



The Post Cleanroom Fab THE NOVEL CLEANSPACE FABRICATOR CONCEPT

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Semiconductors have revolutionized our lives, but the way we produce semiconductors has changed very little. The next evolution in semiconductor devices demands an evolution from the traditional cleanroom to the Futrfab cleanspace fabricator.

Since semiconductors are made up of elements that can be smaller than dust, it's always been crucial to fabricate them in a dust-free environment. In the beginning that meant hoods. Clean hoods evolved into clean rooms encompassing the hoods, people, processing tools and materials. Not much has changed since then. Today's state of the art "Ballroom" fabricator is still, basically, a very, very large room which is kept clean. We call it a cleanroom.

Figure 1 shows a state of the art Ballroom fab. Since it houses all the tools, personnel, materials and automation in one space, it can be the size of six football fields, with a ceiling as high as an aircraft hangar.

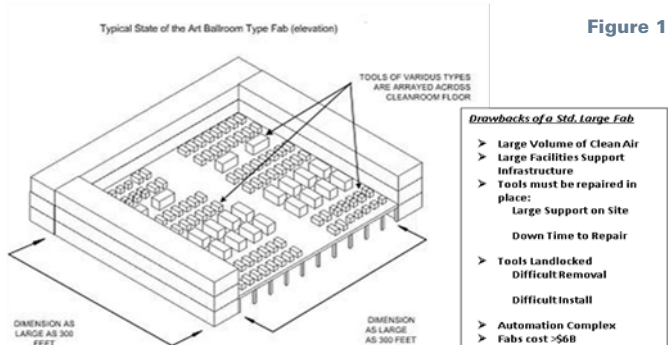
As key materials like the semiconductor wafer have grown steadily larger, so have the cleanrooms. And so has their price tag. Today a fully equipped semiconductor cleanroom fabricator costs roughly \$5-10 billion.

The building alone, without tools or materials, can cost \$1 billion or more.

Just keeping the cleanroom running—Maintaining air quality, humidity and temperature; providing and exhausting chemicals and gasses; treating waste water—can add up to tens of millions of dollars a year.

The solution? Rethink the cleanroom. The new Futrfab Cleanspace model houses the entire fabrication process; efficiently and cost-effectively.

As shown in **Figure 2**, the relatively small *cleanspace* accommodates all the elements of a cleanroom, but changes their orientation for easier access, better automation and lower personnel costs.



Vertical Tools: Tools densely packed in arrays can be removed, repaired, and replaced without entering the fabrication space. Distance between tools is also much shorter, making automation simpler and more efficient. Even the tools themselves can be small enough to operate efficiently at a 2-inch wafer size (as opposed to today's 12-inch wafer.)

Personnel: There's no need for personnel in the Futrfab cleanspace

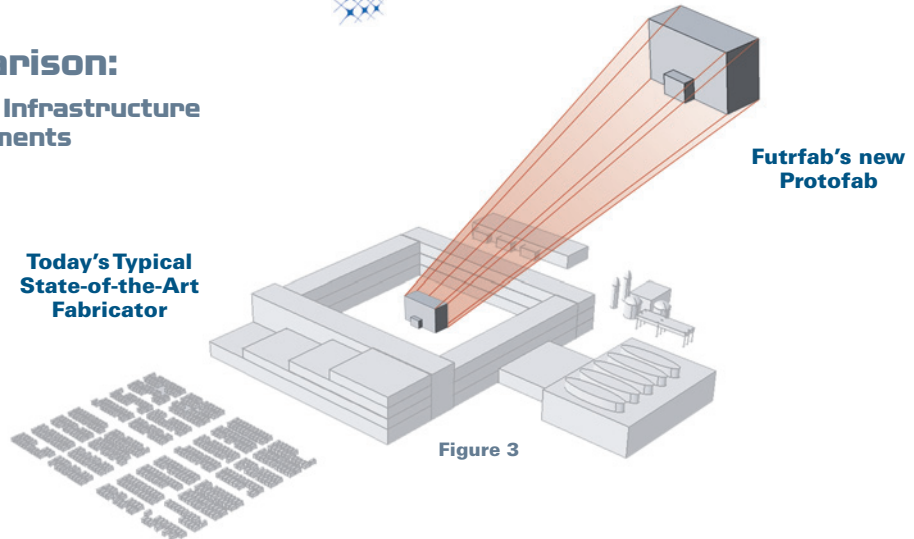
itself, which makes it easier to keep clean. And since tools can be removed for repair, there's less demand on the technical staff.

Figure 3 compares the scale of a small volume fab, called a *Protofab*, to today's state-of-the-art fabricators. It can be run at a fraction of the size and—using maskless lithography—at a fraction of the cost. The lower costs of these small-scale activities will promote the kinds of innovations that increase demand for large-volume fabrication.

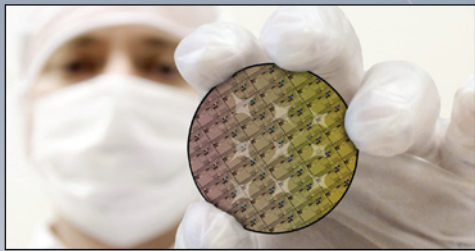
The Futrfab infrastructure, by improving small-scale fabrication, also supports significant improvement in large-scale tooling. By making R&D, design prototyping and manufacturing cost-efficient at small volumes, Futrfab makes it easier than ever to improve the efficiency of large-scale manufacturing fabricators. The Futrfab *Cleanspace* Fabricator, by driving innovation *and* production, will fuel the next revolution in semiconductor performance.



Comparison: Size and Infrastructure Requirements



Futrfab, Inc. – Enabling Revolution Through Innovation.



The cost of building a fabrication plant has increased by over 5,000% in the last 30 years. In 1980, a typical state-of-the-art fabrication plant, or 'fab', cost approximately \$100 million to build. Today, a true state of the art fab, costs nearly \$10 billion. Given a liberal operating lifetime of 10 years, the fab will need to produce nearly \$20 million of gross margin output every week of its life just to cover depreciation costs.

With today's economic pressures, companies face high risks when placing 'novel' designs into large volume production lines. A truly viable small volume manufacturing solution greatly decreases the associated financial risks.

A one-stop resource for R&D, prototyping, production and packaging. Large volume fabrication facilities simply don't support small volume activities well. Research and Development is often done thousands of miles away from the designers. Prototyping is restricted to standardized flows. Packaging is usually performed in far off locations, resulting in weeks of delays due to shipping and customs issues.

A *Futrfab* incorporates every aspect of the manufacturing process into one centralized location for small volume fabrication, and will be the environment of choice for development of new types of components that incorporate or support electronics.

It's the semiconductor fabricator of the future.

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