

## FACILITY ANALYSIS AND PLANNING FOR ULTRAPURE WATER PRODUCTION: A KEY ROLE FOR UMBERTO

Umberto enables users to speed up facility planning; consistently document process balances, including the energy balance; ensure the reusability and expandability of process models.

### THE BASIC PROBLEM

In 2011, one of the most modern semiconductor manufacturers, with several production facilities in Europe, was planning the long-term expansion of its production capacity. The company produces innovative semiconductors for, among others, the mobile phone industry on more than 50,000 m<sup>2</sup> of clean room floor space spread across several buildings. One of the most elementary steps in its silicon wafer manufacturing is rinsing the wafers with ultrapure water (UPW). Several systems, which were of various ages, were being used to provide a continuous supply of ultrapure water for this vital

processing step. In order to ensure that the supply of UPW would keep up with the planned expansion, the manufacturer hired Arcade Engineering GmbH to analyze the productive efficiency of the existing UPW systems. The analysis found shortfalls of production capacity that simple debottlenecking of the existing systems through standard capacity upgrades would not have solved. As a result, a decision was made to build an additional ultrapure water system. Based on a well-founded overall concept, Arcade Engineering's proposal to plan and install the new system was accepted.

### OPTIMAL SOFTWARE SUPPORT: UMBERTO

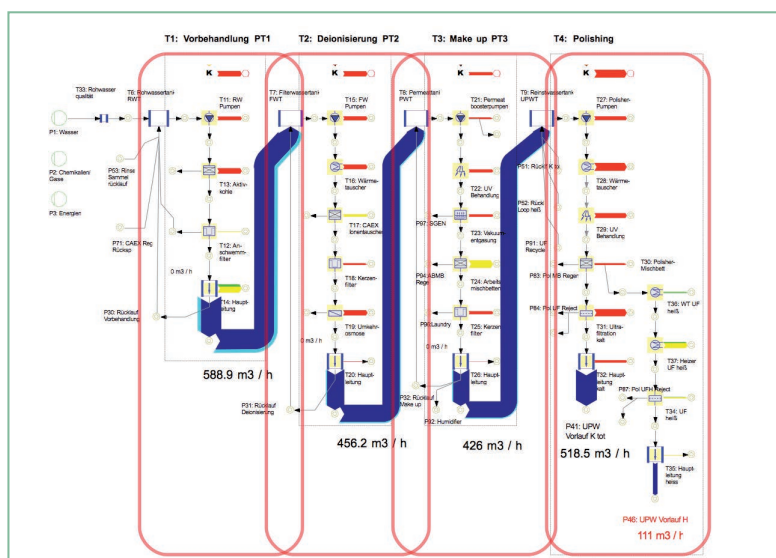
*„Other software tools wouldn't have allowed us to achieve the same level of in-depth calculation and modeling flexibility.“*

Klaus Wohlmann,  
Director of Sales and  
Marketing at Arcade  
Engineering GmbH

### THE MISSION: TO ANALYZE CAPACITIES

The planned expansion of semiconductor production would generate a proportionately higher demand for ultrapure water. The company's management assumed that possible bottlenecks in the existing system could be detected and removed,

resulting in higher UPW production. The engineers, in turn, suspected that the existing capacity to produce ultrapure water would not be sufficient to meet the growing demands within an expanded production environment.



Capacity of the final stage of the planned expanded production facility.

### RISKS INHERENT IN A SHORTFALL OF PRODUCTION

- The quality of the ultrapure water cannot be ensured
- Uninterrupted production cannot be guaranteed
- Dependent assembly processes could be affected as well

For a comprehensive analysis, current conditions must be determined and the expandability of the existing systems calculated.

**RESULT:**

The ultrapure water system would have to be expanded. An important tool to get the job done quickly? Umberto.

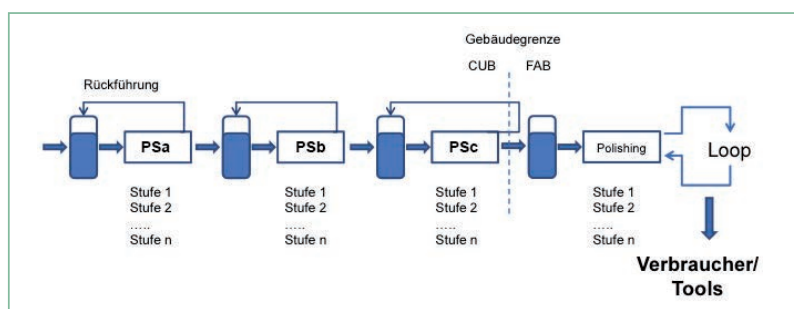
Arcade Engineering won the contract to plan and construct the additional UPW manufacturing system. It took Arcade only 16 months from securing the contract to the system's final inspection.

**AT A GLANCE - EXISTING CAPACITIES WERE INSUFFICIENT**

As part of the analysis a graphical mass balance model is created with Umberto. It includes the four sub-processes within the ultrapure water production system (shown left to right) as well as the various processing steps within these sub-processes, displayed vertically. The corresponding water flows and capacities are shown in parallel. By setting definitions for the visualization, capacity reserves can be shown in green or yellow, while capacity shortfalls appear in red, along with water (dark blue) and service flows (light blue).

A well-founded demand analysis showed that the expanded facility would require nearly 400 m<sup>3</sup> of UPW for its production processes, instead of the current more than 250 m<sup>3</sup>/h use rate. In addition to the higher demand, a change in the character of its use would also have an important influence: quickly changing flow volumes would need to be available while maintaining constant pressure. The current system could not ensure this scenario, even with extensive upgrades and more efficient utilization of the system.

Illustration of the ultrapure water system

**CUSTOMER TESTIMONIAL**

*„By modeling the expansion with Umberto, we were able to obtain a corresponding energy balance for each new mass balance we created, after integrating enthalpy flows. This surpasses the capacities of the competition by far.“*

Dr. Martin Schottler,  
modeling specialist for  
Arcade Engineering  
GmbH

**BACKGROUND**

The preexisting installation (subsection) has a capacity to produce and use more than 250 m<sup>3</sup> of ultrapure water per hour. The entire installation consists of the four sub-processes PSa, PSb, PSc, and polishing. Each step in the process - through its multiple applications of individual operational elements and supply units - is designed so that individual steps in the process can be removed from the system in order to allow rinse and regeneration

phases to proceed without decreasing overall production flow. During these "service flow" phases, the water in the removed subsections is thoroughly cleaned and all residues removed, while the remaining operational components and supply units handle a temporarily increased flow volume. This continuous cycle of production, as well as cleaning and regeneration, guarantees a continuous supply of UPW for semiconductor production.

**MAJOR RESULTS FROM THE APPLICATION OF UMBERTO**

- Umberto was able to calculate and present three detailed ultrapure water systems, each with the same basic structure, but utilizing different connections.
- A more highly transparent analysis was achieved, which also benefited the client.
- The planning process was quicker: for example, only four hours after the start of the modeling process, a water balance was available that proved to be 90% correct and only needed some further refinement.
- Energy balances were always calculated simultaneously and consistently with mass balances.
- High transparency was also achieved in another important sector: reserves management
- Consistent balance documentation was made available.
- The model is expandable and can be reused.
- An intense transfer of knowledge could be achieved by handing the model directly to the client's employees.