FEATURES

HISTORICAL NOTE

Academic genealogy to follow the evolution of materials research

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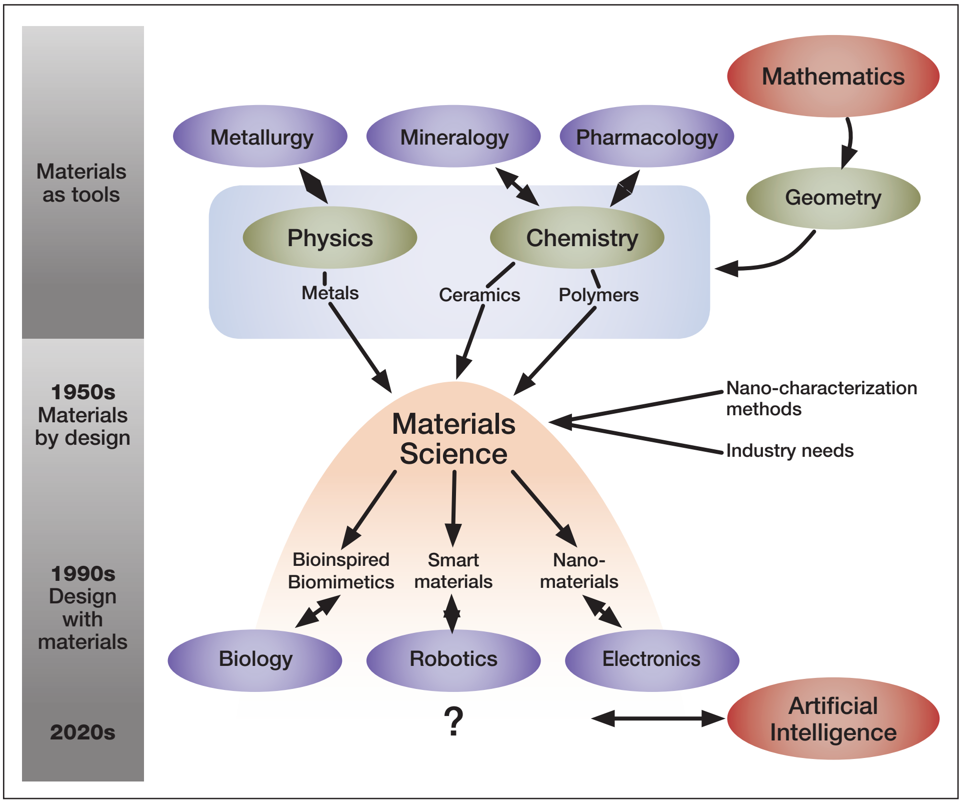
Genealogy and building family trees are popular pastimes that trace our ancestry through family history. But, establishing links and connections between individuals is also a research activity that interests philosophers, sociologists, and historians of science. Trees can be drawn to connect individuals not only by their family ties, but also by their publications and citations, disciplines and ideas, and PhDs and their mentors. This last category of family trees is known as academic genealogy.

To build academic trees with less effort, crowd-sourced online platforms have been developed to collect researchers' names, their masters', PhD, or postdoctoral mentoring relationships, along with details such as PhD thesis title, date, and university. One such website is academictree.org. It forms a database segmented into a total of 61 academic disciplines, such as neuroscience (Neurotree), physics (Physics Tree), chemistry (Chemistry Tree), and engineering (E-tree). When typing the name of an academic, it automatically builds their tree using the databases of all disciplines. Although the website was originally developed in the United States, it now covers academics from all continents and is growing every day thanks to input from users.

An academic tree can be used to understand the various influences that may have shaped the current research of a person, to network using academic ties, or to look for an eminent ancestor. Conducting this exercise with scholars in the field of materials science, it becomes apparent that the academic tree reflects the evolution of society in general. For example, the 19th century is largely dominated by scientists from Germany (the former Prussia), whereas in the 20th century, most people have at least one mentor in the United States. This is parallel with the massive immigration from Germany to the United States at the end of the 19th century. Furthermore, women are present mostly in the latest generation, as their roles continue to further increase in the materials field. What is also interesting is that since there is no material tree per se on the platform, the academic genealogies also reflect the evolution of materials science as a discipline through the ties between the trees and the topics of the PhD theses.



Simplified visualization of the academic genealogy of materials science and engineering.

In the 18th century, most academic ancestors of current materials scientists belonged either to physics or chemistry, with little interconnectivity between those two fields. The direct descendants generally stayed in the same field, in the same country, and studied fundamental topics. Some examples of PhD theses from then include the study of the complexation of lead nitrate and potassium nitrate, and the effects of radiation pressure on spheres of arbitrary electrical properties. The beginning of the 19th century was more diverse, with researchers in physics, chemistry, and with many PhD topics related to the study of the microstructure of metals. Those topics also relate to more applied studies, such as recrystallization of Armco iron and the observation of the weldability of

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steels, and phase equilibria of quaternary metallic systems. This is the generation that initiated the independence of materials science and engineering (MS&E) as an academic discipline; in 1955, the world's first MS&E department was created at Northwestern University, USA.

After the microstructure of metals came ceramics and polymers, with works on the effect of solution properties on crystal nucleation in polymers, or on the crystallization of Ti-opacified vitreous enamels. The generation in the 1990s was even more diversified, with ties to other trees such as zoology, medicine, or mechanical engineering, and topics related to composites and to the properties and applications of materials to a specific field. Examples include properties of aqueous polymer film coatings and the study of crack propagation in yttria-stabilized zirconium for biomedical applications. Topics in the early 21st century are multidisciplinary and related to sophisticated functions, advanced characterization, or fabrication methods. Examples of those are nonlinear dynamics and control of bistable composites for morphing applications, and atomic force microscopy studies of biomolecular adhesion and mechanics.

This evolution of research topics from fundamental to multidisciplinary and applied sciences has forged the discipline that we know today (**Figure**). In short, it emerged during the Cold War (1947–1953) under pressure from industry and thanks to the development of nano-characterization equipment with electron microscopes and x-ray diffractometers accomplishing near-atomic resolution. This led to a paradigm shift: Materials are no longer considered homogeneous elements used to build structures, but instead as entities with an atomic organization and microstructure that determine macroscopic properties and functions: Materials can be designed. With composites, nanomaterials, biomimicry, and smart materials, another change in definition occurred in the 1990s: the possibility to engineer and design using finely nano- and microstructured materials.

With the current developments in artificial intelligence, machine learning, additive manufacturing, and the need for sustainability and mitigation of global warming, materials science and engineering is still evolving. The academic genealogy of future generations will tell us how those pressures are impacting today's materials science. □

We welcome comments and feedback on this article via email to Bulletin@mrs.org.

Further reading

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