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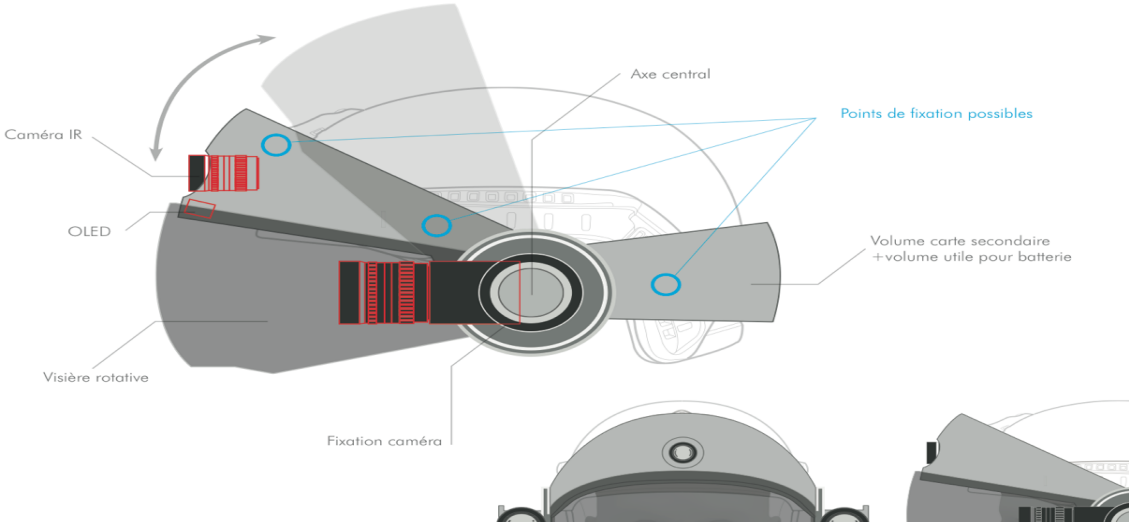
NEXVISION
OPTRONIC DESIGN

How To Make A Tangible Embedded Product

from your lab developed's algorithm

WE DESIGN
INNOVATIVE VISION SYSTEMS
FOR ANY MARKET
ALL OVER THE WORLD



INTRODUCTION

- Nexvision is an European specialist in embedded electro-optics system design

- Our expertise includes optics, multispectral sensors, image processing and analysis, compression and streaming on FPGA, GPU and CPU, on several markets

- We design complete embedded system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TEGRA MODULE
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KINTEX

CASE STUDY: VTOL GIMBAL [1/4]

An advanced guimbal for situational awareness

- One of the desired feature requirement:
  1. Detect helideck from 2 nautical miles away
  2. Track the detected helideck to help the autopilot plan the flight path
  3. Detect obstacles on the computed route

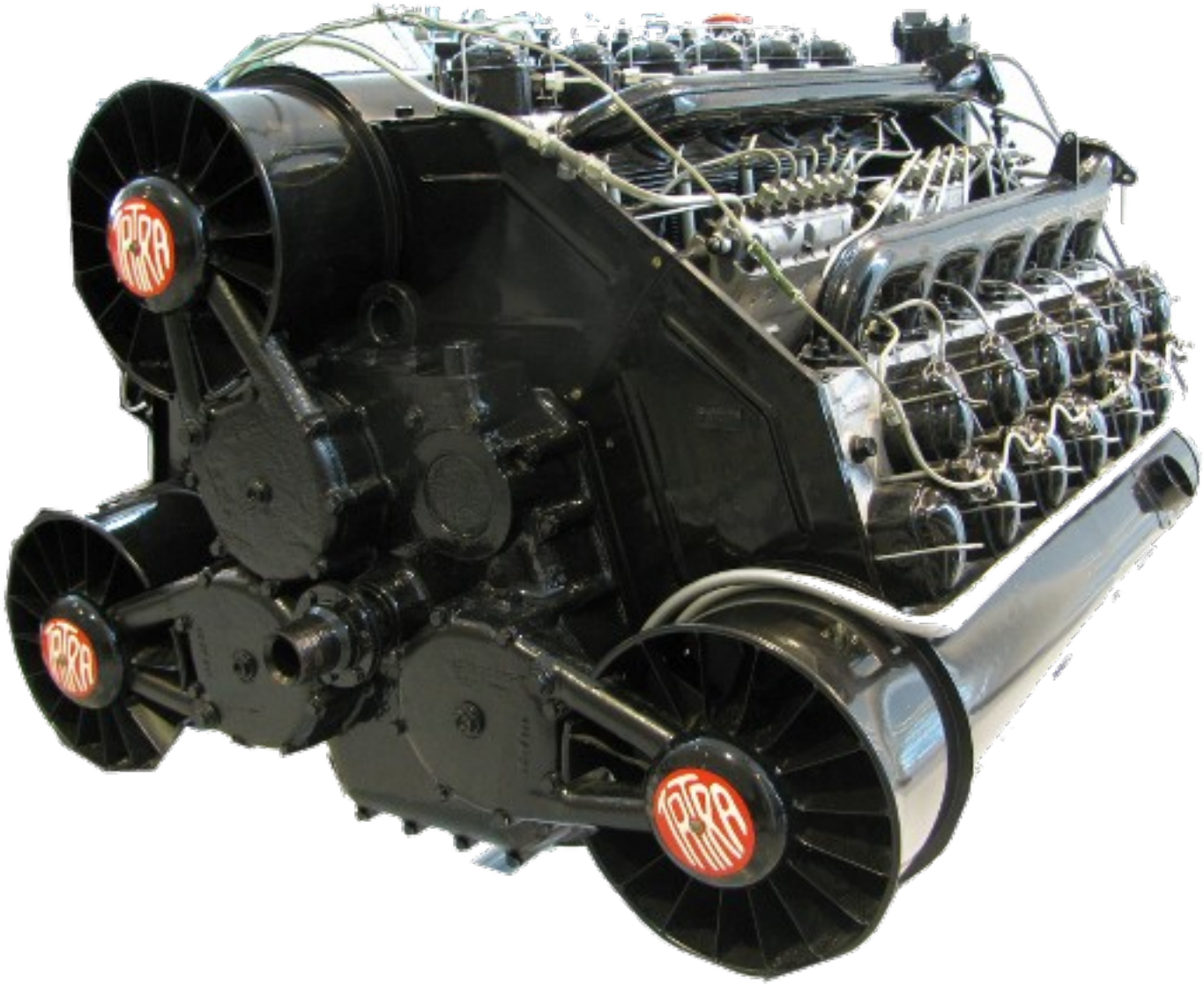
CASE STUDY: VTOL GIMBAL [2/4]

Typical process:

- Is it possible to achieve this requirement ?
- How to perform this task ?
  - Which algorithms ?
  - Which platform ?
  - Environmental conditions ?
  - How to test/assert the implementation ?

Resumes to...

How to fit ☞



In this ☞

PC GPU VS EMBEDDED GPU [obvious diff]

- Processing power
- Power consumption
- Form factor
- Location of processing algorithms (CPU, GPU, ISP)

PC GPU VS EMBEDDED GPU [less obvious diff]

- Managing the industrial image sensors (not MIPI) and their bandwidth
- Signal processing (pre/post processing and comp. offloading)
- Is an additional different sensor more efficient to simplify further processing?

PC GPU VS EMBEDDED GPU [less obvious diff]

- FPGA based ISP for the other sensor types (linear, SWIR/Thermal/THz, beam forming radar, ...)
- High speed feedback loop and signal latency optimization
- Backing up processing results for subsequent error analysis and feedback reporting

INDUSTRIAL PRODUCT DESIGN PROCESS

Before starting the process

1. Profile the algorithm on a Jetson dev board
2. Does it run within the given latency budget ?

Yet it's a...

- Bad idea: To expect the input signal from the embedded system to match the lab's test sequences.
- Bad idea: Using “black boxes”
- Good idea: To specify type and format of the input signal (dynamic range, SNR, frame-rate)

STRATEGY FOR ALGORITHM FITTING

- Is it possible to move part of it in the pre-processing part ?

Rule of thumb:

Ease of development: **CPU** > **GPU** > **FPGA** > **ASIC**

Processing speed & dev cost: **ASIC** > **FPGA** > **GPU** > **CPU**

- Else => Required embedded power w/technical constraints (power consumption / weight / size / environment)

CASE STUDY: VTOL GIMBAL [3/4]

- Tracking algorithm could not run in realtime with the selected 12MP image sensor
- Algorithm profiling charged the feature point extraction code for half of the processing time
- Optimizing the algorithm more would have used too many time and gains were asymptotically decreasing. Instead, we moved the HOG computation code in the FPGA's ISP
- The GPU relaxed and we could focus on other algorithms optimization.

CASE STUDY: VTOL GIMBAL [4/4]

- Which platform ? 3 IS + 2 FPGA + 3 Tegra K1 SOC ✓
  1. Tegra K1 because industrial temp condition
  2. 2 GPU because aero safety requirement of independent algorithms
  3. One FPGA to deal with 3 IS preprocessing and computing HOG

- Which environmental conditions and how to test/assert the implementation ? ✓
  1. Build only one prototype that'll be used flight tests used to record test sequences and capture env conditions, vibration, exposure time, contrast, dynamic range in real conditions
  2. Then build the product

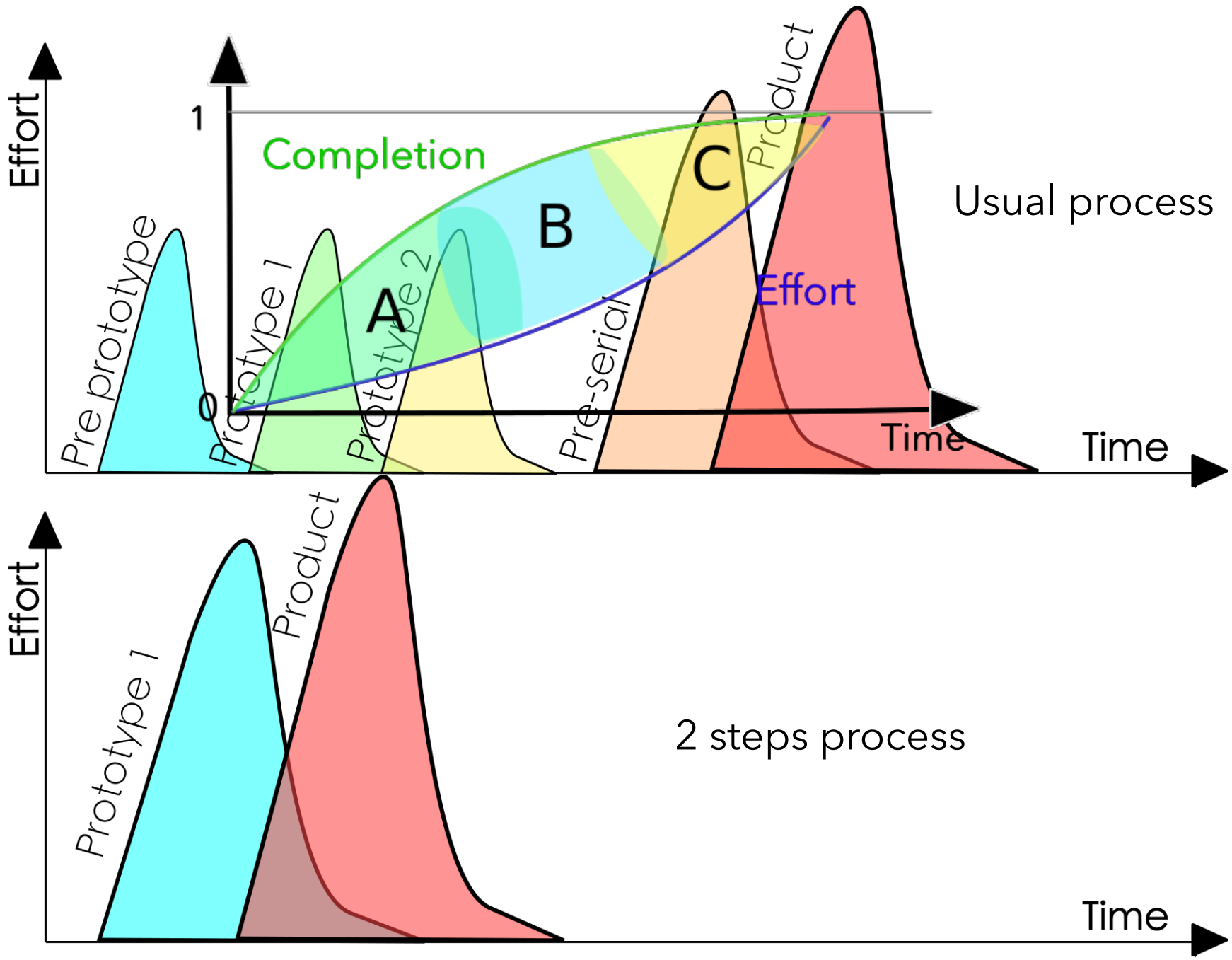
INDUSTRIAL PRODUCT DESIGN PROCESS

- Design of a first electronic board (and mechanical structure) for a prototype
- Usually reuse IP as it saves dev. time and TTM
- Development of:
  1. Hardware boards
  2. Firmware for the ISP chip
  3. Software stack for the CPU
  4. Signal analysis stack for the GPU
  5. Test/reporting stack for all components

TIME SAVING IN IND. PRODUCT DESIGN

- Don't double spend your product development budget
  1. Use the first prototype to tests all the crazy ideas you have
  2. Capture as much data as possible from all your sensors
  3. Don't skip the input signal preprocessing step
  4. But don't re-invent the wheel for the ISP code
  5. No more 3+ steps development
  6. Use your customers as beta testers, they love it

"we'll see later" is a bad motto.


Effort
1
Completion
Pre prototype
Prototype 1
Prototype 2
A
B
C
Pre-serial
Product
Effort
0
Time
Time
Usual process
Effort
Prototype 1
Product
2 steps process
Time

CONCLUSION

- No black box.
- Straight to the product.
- Real-world input signal.
- Early customer implication in project.

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