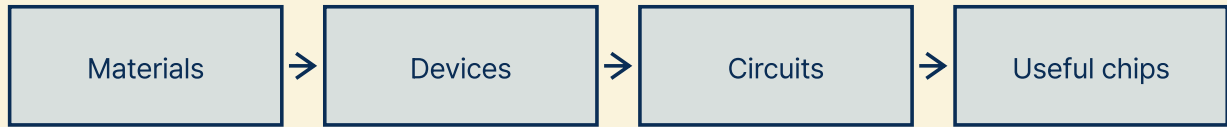


From materials to useful chips

Semiconductor devices control electrical signals. Many devices and wires form an integrated circuit.



Original concept illustration

Original concept illustration; not to scale.

Logic

Computes and controls operations.

Memory

Stores information for a system.

Manufacturing

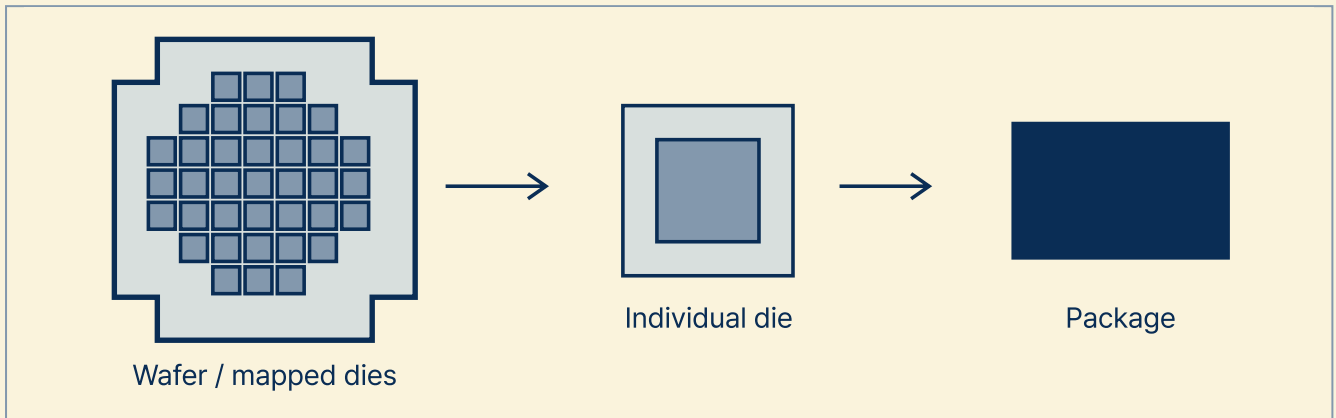
Builds, connects and tests tiny structures.

A fab is a factory; a chip is its product.

[Samsung · fabrication overview](#) · [Micron · introduction to memory](#)

Wafer → die → package

The round starting surface, an individual circuit and the protected product are different things.



Original concept illustration; not to scale.

Wafer

A substrate carrying many repeated circuits.

Die

One individual circuit on the wafer.

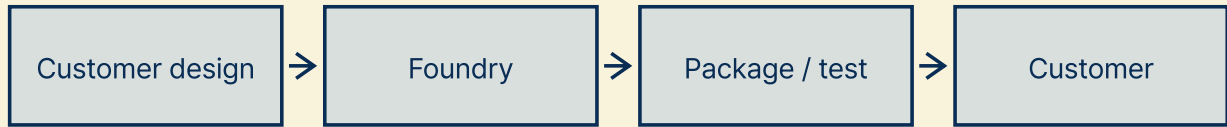
Package

Protects a die and connects it to a system.

Wafers, dies and HBM stacks are different counting units.

Who designs, and who manufactures?

These terms describe business roles, rather than different kinds of memory.



Original concept illustration

Original concept illustration; not to scale.

Fabless

Designs chips and commissions their manufacture.

Foundry

Manufactures chips for customers using their designs.

IDM

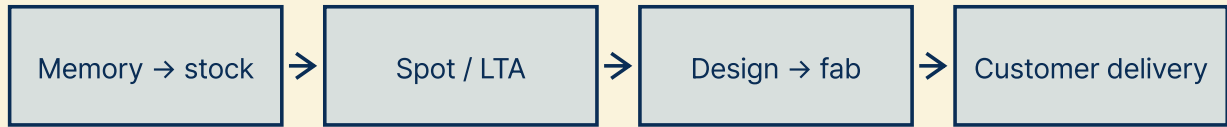
Combines chip design and manufacturing.

A foundry does not own an interchangeable stock of every customer's design.

TSMC · foundry model

Memory and foundry: two revenue routes

Product categories and manufacturing business models are different classification axes.



Original concept illustration

Original concept illustration; not to scale.

Memory sales

This game lets you make memory and choose when to sell.

Foundry delivery

Agree on the design, quantity, price and deadline first.

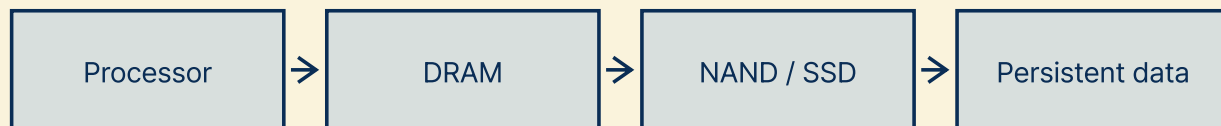
Customer stock

Store surplus for a later order of the same design.

Real memory is also sold through negotiated contracts. The spot desk is a teaching simplification.

DRAM and NAND do different jobs

Both store information, but the requirements of active work and persistent storage differ.



Original concept illustration

Original concept illustration; not to scale.

DRAM

Working memory; volatile and periodically refreshed.

NAND Flash

Nonvolatile storage, used in products such as SSDs.

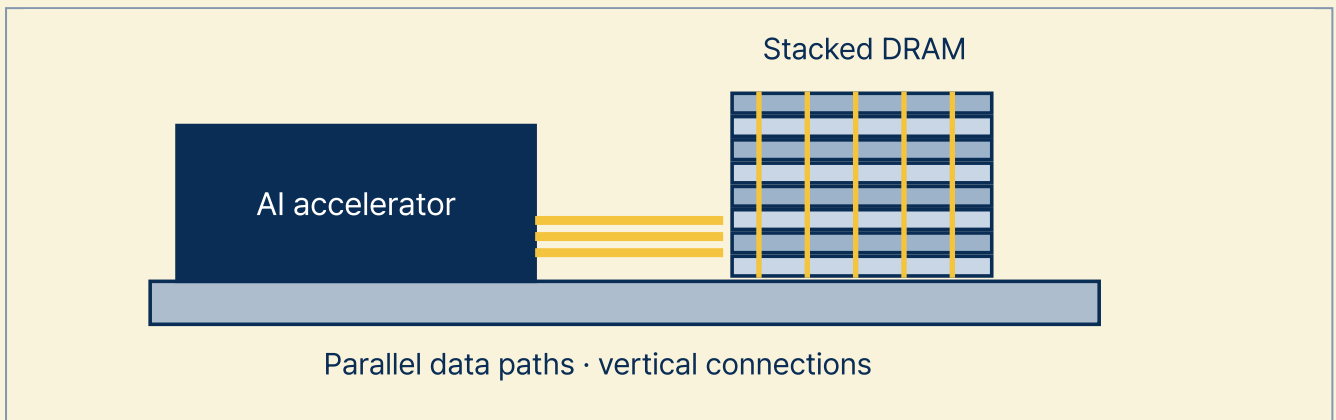
Different processes

Different device structures need dedicated qualified flows.

The product selector simplifies a factory's allocation across dedicated product lines.

Why does AI use HBM?

Fast computation also needs data to arrive quickly enough.



Original concept illustration; not to scale.

Stacked DRAM

HBM stacks multiple DRAM dies with vertical connections.

High bandwidth

Many parallel data paths move large amounts of data.

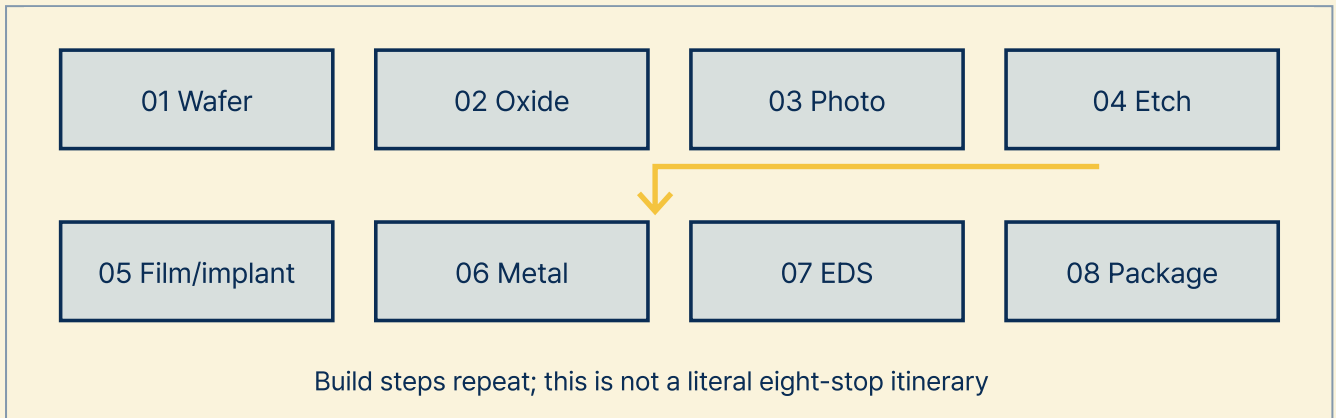
AI accelerators

Bandwidth helps feed data to demanding AI computation.

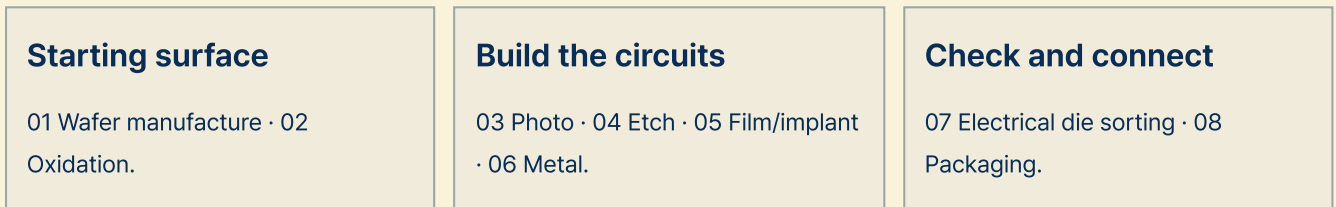
Capacity is how much fits; bandwidth is how much moves per second.

The eight process groups

Eight headings organize many repeated manufacturing and testing operations.



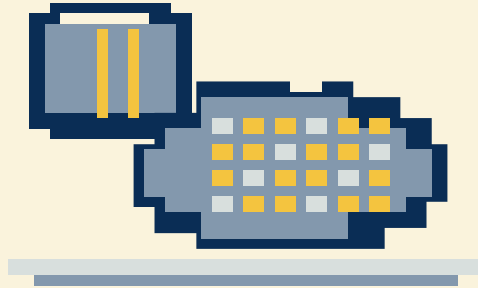
Original concept illustration; not to scale.



The real flow repeats patterning, deposition, removal, cleaning and measurement many times.

01 • Wafer manufacture

A flat, clean starting substrate is needed before circuit fabrication.



Original concept illustration; not to scale.

Crystal growth

Prepare a high-purity single-crystal silicon ingot.

Slice and polish

Slice the ingot and finish the wafer surface.

Incoming quality

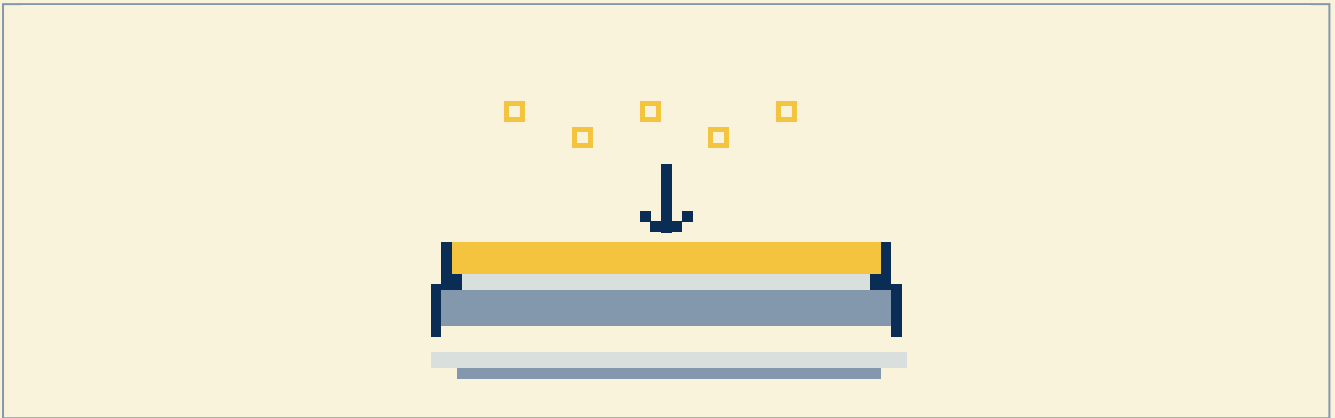
Surface defects and contamination affect later processing.

In FAB, wafers are purchased inputs, not grown inside your playable fab.

Samsung · wafer manufacture

02 · Oxidation

Thermal oxidation reacts silicon with an oxidant to grow silicon dioxide.



Original concept illustration; not to scale.

Purpose

Form an insulating or protective oxide where appropriate.

Control

Temperature, time and ambient affect growth.

Integration

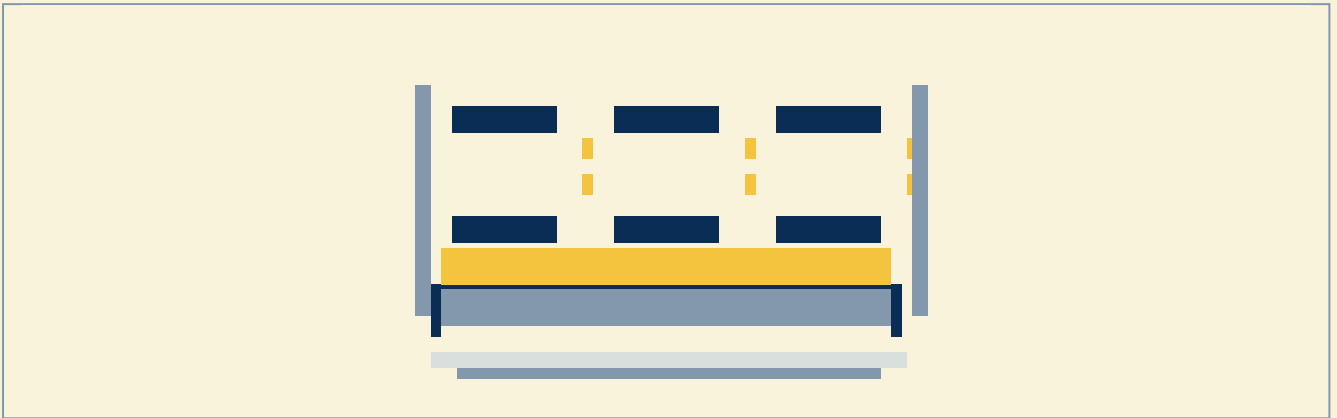
Thickness, uniformity and thermal budget must fit the flow.

Growing oxide consumes silicon; depositing a film is a different mechanism.

Samsung · oxidation

03 • Photolithography

Light transfers a pattern into a photosensitive resist layer.



Original concept illustration; not to scale.

Coat

Apply photoresist and prepare it for exposure.

Expose and develop

Expose selected regions; develop the resist pattern.

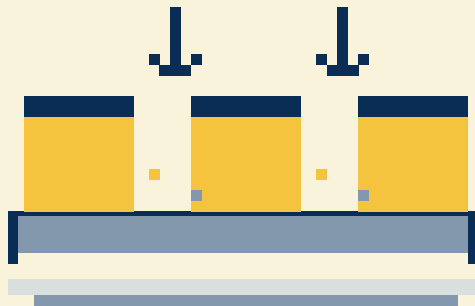
Alignment

New patterns must align with existing structures.

The resist pattern guides a later process. Light does not directly carve all device layers.

04 • Etching

Selected material is removed while protected regions remain.



Original concept illustration; not to scale.

Wet etch

Liquid chemistry removes a target material.

Dry / RIE

Plasma chemistry and ion effects can improve directionality.

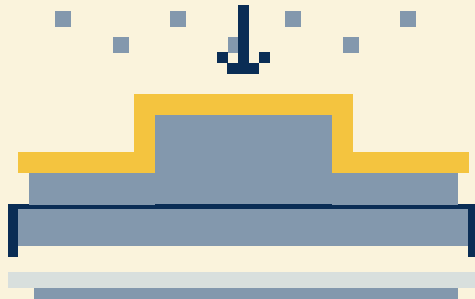
Trade-offs

Control shape, selectivity, damage and residues.

Dry etch is not universally better; the material and geometry determine the choice.

05 • Thin films and ion implantation

Adding a film and changing doping are different operations.



Original concept illustration; not to scale.

Deposition

PVD, CVD and other methods add required materials.

Implantation

Introduce dopant ions into the substrate.

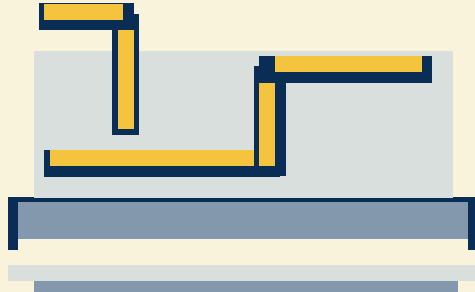
Annealing

Activate dopants and repair implantation damage.

Film properties, conformity and temperature limits matter alongside throughput.

06 • Metal interconnects

Individual devices must be connected into useful circuits.



Original concept illustration; not to scale.

Lines and vias

Metal paths connect devices and different wiring levels.

Isolation

Insulators keep neighboring conductors separated.

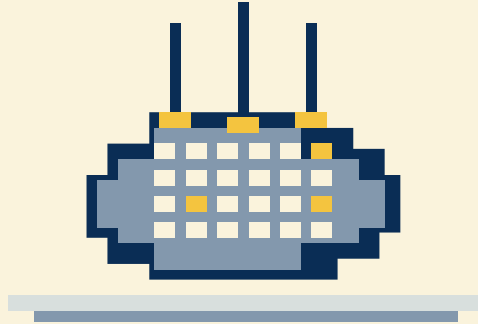
Reliability

Open circuits, shorts and resistance can limit operation.

The sketch is a concept; real interconnect stacks contain many materials and levels.

07 · Electrical die sorting

Test individual dies electrically while they are still on the wafer.



Original concept illustration; not to scale.

Probe

Test equipment makes electrical contact with each die.

Sort

Identify dies that meet the required test conditions.

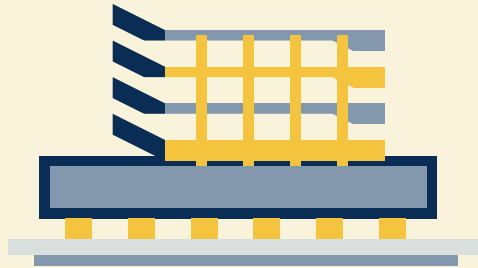
Record

A wafer map records the result of each location.

Inspection identifies problems; it does not automatically repair every defective die.

08 • Packaging and final checks

A usable die still needs physical protection and system connections.



Original concept illustration; not to scale.

Separate and assemble

Separate dies and assemble the required package structure.

Connect and cool

Provide electrical connections and a route for heat.

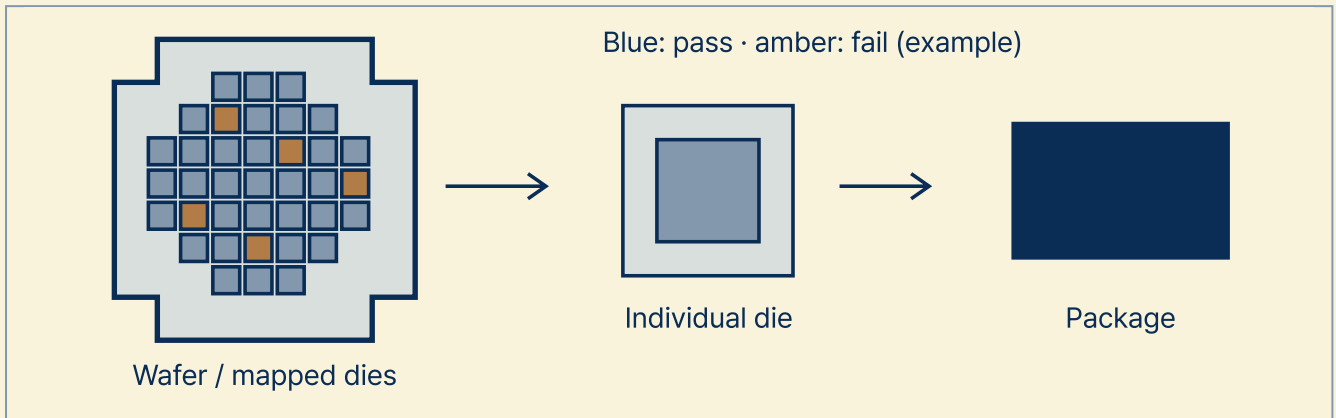
Final checks

Check the assembled product before shipment.

Packaging is a functional part of the device, not just a protective box.

Yield and stoppage are different

Input quantity is not the same as the number of usable products.



Original concept illustration; not to scale.

Yield

Good output divided by the tested population at a defined stage.

Stoppage

The stopped line produces nothing in that settlement.

Cost per good unit

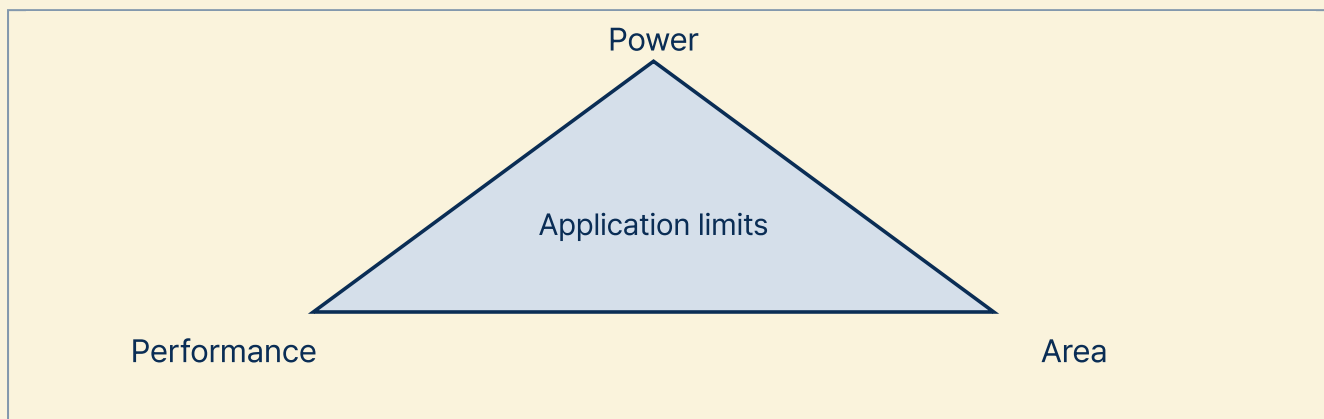
Similar input cost spread over fewer good units costs more each.

Example: $100 \text{ dies} \times 90\% \text{ die yield} = 90 \text{ good dies}$. This is not a real fab yield report.

Samsung · electrical die sorting

PPA: match the application

Power, performance and area describe different design requirements.



Original concept illustration; not to scale.

Power

Electrical power consumption, shown as mW in FAB.

Performance

Speed or throughput; the game uses a simplified MHz target.

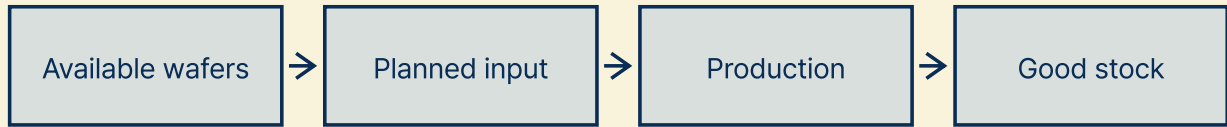
Area

The physical size of one die, shown as mm².

Existing fabricated stock keeps its original design and specifications.

Capacity, load and maintenance

Owning capacity does not automatically supply wafers or make output.



Original concept illustration

Original concept illustration; not to scale.

Capacity

The maximum weekly load available in the game.

Actual input

Limited by the plan, available wafers and operating conditions.

Maintenance

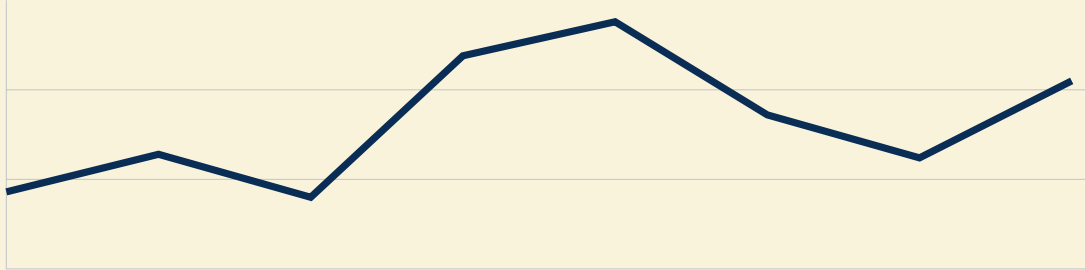
Costs cash, but helps control wear and stoppage risk.

Hwaseong expansion raises 150 → 225 wafers/week for \$2.20M; active fixed cost +\$50k/week.

Game rules and illustrative economics, not real facility data.

Why do memory prices move?

Demand, available supply and customer inventories influence market conditions.



Illustrative curve · not a forecast or historical data

Original concept illustration; not to scale.

Demand

More data-center or device purchases can tighten supply.

Supply

Capacity changes and inventory releases can ease shortages.

Selling decision

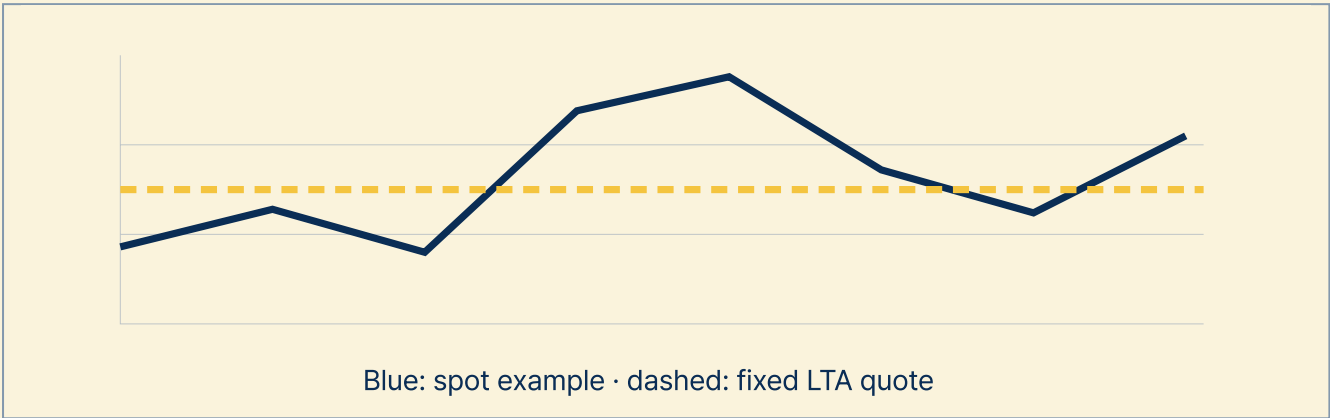
Cash now competes with the uncertain value of holding stock.

The drawn curve and every price, cycle probability and weekly jump in FAB are fictional teaching parameters.

Game rules and illustrative economics, not real facility data.

Spot sales or a long-term agreement?

A fixed-price agreement exchanges some market exposure for a supply commitment.



Original concept illustration; not to scale.

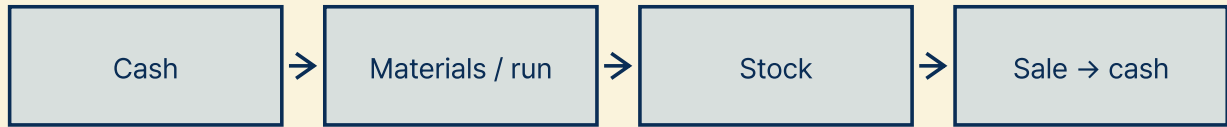
Spot	LTA	Commitment
Sell available memory at the current quote.	An optional W3 mail offers a fixed DRAM price for W3–W6.	10k/week, 40k total; cancellation costs 10% of undelivered value.

FAB auto-ships after production, carries shortfalls within the term, and charges the same fee on W6 shortfalls.

Game rules and illustrative economics, not real facility data.

Cash, assets and profit

A profitable-looking inventory position may still leave the company short of cash.



Original concept illustration

Original concept illustration; not to scale.

Cash

Money available for the next bill or investment.

Net assets

Asset value after debt and relevant obligations.

Operating profit

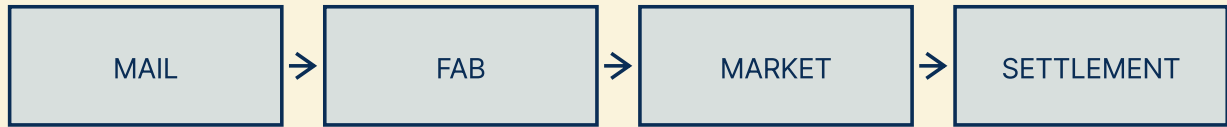
Recognized sales minus cost of sold goods and operating expenses.

Borrowing increases both cash and debt. It is not operating revenue.

Game rules and illustrative economics, not real facility data.

Turn the background into your first decisions

Start with memory. Foundry opens in W3 and remains optional.



Original concept illustration

Original concept illustration; not to scale.

1 · Read

MAIL explains requests, offers and deadlines.

2 · Plan

Open a site, adjust load and check operating cost.

3 · Sell and settle

Sell stock for cash; settlement creates the next output.

W8 goal: net assets at least \$8M and management stake at least 70%. At final settlement, all memory including new output is sold at the current applicable W8 price. Eligible foundry stock ships against open contracts; unrelated surplus is not spot-sold.

Game rules and illustrative economics, not real facility data.