Hole (size & quantity)
- Additional drilled/routed features
- Hard gold/thick gold
- Impedance
- Excessive tolerances
- Copper foil weights
- Soldermask, legend/silkscreen, carbon print
- Surface finishes
- Materials

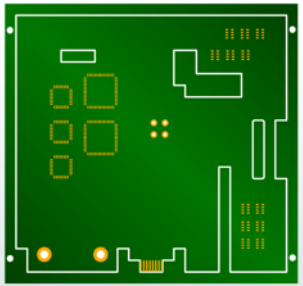
HARD COST DRIVERS

The PCB size

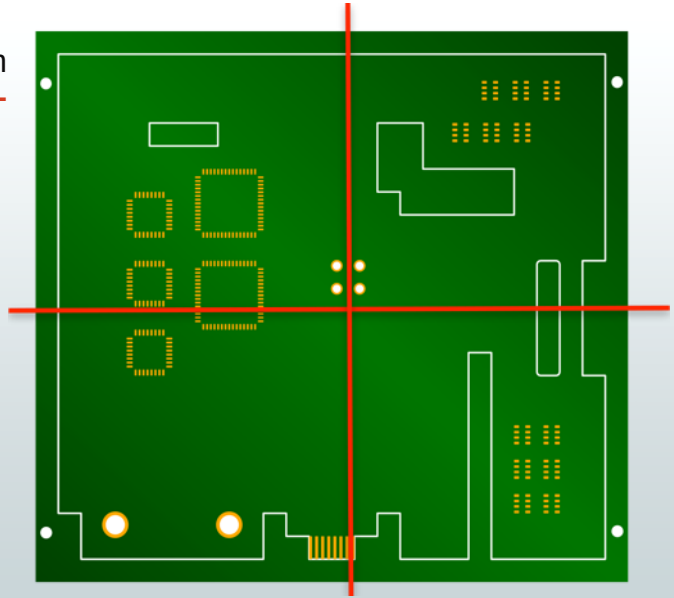
If we are able to reduce the size:

SUSTAINABILITY IMPACT METER

Size 150*150mm
Price x1
(base price)



Size 300*300mm
Price x4+



HARD COST DRIVERS

Layer count

If we can reduce the number of layers:

SUSTAINABILITY IMPACT METER

Specific reasons for layer count driving cost:

- Each layer will have to go through the same various processes
- Cost for each of the inner layers / dry film
- Increased material cost and processing cost
- Developing / Etching / AOI inspection for each inner layer
- Labor costs
- Black / brown oxide for each inner layer
- Cost for each piece of pre-preg used between layers
- Pressing / bonding cycles necessary

1	›	2 layer	**+45%**
2	›	4 layer	**+40-45%**
4	›	6 layer	**+35-40%**
6	›	8 layer	**+30-35%**
8	›	10 layer	**+25-30%**
10	›	12 layer	**+25-30%**
12	›	14 layer	**+15-20%**

The figures above are average cost adders based upon a cross section of factories. As such these figures shall only be considered as a guide or point of reference.

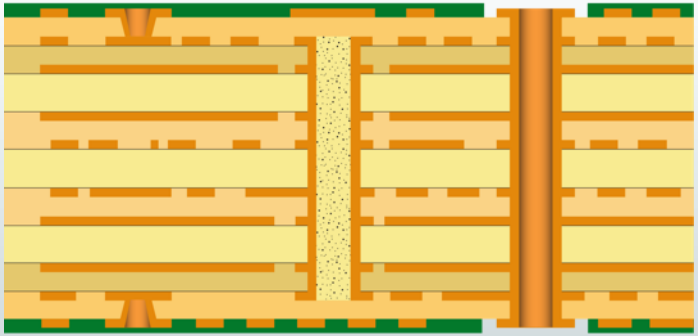
HARD COST DRIVERS

Build / Complexity

If we are able to design a less complex board:

SUSTAINABILITY IMPACT METER

10L PCB	Base price
Layer of microvia **(1+8+1)**	**+ 40 - 70%**
Buried via and microvia **(1+8b+1)**	**+ 80 - 120%**
Buried via and microvia with copper fill	**+ 120 - 140%**



HARD COST DRIVERS

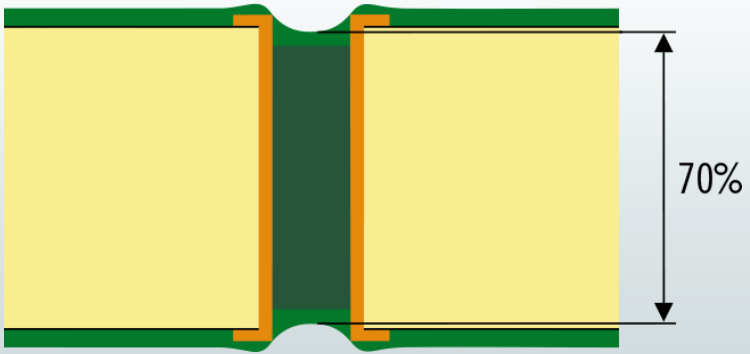
Via treatments

If we are able to reduce or eliminate via treatments:

SUSTAINABILITY IMPACT METER

Via treatment cost impact

Soldermask covered (Tented)	**+0%**
Soldermask plug	**+1-5%**
Type VI	**+5-10%**
Type VII Nonconductive resin	**+7-12%**
Type VII Conductive resin	**20+%**, subject to material MOV

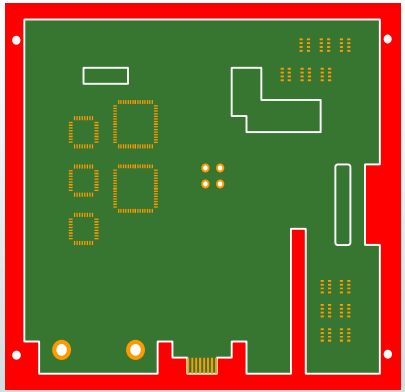


HARD COST DRIVERS

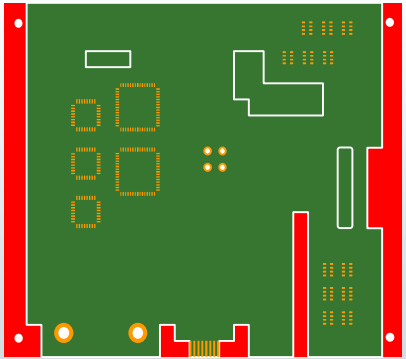
Material / panel utilization – Example 1

If we make the best use of space on the panel:

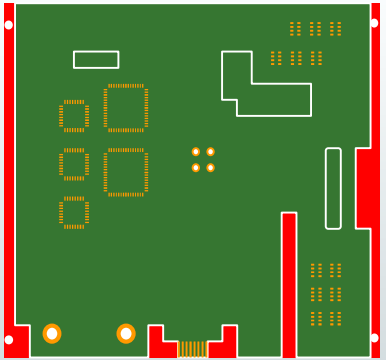
SUSTAINABILITY IMPACT METER



Panelization 1



Panelization 2

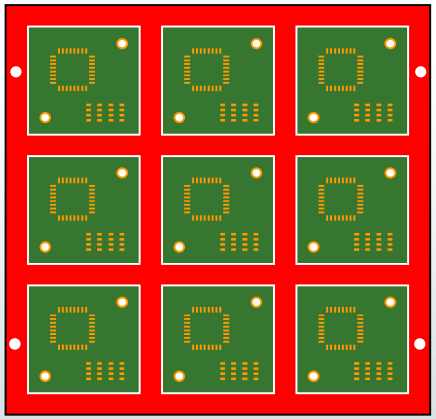


Panelization 3

Material / panel utilization – Example 2

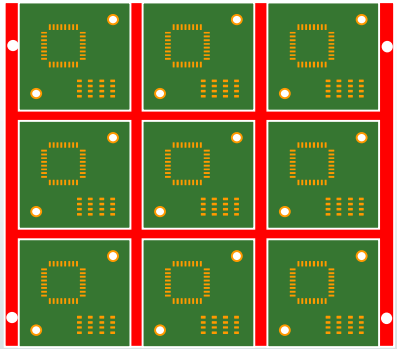
If we make the best use of space on the panel:

SUSTAINABILITY IMPACT METER



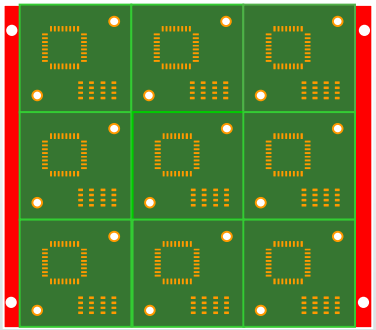
Panelisation 1

Panel option 1 = 1 panel of 9 circuits,
40mm x 40mm, 10mm carrier rail on 4x sides.
Route gap 2.4mm between all circuits
Total Panel size = 304.15 mm^2



Panelisation 2

Panel option 2 = 5mm carrier rail on 2x sides.
Route gap 2.4mm between all circuits,
Total Panel size = 215.54mm^2
Material reduction = **29%**



Panelisation 3

Panel option 3 = 5mm carrier rail on
2x sides. Score lines between all circuits.
Total Panel size = 156.00mm^2
Material reduction = **49%**

HARD COST DRIVERS

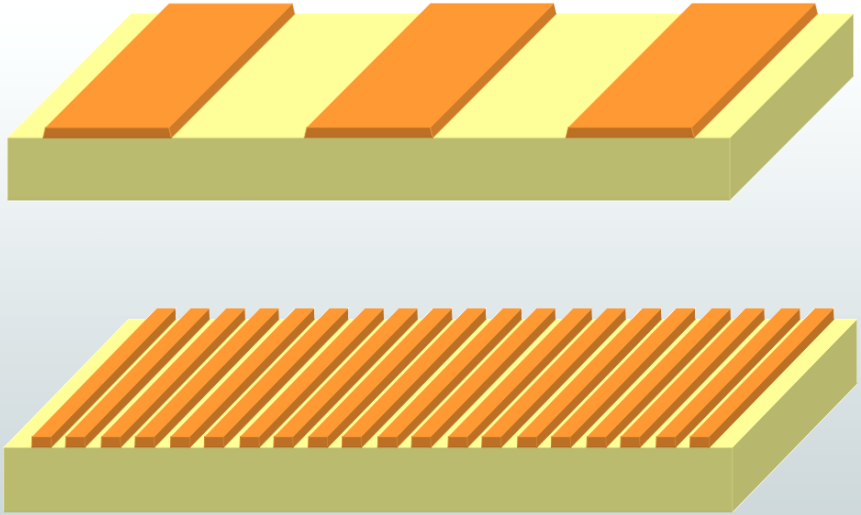
Track and gap

If we are able to decrease the amount of smaller/finer traces and spaces:

SUSTAINABILITY IMPACT METER

How does this influence the design and cost?

- Length of fine line tracks
- Copper weight / base foil
- Exposure units
- Etching methods
- Handling methods
- Type of clean room
- Additive processing vs traditional imaging



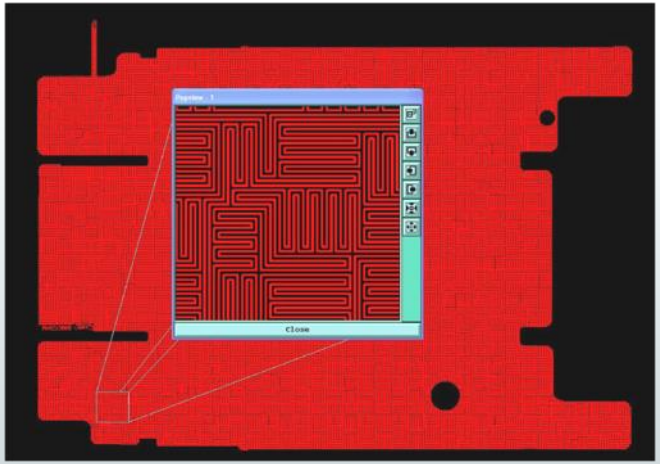
HARD COST DRIVERS

Track and gap

If we are able to decrease the amount of smaller/finer traces and spaces:

SUSTAINABILITY IMPACT METER

Fine features should be used sparingly, if you don’t need an entire layer to be fine featured only have as much miniaturization as needed.



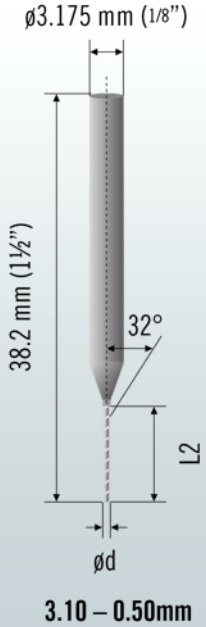
HARD COST DRIVERS

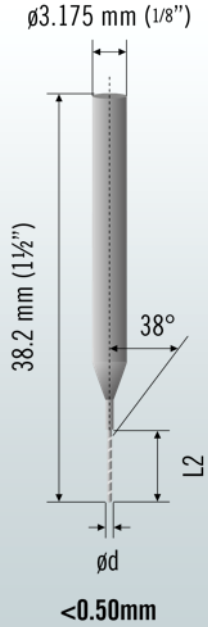
Hole (size & quantity)

If we are able to reduce the number of holes and increase the size:

SUSTAINABILITY IMPACT METER

This graphic shows two mechanical drill bits, the smaller having a shorted flute which is the part of the bit that does the actually drilling.





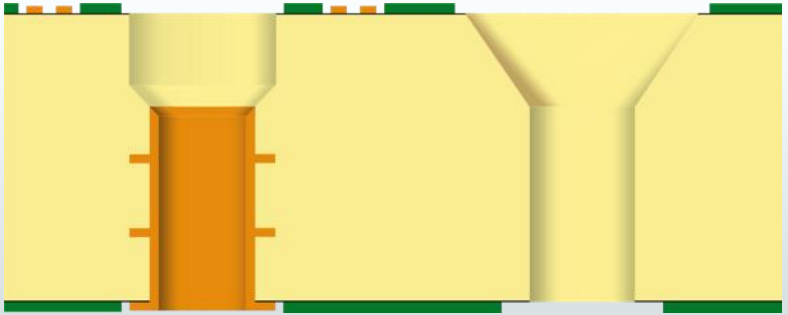
HARD COST DRIVERS

Additional drilled/routed features

If we are able to reduce the amount of drilled/routed features, or the size:

SUSTAINABILITY IMPACT METER

- Counter bores
- Countersinks
- Backdrilling
- Controlled depth milling
- Double sided routing processes.



HARD COST DRIVERS

Hard gold / thick gold

If we can decrease the amount of hard and/or thick gold:

SUSTAINABILITY IMPACT METER

Examples of common cost adders for hard/thick gold:

- Extra dry film process
- Additional space necessary for tracks to connect necessary areas
- Less panel utilization with boards with slot-in contacts

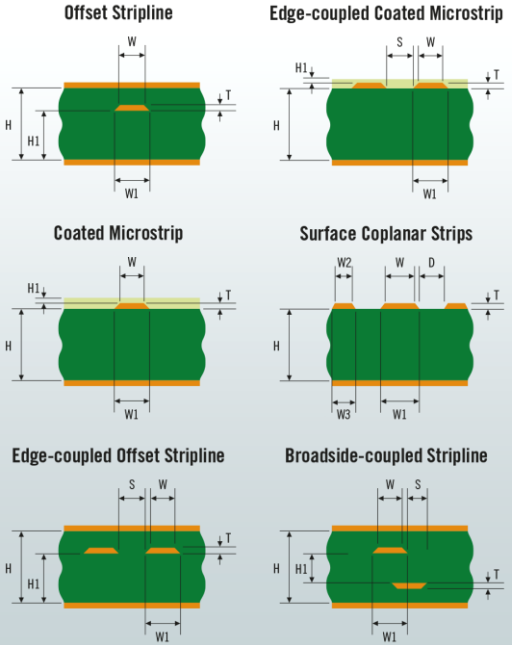
HARD COST DRIVERS

Impedance

If we can reduce impedance needed:

SUSTAINABILITY IMPACT METER

- Controlled impedance is a cost driver because it demands very specific controls on line width and spacing along with the dielectric spacing. The production panel must have extra space available for the testing coupons and the actual testing of the coupons via Time Domain Reflectometer test (TDR) is a non-standard process requiring labor.
- This graphic illustrates some common track structures for impedance variables along with the variable type.



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%
- Line width tolerance tighter than IPC standard

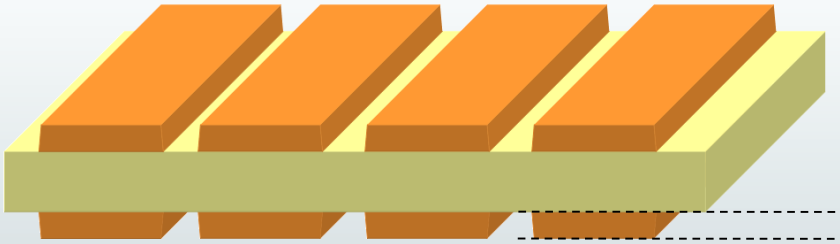
If we are able to eliminate unneeded excessive tolerances:

HARD COST DRIVERS

Copper foil weights (thickness)

If we are able to reduce the amount of copper:

SUSTAINABILITY IMPACT METER



Ref copper weights IPC-6012!

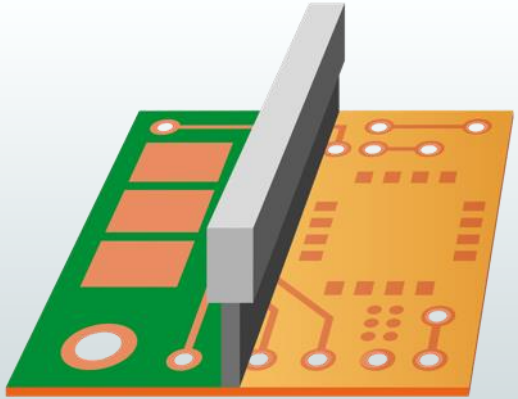
HARD COST DRIVERS

Soldermask, legend / silkscreen, carbon print

If we are able to eliminate or reduce specialized solder mask requirement and/or legend silkscreen:

SUSTAINABILITY IMPACT METER

- Each one is a separate screen print / cure operation
- Cost can be in the region of 2-5% extra dependent upon technology
- Specific soldermask types and colors (high chemical resistance, or blue soldermask for example) can also add more to the price due to material cost, complexity of application or available factory capability.
- Thick soldermask requirements or heavy copper may require multiple coats increasing labor and throughput.



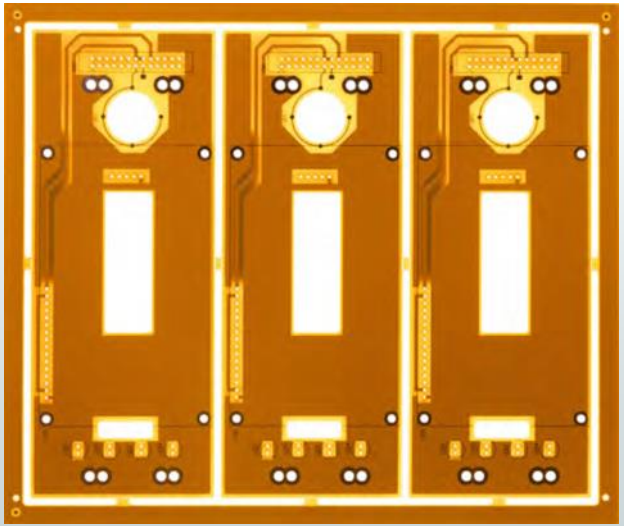
HARD COST DRIVERS

Surface finishes

If we are able to use more common surface finishes:

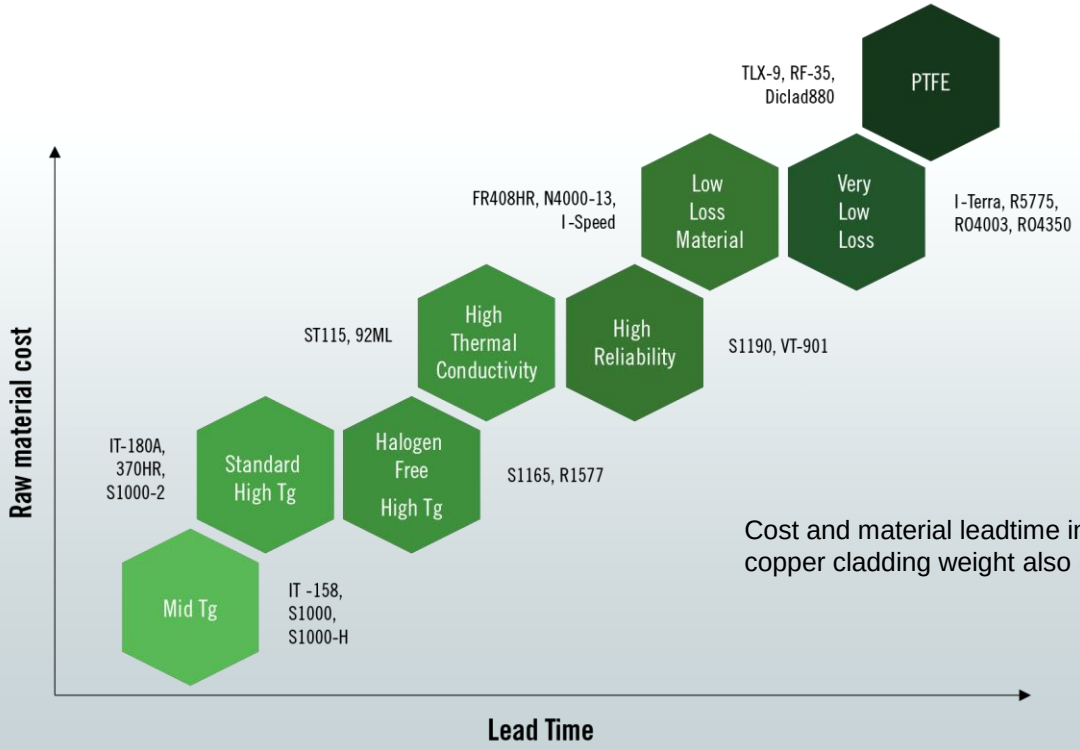
SUSTAINABILITY IMPACT METER

Type	2-Layer	12-Layer
OSP	0%	0%
HASL	0%	0%
LF HASL	0 - 4%	0 - 1%
Imm Ag	18%	4%
Imm Sn	18%	4%
ENIG	28%	6%
ENEPIG	By quote	By quote



HARD COST DRIVERS

Materials



Cost and material leadtime increase as base copper cladding weight also increases.

If we are able to use more common base materials:

SUSTAINABILITY IMPACT METER

Soft cost drivers

- Under specification
- Over specification
- Reliability
- Lead times
- Transportation costs
- Lack of knowledge, communication, willingness

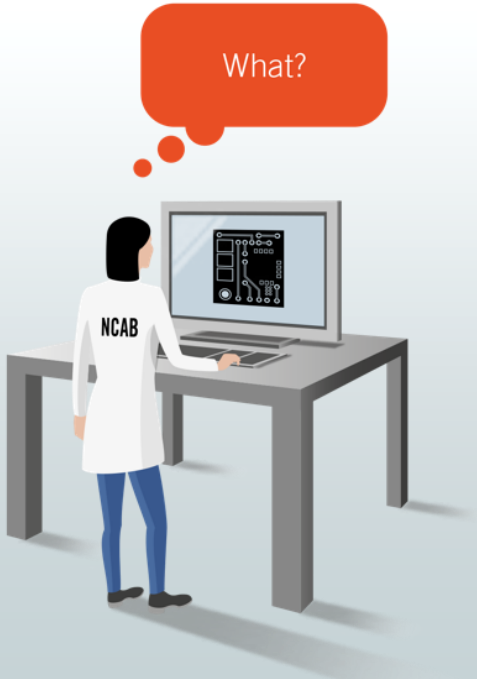
SOFT COST DRIVERS

Under specification

If we specify more clearly:

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 color
- Thickness of finished board
- Missing Gerber files
- Etc…



SOFT COST DRIVERS

Over specification

If we have too much or unnecessary information:

SUSTAINABILITY IMPACT METER

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

If we design to IPC Class needed rather than Class III which is not needed often:

SUSTAINABILITY IMPACT METER

To be able to fulfil 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

Lead times

If we are able to manage with longer lead times:

SUSTAINABILITY IMPACT METER

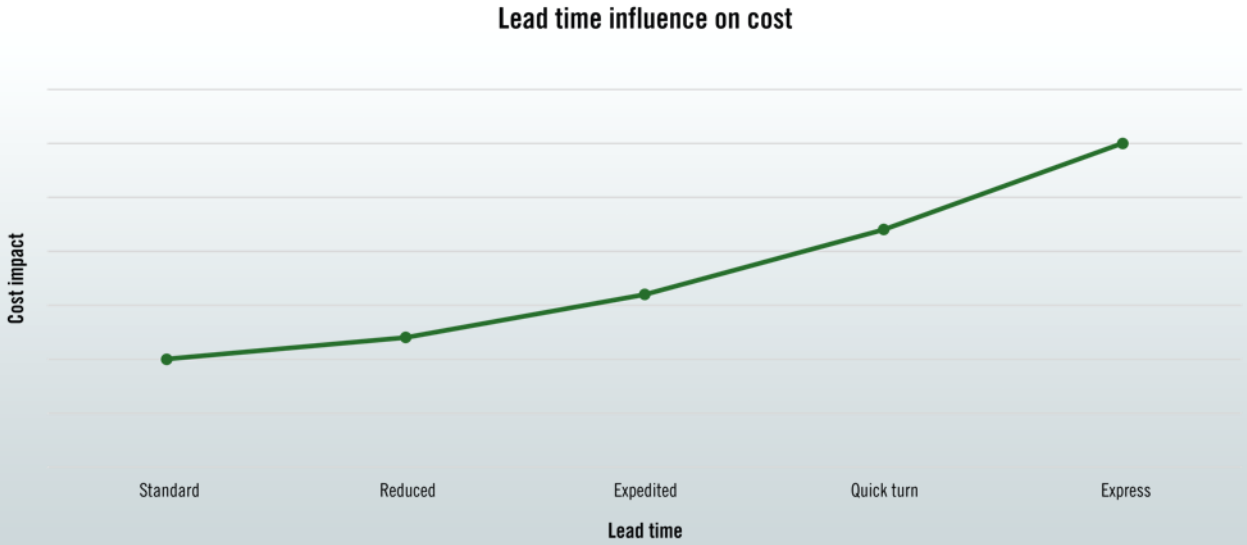
20 days x**1 (Base price)**

15 days x**1.2**

10 days x**1.5**

5 days x**2**

3 days x**2.5**



SOFT COST DRIVERS

Transportation costs

If we are able to choose various freight methods:

SUSTAINABILITY IMPACT METER

Transportation can be a varied sustainability driver. Expedited freight methods typically have a larger carbon footprint than slower methods.

SOFT COST DRIVERS

Lack of knowledge, communication, willingness

If we are able to communicate with the experts from the start of the design phase:

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 too easy to say: **“it doesn’t matter, this is just the prototype, we can look at or fix this later…”**

This can lead to delays or problems when the build gets to volume production. NCAB recommends working with our Field Application Engineers, at the earliest design stages, in order to optimize the design.

PCB Cost Drivers – summary