

By thinking outside of the box and embracing 450mm manufacturing, could Europe's semiconductor industry get a new lease of life? By **Graham Pitcher**.

The first chips manufactured on 450mm wafers will begin to roll out from a handful of fabs within the next few years. The move, being made by companies like Intel and TSMC, is the next step in the industry's pursuit of Moore's Law. In following Moore's prediction that the number of transistors on a given area of silicon would double every 18 months, these companies are subscribing to a school of thought which has become known as 'More Moore'.

And it's no surprise that Intel and TSMC are in the vanguard; chip manufacturing at the leading edge is an incredibly expensive business and few companies have pockets deep enough to invest in the necessary equipment.

Traditionally, new developments are applied by semiconductor manufacturers to leading edge products. Intel provides a good example with its 'tick tock' approach, alternating between improving the device's microarchitecture and manufacturing on a new process technology. Between the 'ticks' and 'tocks', Intel advances its products on an annual basis.

Similarly, TSMC – the leading foundry – rolls out new processes regularly. Currently, the Taiwanese company is bringing a 28nm process online, but is working on technology for the 22 and 14nm nodes and beyond.

But even companies with pockets as deep as those of Intel and TSMC realise that relying on process shrinks alone will not sustain them in the future. TSMC says the only way it can see to manufacture devices economically beyond the 22nm node is to move to 450mm wafers.

In a recent interview with *New Electronics*, Maria Marced, president of TSMC Europe, said: "We believe 20nm production will need to be on 450mm wafers, certainly for 14nm. Otherwise, chips will be too expensive. We're looking for ways to improve prices for customers and the only way we can see is 450mm wafers."

As 450mm production looms into view, leading companies are collaborating to develop the necessary technology. Working under the banner of the Global 450 Consortium, Intel, TSMC, Samsung, IBM and Toshiba are building a 450mm pilot line at the College of Nanoscale Science and Engineering, based at the State University of New York's Albany campus. Intel's president and ceo Paul Otellini believes the initiative is a 'critical element in moving the industry to the next generation wafer size'. But getting to 450mm wafers isn't going to

**Marced:**  
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# Building

be cheap: estimates believe the transition costs – developing the technology and building the pilot line at Albany – will be at least \$25billion and could reach \$40bn.

The 450mm transition will be critical to the semiconductor industry, largely because it will be the last big move – nobody envisages manufacturing on larger wafers.

Nobody knows how many 450mm fabs might be built; some estimates



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say up to 15. Some of those – but not many – are likely to be in Europe.

Malcolm Penn, chairman of researcher Future Horizons, said: “Unit production is increasing by 10% a year. Because the average size of a chip remains constant, you need 10% more capacity. A 450mm fab has 2.25 times the output of a 300mm fab, but will use the same number of people. Intel, for one, can think about two 450mm fabs instead of six 300mm units, with the associated savings.”

Penn believes Intel may only build three 450mm fabs. “Once the structures are built, they can rotate the technology upgrades around them.” While Intel’s first two 450mm fabs will be in the US – D1X in Oregon, followed by Fab 42 in Phoenix – Penn believes a third will be built in EMEA; the likely sites being Ireland or Israel.

Throughout all the talk about 450mm developments, one word is largely missing – Europe. Penn believes that, unless Europe gets involved with the Albany project in a meaningful way, it could have serious consequences.

And that is somewhat ironic; the 450mm transition is unlikely to happen without European involvement. But that involvement will be at the tools provider level, rather than as one of the main drivers of the technology. “European research institutes – imec in particular – are being used by everyone except IBM and STMicroelectronics; everyone relies on imec for leading edge transistor design,” Penn believes. “But without imec and [tool manufacturer] ASML, there will be no 450mm; no other companies are in their position – not even Applied Materials.”

Penn’s worry is the continuing lack of an apparent European interest in 450mm will have knock on effects on companies like ASML. “Europe has a lot of materials companies that address the global market aggressively and have leading positions. Intel, TSMC and, to an extent, GlobalFoundries are keeping the equipment suppliers at the leading edge – but they aren’t

based in Europe and they don’t need Europe. Europe has to preserve its research interests and its materials industry otherwise those organisations will go where the market is so they can remain at the leading edge.”

Neither is Penn particularly impressed with the state of Europe’s chip industry. “Manufacturing, with a few exceptions – Dresden and Intel in Ireland – is not strong. Chip developers have become manufacturing averse, with the exception of niche products,” he said.



**Otellini:**  
**“A critical element in moving the industry to the next generation wafer size”**



**Penn: "Europe has to get involved with the 450mm project in Albany. If we don't ..."**

He is worried about the long term. "It's a question of right time, right place," he continued. "In 10 years, Europe's production base will be getting pretty dated; at best, it will be making 65nm chips on 200mm wafers. That might be good for today's More than Moore designs, but in a decade, it won't be." More than Moore refers to applications oriented devices, which may include such functionality as rf, analogue and MEMS.

"If you look at how manufacturing technology is developing, what's being done today at the leading edge will look like a walk in the park in 10 years. Fabs will be manufacturing 28nm devices on depreciated equipment, addressing what's being made on 300mm wafers today at 65nm. And even a fully depreciated 300mm fab will not be able to compete with 450mm wafers." The implication is that, if nothing is done, then nothing of consequence will be made in Europe and, extrapolating, there will be no research or materials industry left.

So 'what could be done?' and 'what should, if anything, be done?'. Those are questions which Penn is currently addressing in a report commissioned by the European Commission (EC). While he can't talk about the report's content – it is being reviewed by the EC – he can discuss the context.

One thing his report considers is whether the EC should finance the building of a 450mm fab in Europe. "What do we do about the chip industry?," he mused. "I believe Europe needs to 'think outside the box'. Europe has to invest in new capacity – and why shouldn't it be jointly owned?"

His point is that Europe's semiconductor manufacturing base is obsolete. "There's been little investment for years. What growth there is being accommodated by foundries. Manufacturers say a shared fab isn't possible, but that's what they're doing when they go to foundries. Why shouldn't they own a fab between them and share its capacity?"

The problem is that, despite a unified research base, Europe's semiconductor industry is fragmented, with its constituent companies pulling in largely different directions. Could the 'cats be herded'?

Penn believes one compelling argument that could be constructed is around security of supply. "European semiconductor companies are

predominantly reliant upon foundries. But someone in a foundry is sitting down looking at a production schedule. If they have less orders than capacity, then there's no problem. If it's the other way round, then there is. Someone has to determine who gets access to the production facilities and that determines when you get your products.

"A big fabless company will get priority over a fab lite client, because the fab lite company will probably not have the volume."

Where Penn differs from the mainstream is that he believes 450mm offers an opportunity to improve Europe's chip offerings without climbing on the More Moore bandwagon.

"If you go to 14nm, you'll need to use extreme ultraviolet and sophisticated immersion lithography. But if you stay at 45nm, say, you can use non immersion lithography. Companies will be able to run their products on better geometries and get better yields through the full benefit of 450mm automation. It will offer a cost structure 'to die for'. Companies will manufacture devices for 30% less."

But such benefits will come at a cost. "Companies will have to share the cost; it would have to be a consortium," he added.

And this is where politics takes over. He believes the EC, if it sees merit in the idea, could be 'very persuasive'. "But individual European states will apply more subtle politics," he said.

But could a cooperatively owned Eurofab ever get support? Convincing European companies of the need to collaborate will not be easy. "NXP says 'never' when it comes to collaborative manufacture," Penn continued. "Infineon doesn't see the need at the moment; it's just gone to 300mm and is ahead of other companies. But ST could be the difference; it's still the biggest European semiconductor company."

Although ST has been moving more production to foundries of late, it recently admitted that manufacturing is 'important'. "Maybe ST could be persuaded," Penn said.

Such a Eurofab would have to operate as a foundry. "If you invest, say, \$1bn, then you get 10% of the capacity," Penn suggested. "And some capacity can be reserved for Europe's fabless companies."

Semiconductor industry politics would also come to the fore. "There would be arguments about who would be the ceo, for example. Just hire the best person there is to run it," Penn said. "Similarly, get the best operations director."

But where might such a Eurofab be built? Penn says it won't be anywhere there isn't already an infrastructure. "The viable options are Agrate, Dresden, Ireland, somewhere near imec in Belgium and maybe somewhere in The Netherlands."

Will it all happen? Penn is optimistic. "I think we'll see Intel putting a 450mm fab into Ireland. And if I had to put a location in an envelope for a European cooperative fab, I'd say Dresden."

But Penn concluded with a warning. "Europe has to get involved with the 450mm project in Albany. If we don't, it could be the end of manufacturing in Europe."

