

## Aesthetics in chemistry

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**Abstract** This highlight article invites supramolecular chemists to read the recent paper of Joachim Schummer on the origin of molecular nanotechnology.

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Joachim Schummer recently presented in the journal *Foundations of Chemistry* 2006, 8, 53–72 an article entitled *Gestalt Switch in Molecular Image Perception: the Aesthetic Origin of Molecular Nanotechnology in Supramolecular Chemistry*.

As given in the title, the paper intends to find or to found the aesthetic origin of molecular nanotechnology in supramolecular chemistry. In contrast to the ‘standard histories’ of nanotechnology based on the colourful pictures of atoms produced by scanning probes and molecular models, mainly developed by Drexler and Merkle, the author prefers to argue that the basic idea of molecular nanotechnology already started with the construction of molecular systems by supramolecular chemists in their search of molecular devices and their fascination in constructing molecules looking like ordinary objects such as: basketane, rotane, rotaxanes, catenanes giving some example from 1989. This aesthetic fascination for the construction of molecular objects uses technomorph representation of molecules called technomorph sign language which induces the chemists to create new systems such as

molecular brake, molecular turnstile etc. In the last part of his text the author makes a link between the aesthetic perception of signs of supramolecular chemists to create new objects and the aesthetic perception of signs according to Umberto Eco. Eco’s theory allows understanding not only the aesthetic phenomenon of the chemists’ fascination with certain images, but also the aesthetic motivation for the development of supramolecular chemistry and the technomorph sign language. It provides insight into the researchers’ own and otherwise hidden motivation and worldview, beyond and before the current nano hype. The aesthetic analysis suggests that current scientific research is indeed largely driven by technological imaginations rather than by understanding the ordinary or molecular world. The examples given by Joachim Schummer are now more and more numerous with the arrival of molecular machines and related molecular objects in the literature.

As any other assumption, there is always an exception to the rule. In order to lay a foundation for creating a technology for manufacturing at the nanoscale level, Drexler, Merkle and collaborators [1–3] have been analyzing designs for mechanical systems at the nanoscale (1–100 nm) that could in principle be manufactured. Indeed in *Nanosystems* [2], Drexler considered many aspects of how the scaling of familiar macroscopic concepts changes as one goes to the nanoscale. In order to make progress here it is necessary to consider specific nanoscale supermolecular systems which could in principle be manufactured. Without worrying about the practical aspects of synthesizing the system, can one make supermolecular assemblies that would function as useful nanoscale machines? Can one design synthetic procedures that

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could in principle manufacture these machines? Again it is not essential to have a practical cost-effective design. It is sufficient to demonstrate the existence theorem that sequences of steps involving real atoms with the properties of real molecules can indeed lead to processes that would manufacture nanoscale machines with useful functionality. If the aim is achievable, then we can focus on ways to achieve the design in a practical fashion. Along these lines Merkle and Drexler [3] have designed a *nanoscale planetary gear* with eight moving parts using molecular mechanics force fields to ensure that the bond lengths, bond angles, van der Waals distances and strain energies are reasonable. But the system they designed is un-synthesizable. However the concept remained true and chemists have been able to produce a molecular gear with cucurbiturils CB[ $n$ ] which are macrocycles built with  $n$  glycoluril units linked together and that have different sizes [4]. This *cucurbituril-based-gyroscone*, or CB[5]@CB[10] complex, is a new supramolecular form in which one cucurbituril is included in another. And one can assume that the concept withdrawn by Drexler and Merkle was also due to in some parts to aesthetical needs.

The paper of Joachim Schummer is of interest for supramolecular chemists dealing with the construction of increasingly sophisticated artificial molecular systems and shows that the main factor is the aesthetic choice remembering the words of Jean Pierre Sauvage speaking of his first catenanes: “They are not useful: they are beautiful”. In his paper the author cites a certain number of journals the majority of them being well-known of supramolecular chemists: from *Journal of Supramolecular Structure* (created in 1972) to

*Encyclopedia of Supramolecular Chemistry* (created 2004).

In a larger point of view the work of Joachim Schummer is to bridge the gap between philosophers and chemists. For this purpose he is the editor of *HYLE* which is a peer reviewed international journal published since 1995 and dedicated to all philosophical aspects of chemistry and which had also a special issue on “Aesthetics and Visualization in Chemistry” in 2003.

The present paper has been written to invite supramolecular chemists and more generally chemists to help in filling the gap between chemistry and philosophy.

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