

## Comment on “The 1.7 Kilogram Microchip: Energy and Material Use in the Production of Semiconductor Devices”

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## Comment on "The 1.7 Kilogram Microchip: Energy and Material Use in the Production of Semiconductor Devices"

The paper by Williams et al. (1) was based upon the premise that large amounts of water, chemicals, and energy go into producing a semiconductor as compared to the weight of the final product. The conclusion then drawn was "the widespread assumption that the microchip represents a prime example of dematerialization is misleading at best and probably false".

We feel that this study's conclusion is itself misleading simply because using weight as the basis for comparison is arbitrary, nonscientific, and inaccurate. Product weight is a metric that is inherently limited in its ability to assess the impacts of high-technology products because it does not account for performance, utility, and benefits of these products. Consequently, relatively "low-technology" and heavy consumer products, such as a clay pot or wooden table, will appear to have a smaller environmental footprint than semiconductors or pharmaceuticals. To properly assess the impact of dematerialization, normalization factors should also attempt to account for the social, economic, and environmental impacts of products. By not including the value and benefits derived from high-technology products, one reaches the erroneous conclusion that products such as semiconductors, pharmaceuticals, and software present a disproportionately higher environmental burden than products of other industries.

On the contrary, the electronics industry has continuously shown improved performance in both its products and its manufacturing processes. Unfortunately, performance cannot be adequately measured by product weight. The semiconductor industry continues on the path of Moore's law to deliver better products with higher performance at a lower price. The industry's environmental performance has also displayed continuous improvement, as evidenced by the decreasing trends in resource usage and environmental emissions. For example, Intel uses 112 million gal of

freshwater each week for all manufacturing operations worldwide. Meanwhile, the U.S. EPA estimates that to print the Sunday edition of *The New York Times* alone requires over 200 million gal of water/week. Similarly, volatile organic compound (VOC) emissions from Intel worldwide last year was 220 t, roughly equal to the annual VOC emissions from thirty gasoline service stations.

The study also suggests that the materials intensity of a semiconductor is greater than that for an automobile. However, this study did not analyze the complete life cycle of either the semiconductor or the automobile. Rather, this study focused on only the assembly stage of an automobile's life cycle and attempted to compare that one stage to both manufacturing and assembly stages for the semiconductor. Furthermore, the study's analysis did not include data on the materials, water, and energy required to make automotive components. Neither did it include robust, quantitative data on semiconductor manufacturing as "quantitative information on process input/outputs was largely unavailable". Accurate, comparative analyses would have resulted if this study examined the same life cycle stages and contained robust and valid data. Given the significant weaknesses of the study, we strongly dispute its conclusion.

### Literature Cited

- (1) William, E. D.; Ayres, R. U.; Heller, M. *Environ. Sci. Technol.* **2002**, *36*, 5504-5510.

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