Path-Creating Networks

Innovating Next Generation Lithography in Germany and the US

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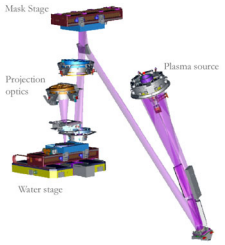
Introduction

In the semiconductor industry, the basic production technology called *optical lithography* is presently facing commercial and technological limits, thus forcing the semiconductor companies to look for succeeding technologies which are commonly referred to as *next generation lithography* (NGL).



Schematic of Extreme Ultra Violet Lithography. Source: Sweeney, D. (1999): Extreme Ultraviolet Lithography: Imaging the Future, In: Science & Technology Review, 11: 6.

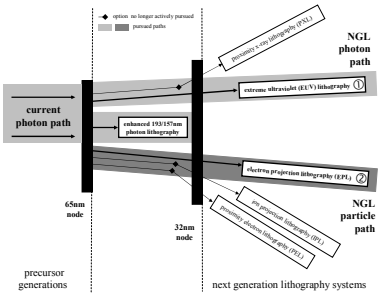
In order to create a new production technology chip makers, suppliers and university laboratories have to co-ordinate an array of novel technologies, each with its own technical and economic challenges. Around the globe, especially in the U.S., Europe and Japan, they organise their activities in multiple R&D consortia, joint ventures and government research programmes which serve as a locus for organising the individual efforts.

The case study: path dependency and path creation in the field of NGL

Technological innovations do not happen out of the blue. In the classic study of the QWERY keyboard layout, David (1985) has pointed to the historical determination and prolonged existence of sub optimal technological solutions and labelled this aspect *path dependency*. Also, technological innovations may be influenced by powerful actors who are capable of building up the necessary momentum for *path creation* (Garud/Karnøe 2001).

The success of a technological option in the field of NGL depends not only upon technological feasibility, but also on the ability to establish powerful alliances for developing and introducing a major change in production methods. For this reason we focus on forms of inter-organisational cooperation, like R&D consortia, in the pre-competitive area and their coordinating practices, like roadmaps, for aligning the R&D efforts and for providing planning reliability in an area, where specialists constantly work 'on the edge of physics'.

The picture below illustrates the various paths that existed in the field of NGL in 2003. The current *photon path* of optical lithography is estimated to end around the year 2014. Optical lithography has experienced continual incremental enhancements so that is has outlived many rival technologies in the past two decades. This persistence can only be explained by the active engagement for continuing the use of optical lithography.



The developments in NGL, which is expected to be used from 2014 on, can bee seen as efforts toward creating a path. Technologies like *extreme ultraviolet lithography* (EUV) require radical changes in production, like using mirrors instead of lenses and developing a whole new photon source.

American manufacturers like Intel and AMD cooperate with European suppliers like ASML and Carl Zeiss since 1996 in order to make this technology ready for marketing. *Electron projection lithography* (EPL) as another option, has been supported by companies like IBM and Nikon.

The challenge that all chip manufacturers likewise face, is the narrowing of options in order to select a reliable and cost effective technology for mass production, that is: to create a path that will enable them to follow the requirements of Moore's Law by making ever smaller structures on computer chips in a cost effective way.

Research Questions & Methods

In the main, our project asks the questions:

- Can inter-organisational arrangements like R&D consortia be understood as path-creating networks who serve as a locales for organising innovation processes?
- Which practices are connected with collectively innovating a new technology, looking at the ability of the actors to influence the development of technologies?

To analyse the social, technical and economic relations between companies, laboratories and government funding as well as legislation remains the key issue to be addressed in the course of the project.

For theory, we draw on the concepts of path dependency and path creation for identifying different technological paths and on Giddens' theory of structuration to provide a solid sociological foundation for the subsequent analysis.

Regarding methods, we conduct qualitative interviews with experts from the field, attend conferences and analyse publications. We use qualitative methods for analysing the interviews and publications in order to asses the significance of actor relations and events, which will be supported by quantitative data on the changes of actor relation over time with respect to a specific path.

Literature

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