# WHAT INTEGRATED CIRCUIT INDUSTRY NEEDS FROM NTNU

Carsten Wulff, 2021-10-26, version 1.0

***We give an outline of what we in the industry needs in terms of skills and qualities.***

## 1. WHO

The audience is educators of bachelor, master, or Ph.D in electronic circuits.

## 2. WHY

When we search for new employees, there are skills that we look for, and qualities that we value. We don't hire unless there is a match.

Within some skills, there is insufficient capacity in Norway to meet demand, and companies need to bring in resources from outside Norway.

Integrated circuit companies in Norway mostly use a foundry less model, although some parent companies have fabs, which means that we focus on the design of integrated circuits, but much less on how the integrated circuits are manufactured. We need people that know how to design, test, and use integrated circuits.

It's an advantage that some employees know how integrated circuits are manufactured, but they do not need to be able manufacture integrated circuits. Knowing how integrated circuits are made helps inform design, test, and debug of integrated circuits. As of 2021, there are no large volume fabs in Norway for modern integrated circuits.

A typical integrated circuit design chain is shown in the Figure 1.

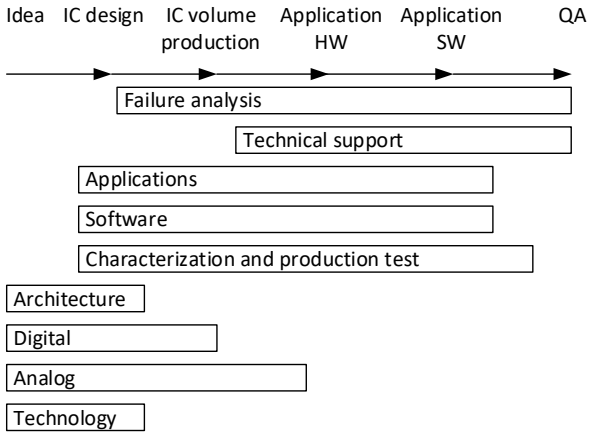


*Figure 1 Typical disciplines needed for the Integrated Circuit Design flow, and when the main workload during development is.*

## 3. SKILLS

Integrated circuit design requires us to be well versed in how to design and verify (analog, digital, RF, architecture), how to characterize and test (PCB, instruments, production test) and how to use (software, example hardware, solving customer problems) integrated circuits.

In the table below we give an outline of required skills and approximate yearly demand.

| Skill | NTNU department or professors | Yearly demand |
|---|---|---|
| General skill | | |
| Embedded programmers | Computer Science | 25 |
| Digital design | Kjeldsberg,Larsen,Aunet, Kursun, Orlandic | 15 |
| Embedded protocols – wired and wireless | Telecom, Computer Science | 10 |
| Analog & RF CMOS IC Design | Ytterdal, Aunet | 10 |
| Desktop programmers | Computer Science | 10 |
| Specialized skill | | |
| Prototype and production test engineers | | 5 |
| Software development tools - toolchain | Computer Science | 5 |
| Analog IC Layout | | <5 |
| PCB production test and user applications | | <5 |
| App developers | | <5 |
| Radio algorithms | Kansanen, Ekman | <5 |
| FPGA implementation | Orlandic | <5 |
| Design for test | | <5 |
| Chip synthesis and static checks | | <5 |
| Chip Physical Design | | <5 |
| Formal verification | Kjeldsberg | <5 |
| Electronics developers (PCB) | Midjo | <5 |
| Antenna design | Olavsbråten, Eide | <5 |
| RF (not CMOS), MMIC | Olavsbråten | <5 |
| Real number System Verilog models of analog systems | | <5 |

## 4. QUALITIES

The skills above are necessary, but not sufficient. Some of the additional qualities we look for are.

*Honesty*: Making integrated circuits is an expensive endeavor. As humans, we will always make mistakes, or fail to imagine how what we make will not work. The cost of mistakes increases exponentially the closer we are to a volume product. As such, finding mistakes early is necessary to reduce cost. If people are honest, and acknowledge immediately that something has gone wrong, that can give us time to fix the problem before it costs millions.

*Responsibility:* Time to market is essential in integrated circuits. We must meet the market window for a particular product. Complex projects will be broken down into pieces, and milestones. We require those milestones to be met, as such, we need people that take responsibility, and ensure that milestones are met. If their milestone depends on a delivery from someone else, they need to follow up, and help to ensure that the overall milestones are met.

*Logical thinking:* When things go wrong, we need people that will dig into the problem and find the real physical root cause. There is no place for "hand-wavy" arguments, or arguments from authority "I know everything, so you should listen to me". We deal with physics, and in integrated circuits, how something fails always have a physical reason.

*Humility:* Realizing that humans are fallible, but we should strive for not doing the same mistake twice.

*Diversity:* An employee's brain must have the right skills and the right qualities. We strive for diversity, free from discrimination due to gender, nationality, origin, and religion.

*Ability to learn*: As an engineer you're never finished learning. Integrated circuit electronics is a deep skill, and you will need the ability to learn new things.

*Curiosity:* We want engineers that like to understand how things work. There should be an inherent drive to figure things out.

*Be fearless:* Don't be afraid of asking questions. Be forward leaning. Act. Champion your ideas.