

## Semiconductors 101, unit 24

# From R&D to production: who goes first, and how the handoff works

A new chip, from the first time it's made in a fab to steady high-volume shipments, passes through several legs: design, the fab, test, reliability, the customer and the production fab. This is new product introduction (NPI). A new process generation, or a chip that needs new steps, is also often made

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and made stable on the R&D line first. Each leg is taken over by different people, and how clear the handoff is decides how well the next people can do their job.

# Goals

- 1 Say who takes over at each stage of new product introduction (NPI), from tape-out, the pilot run and revisions to reliability tests, the customer's approval and the handover to volume production, and what question the R&D line and the production fab each ask.
- 2 Know what a technology transfer hands over: the standard process (POR), specs, work instructions, training and reliability data.
- 3 Know how Production control, Manufacturing, Equipment, Process and Integration share the work once production starts, and how word passes from one to the next when something goes wrong.

# New product introduction (NPI): passed on leg by leg

Taking a newly designed chip from the first time it's made in a fab to steady, high-volume shipments is called new product introduction (NPI), and it runs like a relay: the customer tapes out, the photomasks are made, and the fab takes over, starting the wafers of a pilot run. Results that look like the process go to the fab's engineers and results that look like the design go back to the designers; send them to the wrong people and both sides waste their time. If the problem is in the design, there's a revision: the affected masks are remade, which costs several more months. Then the reliability lab and QA run the reliability tests, and the customer, or the company building the chip into its product, tries samples in that product; only once they're approved does the volume order come in. Finally the conditions are fixed and handed to the production fab, and in volume production yield climbs further. On a process already in volume production, the first lot often runs straight in the production fab; when a new step is needed, it often goes to the R&D line first. Whoever runs the NPI is like the coach: setting the schedule, following every lot, getting each problem to the right person and writing down every decision.

# First, the R&D line: can we make it, and why did it fail?

When a new process generation, or a new product that adds or changes some steps, is made for the first time, those first lots are the pilot run, and they are often made on the R&D line. The R&D line has every kind of tool, but often only one or two of each; it makes a few wafers at a time and asks "can we make it, and why did it fail?" The trials don't happen in the production fab because its tools are booked every day with wafers owed to customers, and each side would slow the other down. The R&D integration engineer is in charge of the first lot: splitting the wafers into groups that each change one condition, and making a few fast or slow on purpose to see whether the design holds up. Most electrical results can only be measured once the whole wafer is finished, often weeks after wafer start: WAT comes first (measuring test structures, or test keys, left in the scribe lines between chips), then every chip is tested and drawn as a wafer map, where the shape of the failures gives clues; suspect the measurement before the process. Each problem found goes to the R&D process engineer for that area, who tries a few settings, measures, looks at cross-sections, settles on one and writes it into that step's box in the standard process.

# Technology transfer: more than one list of settings

Once the process is stable, yield has reached its target and the reliability tests have passed, the whole package goes to the production fab; this is technology transfer. It includes the standard process (the POR: which kind of tool and which settings every step uses), specs (what each step's measurement should be), work instructions (so someone else can follow them and get the same result), training (production fab staff come to the R&D line to learn first), and reliability data showing the chips won't fail early. Before it goes, there is a transfer review that checks every item: anything marked "done" has to be backed by something real. Once the POR is locked, changing any number goes through change control.

# After the handoff: everyone covers a stretch, and word has to get through

After the handoff, Production control looks days to months ahead, turning the customer's quantities and dates into how many wafers to start each week and which lots go first; Manufacturing looks at this shift, dispatching to the plan and pushing lots from tool to tool. When a tool stops in the night, the equipment engineer checks the hardware and the process engineer judges whether the wafers stuck inside can be saved; Process and Integration judge, by the OCAP, whether a lot on hold continues, is reworked or is scrapped, and releasing a lot that didn't follow the rules takes a written deviation reviewed by quality; Production control works out whether the ship date moves, and the sales rep tells the customer. The customer can't see inside the fab and decides based on what the contact person says, so what has been checked and what is still unknown are told apart; the same goes for colleagues inside the fab: say things clearly and calmly.

# Common misconceptions

**People say: Once the R&D line has made it, the production fab just copies the settings.**

In fact: Run the same settings on a different tool, and the result can change: how worn the parts are, what state the tool itself is in, every tool is a little different. A production fab has several tools of each kind, and each one has to be tuned to give the same result; this is called tool matching. And after the handoff, yield in early production usually still has some way to climb.

**People say: If the customer is in a hurry, start one more lot and they'll get it sooner.**

In fact: A newly started wafer has to go through every station from the first one, which takes months again, so it does nothing for a date that's close. The cards that can be played are making a lot a hot lot or using a lot that's already far down the line, but whichever card is played, some other lot ends up later. So before Production control says "yes", it first works out who will be late, and by how much.

# Play

**Start at chapter 5, "The Last Box": the standard process goes to the production fab tomorrow, and only one alarm limit is left to fill in**

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# Think

- 1 The reliability tests haven't finished, but the customer wants wafers started in the production fab now (a risk start): if the tests pass, the customer gets parts sooner; if they fail, the lots started early may all be scrapped. In your place, how would you explain the cost of each side to the customer?
- 2 Work instructions are written for someone who may never have trained on the R&D line. How detailed do you think they need to be so that someone following them doesn't go wrong? What can't be passed on in writing alone?

# Read

**How is an R&D line different from a production fab?**

[fab24hr.com/en/blog/rd-line/](https://fab24hr.com/en/blog/rd-line/)

**What does an R&D integration engineer do with a new chip's first lot?**

[fab24hr.com/en/blog/rd-integration/](https://fab24hr.com/en/blog/rd-integration/)

**What is new product introduction (NPI), and who takes over at each step from a new chip's pilot run to volume production?**

[fab24hr.com/en/blog/npi/](https://fab24hr.com/en/blog/npi/)

## Further

What does production control do in a chip fab, and how are due dates set?

What does the customer liaison at a test-and-assembly house do?

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