A Conversation with Haldor Topsøe

Haldor Topsøe[1] and Manos Mavrikakis[2]

[1]Haldor Topsøe, Kongens Lyngby, DK-2800 Denmark

[2]Department of Chemical and Biological Engineering, University of Wisconsin, Madison, Wisconsin 53706-1691; email: manos@engr.wisc.edu

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Video

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Introduction

Haldor Topsøe was born in Copenhagen, Denmark, in 1913. He studied chemical engineering at the Technical University of Denmark (DTU). In 1940, he founded the company Haldor Topsøe, which has become one of the most successful companies in the field of heterogeneous catalysis. The company develops and markets catalysts and processes for petroleum refining, air-pollution control, synthesis gas production, ammonia and methanol production and solid oxide fuel cells. The company Haldor Topsøe is also a leader in the production and state-of-the-art scientific characterization of new catalysts. Dr. Topsøe is currently the sole owner of the company. He has written numerous articles on ammonia synthesis, catalysis, and energy questions. He is the author of several books on economics. Dr. Topsøe has received numerous awards, including honorary doctorates from Aarhus University, DTU, and the Chalmers University in Sweden; the Gold Medal from the Royal Academy of Sciences; the Hoover Medal for his technical abilities and entrepreneurship; and the Grove Memorial Medal for Advances in Fuel Cell Technology. Topsøe is a member of the Danish and the Swedish Academies of Technical Sciences and of the U.S. National Academy of Engineering.

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Manos Mavrikakis

A CONVERSATION WITH HALDOR TOPSØE

Manos Mavrikakis: Good afternoon, Dr. Topsøe. I'd like to ask you a few questions starting with the following: What factors, including family, friends, and teachers, were influential in your choice of career and beyond?

Haldor Topsøe: Well, I was asked almost the same question when recently paying a visit to friends in China, and therefore I will give you a note that I prepared for these friends. But let me answer it verbally now. Firstly, I had to choose what I would like to study after leaving school. I wanted to focus on studying physics and therefore applied for space in the Niels Bohr Institute amongst other young students. And Niels Bohr was very kind to me, so I could follow his lectures and the lectures of many other first-class physicists who came to what later was called the Copenhagen School of Niels Bohr.

I was interested not in atomic physics; I was interested in theoretical physics to be used for other purposes, also to understand chemical compounds, to understand compounds in a more penetrating way, to understand what happened in chemical processes. And next to Niels Bohr, we had the institute of Brønsted. Brønsted, which was one of the famous chemists working with theoretical chemistry. Of course, we all know Brønsted's work about acidity, etcetera. Therefore it was very fine for me that I could go and study at the Niels Bohr Institute, but also spend some time with Brønsted.

Fortunately, believe it or not, such a young man could make friends with both Niels Bohr and Brønsted. And of course it also played a big role for me that at both institute, many foreigners came to study, particularly, of course, at Niels Bohr, where we always had a number of scientists, some having the Nobel Prize in some cases. Therefore, during my study in the early 30s, I almost, as you would say, rubbed shoulders with Nobel Prize winners. So why did I like to study at these two institutes? Because I was sure that a better understanding of molecule structure, of atomic structures and how they interacted, the involved energies and energy changes, would mean something for the future of chemistry, and also for the future of chemical processing in industry.

MM: Okay. So that actually led you eventually to studying chemical engineering, correct?

HT: Well, that's a long story, but after my studies, I wanted to stay with the university with Niels Bohr's Institute, and indeed he offered me a space and position as a young scientist, but I didn't want to work only with theory; I also wanted to work experimentally, and because of crisis in the late 30s, there was no money for experimental work at the institute. Therefore, I was a little bit frustrated, and accepted—got a position in industry. I spent four years in an industrial company working more or less all over the world, and I then saw how important it was in the industry to have a deep understanding of what really happens when you process some feed to end products.

I also had the pleasure of getting to know many, many people in industry. Not so much in Denmark but in countries more or less all over the world where this company worked. Then, of course, the war came, and in the early years of the war, very early periods of the war, Denmark was not occupied. We were occupied the ninth of April, 1940. And that was a day when really, my wife and I had planned to leave to the United States, and therefore during the day of occupation, the American Embassy invited us to come to China, to the US, and would help us coming over there.

Unfortunately, our two children were very ill, and therefore we could not travel. So we decided to stay in Denmark, and on the tenth of April we started the company, and my wife said to me that now you can't go to the States and because of the war you cannot expect to have position in universities in Denmark, so you must now plan to do something, set up something, that will be of value after the war. And I said, fine, I understand that. But in order to do that, I had to find a place where I could work, and we were very fortunate that I could work during the war years and many years after in Sweden and build quite a substantial company in Sweden.

I'm not sure I'm answering your questions, but this company, of course, had to find a way of earning money, and we decided because of my interest in physics and chemistry, and interests of my colleagues we had from the beginning, we decided that we would concentrate, focus on catalysis. We thought that catalysis would offer us everything we wanted, offer us a possibility to use our more scientific interest, offer us possibilities to manufacture catalysts through engineering and develop processes and thus earn sufficient money to justify our work with more theoretical scientific problems.

And, indeed, catalysis grow to be very important as you all know; we had very, very limited activity in industry worldwide based on catalysis, and today more than 90% of all manufacturing is based on catalysis, involving catalysts and catalytic processes.

MM: Okay, Dr. Topsøe, you already referred some early difficulties that you were faced with in your life, including going through the war years. So I'd like to ask you, going beyond the war years, what other major difficulties did you feel that you experienced in your career?

HT: Well, if you are talking about everything that's happened since the tenth of April, 1940, 70 years ago, the major difficulties have always been, I think, to have a company run with sufficient generation of money to pay for a growing staff, to pay for scientific work, to pay for equipment we needed, and for many, many years, this was a problem that of course caused us to look into every day when we had to pay our workers or staff and hope that we could generate enough money to pay them. All our major problems, of course, was to get business, simply to sell what we could offer, catalysts and technologies and designer plans.

Of course, we wanted to do all we did in order to bring something to industry. We wanted to build plants, design and build plants for others, plants which were based on catalysis, and we wanted to build catalyst manufacturing plants for ourselves. And the data, of course, necessitated the liquidity I was just speaking about, and the former to build plans for others, of course, necessitated from the very beginning, we had to focus on several things. To focus on creating new knowledge, doing new fundamental science work, to focus on doing engineering to come from scientific result to practical design of plants, and so on, and to sell, to find clients, to sell. So you might say that our main problem was to come from what we call science to dollars, from developing new knowledge that could be used to get business.

MM: Okay, thank you. Now that we spoke about major difficulties, maybe it's a good time to talk about major accomplishments, in your own view?

HT: That's a very difficult question because if you speak, as I'm sure you do, from a scientific point of view, I do not think that I can look back on very major scientific accomplishments I can be credited for. I think that my main accomplishment maybe is to create a unit, a business unit that made it possible for other scientists, engineers, and operators to work. So in a way, I think my accomplishment was to put together everything it took to have a home for what we were interested in. For instance, George de Hevesy, a very good friend of our family, he told me that he didn't think I would be a very good scientist, but I would be a good fellow to create a home for good scientists.

MM: Well, that's an interesting statement. He must have read some good signs in order to say that.

HT: Maybe. I think I got quite a good understanding of what theoretical physics could do for our field, what we were interested in. And I also, at the Bohr Institute, did a lot of work with others and wrote some papers, which, if I had stayed at university, would have been used for maybe a PhD as you call it in the U.S., maybe. But once I decided that in '36 I could not expect to get a good position at university, of course I forgot it and tried to accomplish everything you had to accomplish in an industrial company. I think that what we could then accomplish was to bring a lot more science into the industry. But that is something specific for every industry, every industrial company.

MM: Thank you. So let me continue with another question that actually, it couples to what you just said. I have been reading your company's leaflets including the Haldor Topsøe Web site, and I quote, "understanding is the basis of development." That's your own saying. One unique characteristic of your company is the emphasis that has been put in on fundamental research, and its serious long-term investment on that. This is in contrast to what other major companies, unfortunately, seem to be doing recently. Can you rationalize your approach, philosophy, to invest in fundamental science to us?

HT: Firstly, I think that, for us, investment in fundamental science was to create new knowledge. Obviously, you might say that you should not study in fundamental scientific matters if you are not sure that it could be used industrially. But I think if you take that approach, you may risk to create neither new knowledge, nor new business. So therefore, I think that the important thing is to be really enthusiastic about creating new knowledge. And then, of course, if you have a company, a company has to do business, and therefore, of course, you have to then ask yourself, to what extent could our company afford to do scientific studies only to create new knowledge?

I would say that, the way things have developed, we are in a situation where we can permit ourselves to spend maybe 20% or more of our efforts in R&D to create just knowledge, and the rest we have to focus on scientific work that we are reasonably sure will be of value for the business. But let me say something about this, reasonably sure. If you want to do something really new, and not just polish existing knowledge a little bit, then you cannot know that you have a result.

If you want to do something really new, you cannot be sure that you get some new knowledge, nor can you be sure that you create something that's useful for industry. But this whole play between fundamental science and business is a very intriguing one. In our situation, it necessitates that we focus on the things that we want to do from the beginning. And also that we keep bringing to industry only something which we have created ourselves.

So everything we do for industry, for business, must be anchored in fundamental science. And also, it has another intriguing problem that's come from fundamental scientific result to something you can use in industry. You might call it a scale-up. Of course, if you do experimental work, the scale-up is a good term. If you do theoretical work, as we also do, for instance in DFT, as you have worked on yourself, then this scale-up takes on a completely different character.

But trying to come back to your question, we think that besides doing fundamental work just for creating new knowledge, we are trying to do fundamental work where we know from the beginning that if we are successful, it can be used in catalysis, in industry. Now even so, of course you are not successful. If you take our situation, I think we have been rather lucky by having a really high, quite high, quite acceptable success rate. But I should think that if you look at all the projects we have started to create new knowledge or create new business, I think that we may approach a 1:2 success rate, which I think is very satisfactory.

MM: Now, Dr. Topsøe, if I could elaborate a little bit on the last point you made, throughout your 70-year career with the company, or more, you have launched hundreds or thousands of projects within the company, either for creating new knowledge or always with the hope that there will be something useful for industry through catalysis. To be realistic and for the young students who may be listening to this interview in the future and have an interest in entrepreneurial activity to build a new company up that would be based in catalysis or something related to chemical engineering: What fraction of these projects that you launched, you'll be happy to know that they came to fruition and to industrial practice. Is it just 1%, is it 10%, is it a fraction of 1%, what is realistically to be expected?

HT: Probably more than a third were successful. But in many cases, they need to approach this with, not at the time useful for industry, you see, if you look upon what all the green people talk about today, it's interesting to see that some of us, also our company, were ahead of our time. We did some work to protect the atmosphere more than a generation ago. We managed to show that it was useful, could work. But we were ahead of time, so therefore, in a way it was a failure that cost us a lot of money.

That has happened again and again. And therefore, when you talk about successful, you have to realize that developments in science and in technology have somehow to fit a time pattern that is developed by industry. But then you also have a peculiar problem that we didn't really realize when we were young, namely, that more and more political processes interfere. More and more people in the government, they want to decide what we can do and what we can't do. For instance, if you take actual problems concerning the atmosphere, examine pieces, all that, we have now to dance to the tune of many political leaders who tell us that is what we are allowed to put into the atmosphere or into the ocean and so on. And also tell us that we may have to somehow solve the problem of CO_2, and maybe even we will have to bring down CO_2 emission drastically, and for instance, develop energy technologies which can rest in themselves by recycles and so on. Some of our political leaders have made statements that we have, in a short number of years, to bring down the CO_2 emission to half of something, and this, of course, creates some problems. Some problems we can foresee, some problems we still don't know what the political leaders, nationally and internationally, will decide shall be the goal.

Also, some may say that we are only allowed to send out CO_2 to the atmosphere if we know how to sequester the same amount. That means that we have the time sequence coming from fundamental science to useful technology, from science to dollars, as I said, which is a business in a company like ours, inside the company. We have the time schedule of industrial development that hopefully we'll need what we bring to the industry when we bring it, and we have the political leaders that sometimes may completely destroy all sorts of reasonable planning. And I also hope that we will see a way of having real fundamental, acceptable, and reliable science for playing a major role in all of these political plannings.

MM: Okay, thank you. Which actually brings me to our next question, Dr. Topsøe, do you think that politicians, say, over the past several decades, have not been adequately educated in science or engineering to the extent that would be more realistic in their announcements and their decisions? What would be an ideal politician in your view?

HT: An ideal politician?

MM: Right.

HT: Well, I can't answer that question. I have never, myself, been interested in going into politics. I have had the privilege to follow many things that happened, I've had the privilege of, in many countries of the world, knowing politicians, participating in discussions with them, sometimes even in planning, but the answer to your question, what is an ideal specification for first-class politicians, I don't know. But I can say one thing. What we lack today more, internationally more than maybe anything else, is real first-class politicians with ideas to make everything better for everybody in the world. We, of course, have some, but we need many more political leaders all around the world who would really emphasize who does the ideas, what they want to achieve to make a better life for everybody all over the world.

MM: Now that we spoke about major accomplishments, perhaps you can comment about major problems you have faced in your career.

HT: The most important problems for chemical engineering have to do with resources, and here, by far the most important is, I think, energy. People have not sufficiently realized how important energy is. It's so peculiar that when you look back to my study years, nobody, not even the very big energy companies, thought there was much of a problem. Of course, the major source of energy at the time was hydrocarbon, oil and gas, and coal. And particularly those responsible for oil and gas resources, they didn't care at all. They all knew that they had known resources in hydrocarbons for maybe only a dozen years, but they didn't care.

This was a mystery to me. Now when you then move to the years after the war, you have the Club of Rome. The Club of Rome was saying a lot of correct and realistic things and warning everybody about the energy situation, but unfortunately, they spoke in such an exaggerated manner that nobody in the political leadership around the world really paid attention to them. So now today, we have a situation where everybody is a little bit upset.

We, also today, know that we have hydrocarbon, known resources of hydrocarbon, for only a couple of generations at the present use. And we know that we are not really finding enough new resources to keep this figure constant, and that we can see that there probably, in my case, probably in some four or five generations from now, we will see a real problem in hydrocarbon resources. What I'm then very much afraid of is that we haven't prepared ourselves for that situation. Obviously, chemical engineering and technology has a lot to do about that, to learn about how you can drill more efficiently, how you can extract a larger proportion of the oil and gas down there, bring it to the surface, which has a lot to do with the technology involved in also chemical engineering.

You also have the problem of using the resources in a more efficient manner; that is chemical engineering. Then, of course, you have the problem of what do we do when we can see the end of hydrocarbon production approaching? Do we let the few who will have hydrocarbons for much longer time than the others, do we let them set the price, do we let them create problems for all of us, or do we prepare ourselves in such a manner that we do not have this fight for energy resources between all countries? Do we have to accept that there will be a very serious fight, very serious economic problems, between those who have not hydrocarbon resources, and those who have?

I'm afraid this could be so serious that if we don't right now find out how to prepare ourselves for this situation, then it may lead to very serious political problems between the countries, maybe even to something approaching war. Now, you ask me what is the most serious problem for chemical engineering. Obviously, my answer here has to do with that because in order to avoid these problems of energy, we can do a lot in chemical engineering.

One thing that we have to do already is to prepare ourselves for reasonable use of coal, brown coal, tar sand, and so on. This, of course, is a way of converting the coal, etcetera, into all sorts of products. Of course, coal can directly be used to make power and so on, and the chemical engineers have, and all engineers have a job to develop a very efficient way of burning coal on the steam boilers and to create, then to create an extra power in turbines and so on. We in Denmark have had a number of engineers who have worked very efficiently on that, and I think we have a world record in the efficiency in using coal in conventional power stations.

So that is a job reasonably well achieved, but there's an end to it, and the end is in somewhere in the late '40s, the race between the energy contained and power sent out, and the energy in coal.

Now then you, of course, also have to be able to convert coal as a substitute for liquid hydrocarbon and for natural gas. There's a lot of work going on in this field. To my mind, most of all of these activities have to go through gasification of coal to create synthesis gas. Some countries are very busy with that. I should mention China, of course, having coal, but only limited resources of hydrocarbon, and this very interesting challenge for chemical engineers.

The gasification itself is an interesting process which maybe belongs to the realm of the chemical engineers, but then downstream, processing of the crude gas to a pure synthesis gas and the conversion of the synthesis gas to, for instance, diesel oil, etcetera, via Fischer-Tropsch, or to gasoline via a process we have developed, is very important, and the conversion to synthesis of natural gas is very important. Many, many jobs already going on do all this, but of course once you have synthesis gas, you not only have a starting point for making synthetic natural gas and diesel and whatnot, gasoline, you also have a starting point for all sorts of chemical industry from the very important fertilizer industry via all sorts of chemicals for polymers like ethylene, and propylene, and so on. And you have a starting point for everything that begins with methanol, goes all the way via formaldehyde and whatnot. And you have a starting point for also using the gasification process for all the raw materials, like coal. So you also have a starting point to use waste of all sorts of things, and you even have a starting point for recycling many things.

MM: So, Dr. Topsøe, do you want to add a comment about fundamental studies of photosynthesis?

HT: Yes, because I think that it would not be impossible; there is something we can all do to improve photosynthesis. Surely, we should remind the public that CO_2 is not just this devil, as all the green people thought. But it's together with water what created all of us.

MM: Exactly.

HT: Therefore, I think there might be a chance to understanding photosynthesis better to see exactly what it is that goes on in this process catalyzed by radiation and by chlorophyll and so on. I have a hope that some of the work that also we are doing in understanding better what happens in a catalyzed reaction, that may also be of value for understating photosynthesis better.

MM: Okay, thank you. So let me change the subject for a moment. Haldor Topsøe has had a long tradition of successful interactions and collaborations with university laboratories. Can you tell us, how can this be done so that we can strengthen, in general, university-industry ties?

HT: Well, let me first answer it by saying, I think that in many, many countries, it's certainly true in my country here, we should make life here much easier for university people. Easier by increasing the relative salary level for university people so that still enough really first-class youngsters select work in universities. So, I think that is maybe the most important, and therefore, that needs in many ways, that government finds a way to support fundamental science, to support university work.

Now here in my country, for instance, there's a lot of talk about having joint ventures between universities and industry. Surely, industries must follow what's going on in universities, must support it, must also employ university professors to give them advice about what to do. But, I, myself, am afraid that you place too much emphasis on having professors being business people. I think that it's fine that you can have work done in universities, it's fine that you can have the advice of professors and scientists, but I'm not so sure that the best way forward is to have these many joint ventures people talk about in so many countries and also here between universities and industry. Indeed, I don't really like when I see some professors in a university setting up a company.

MM: Thank you. Now, do you have any comments on the present state of chemical engineering education? You hire many chemical engineers, say from DTU or from all over the world. Do you feel like some changes are needed in their education so that they are better prepared to serve a state-of-the-art industrial setup as yours?

HT: Well, yes, I could say something about that. Firstly, of course, it depends on what young people really want. Now, young people at an early time, also long before they come to university, have to decide what they want for themselves in the future, and the worst thing there, and that is true for everything, also for chemical engineering, the worst thing is that the youngsters don't know what the practical life would be if they follow a certain career or another one.

So the most important thing is that we—to answer your question—that we make sure that all the young people in the last years in school, that they are really informed about what does it mean for their daily life in the future to be a chemical engineer? We do what we can, but of course it's very, very limited in a company like ours to inform the youngsters in the last years in school, and their teachers, about what it means to work in chemical engineering whether they go into a government job or into a business job.

That's one thing. The other thing is that it's very important for people who really choose to be chemical engineers working in industry, it's very important for them to know what is facing the industry in the future in the Western world, and everywhere. But I should—I mention Western world because it's very important for the Western world to find out a way to be competitive. Now that means that young people have to know a lot about what is the geography of the industry. Where do they emphasize that? Where do they have resources for that? And therefore, it's very important for young people to know something about what you could call the geography of chemical business. And the last thing I want to mention is that all youngsters wanting to go into industry, they have to understand this business of the interplay between science and selling.

MM: So, Dr. Topsøe, let me ask you another question. What advice would you give to a young person about to start a career in chemical engineering?

HT: Well, of course, first to find a really good university at which to study. And, secondly, besides the studies, to complement this knowledge by maybe taking a sabbatical year or two, trying to be allowed to work for other universities, for industries, and so on, to improve his understanding of what is required. But I would very much advise him, if he wants to go into industry, to also make sure that he knows about the economics of business, and also I would very much advise him to understand that if he wants to be an important person in a business company, he has to know how to sell, how to develop.

Then people are always talking about leadership. So thousands and thousands are going to learn how to be a leader. Well, I don't know about that, but surely you have to know how to interact with people. I think that surely leadership is important. Things have to be organized, all that. But I think that in daily life, to be really a good colleague, to be a good friend of your neighbors, to help your neighbors when they need help, to be available, I think that that is very, very important. Of course, that is not something you can teach people. They cannot go to a course to learn that, but they can try and work on the circumstances where this is important, because it is so important, and it means, it has, shall we say, a compensation in itself. Because if you really try your level best to be a good colleague, to be a good friend, then you will also be happy to see how people will rely upon you, and help you when you need. I don't know whether I answered your question.

MM: That was a very nice answer, thank you. So let me ask another question here. We are closing into an end here. Thinking of the past century, and looking into the future, what do you think are the most critical challenges chemical engineering is faced with?

HT: Well, didn't I answer that already by saying something about energy?

MM: Exactly.

HT: Yeah, but I think that a very interesting challenge is, of course, to understand things better. I think I touched upon this. A chemical engineer, he cannot be a fully informed chemist unless he knows about in situ work, knows about what goes on on the atomic level, on molecular levels, and so on, and therefore the challenge is to participate in work that will give us more fundamental knowledge. What is really happening when feed molecules approach a catalyst surface? What's happening that makes them stay there; what situation would the sites be in that would keep them there?

What happens when we act on the surface sites? What happens when they leave the surface again? And to understand all that also means to understand it under situations that really happen in nature or in industry. And that means that you have to understand, you have to do in situ experiments, and this has always been of great interest to us. When I was a youngster I thought that a better understanding of all this would be just around the corner. We had all the new things, with X-rays and power and what have you, but it wasn't just around the corner.

I think it's only in the last few years that we really understand what is happening, at least for a number of processes. I'm not saying we understand it for everything. But also we have had the problem that some of the most efficient tools for investigations could be used only on situations very, very different from the practical. I'm particularly talking about pressure and about electron microscopy. I think that we have a good chance to do electron microscopy under atmospheric pressure; we worked with some friends in Holland about that. We have two units capable of doing work under much higher pressure than you normally use, even atmospheric pressure, and we will do our utmost to bring that forward.

So that means that—I'm talking too much about that. That means that one of the important tools to really see what is the atomic structure of something, can also be used under conditions where some reactions take place on the surface of a catalyst. I think that whole business of using in situ starters more and more is a big, big challenge. But then, of course, you can't do experimental work unless you also perform theoretical work, understand what it really means, what does it mean what you are seeing? And therefore, when you and others work with this DFT, that some of our good friends here in Denmark have been very good at developing and where you also have some very interesting work done elsewhere in France and in the States and so on, I think it's very important that we really can marry the in situ observations, experimental factor, with fundamental, you might say mathematical, studies of all the energy steps involved.

MM: Great, thank you. So, Dr. Topsøe, I asked you several questions. I always like to ask a last question, that is, is there anything that you would like to add to this conversation that I didn't ask you about, perhaps, and that you feel would be important for the general audience and readership of the *Annual Review of Chemical and Biomolecular Engineering*?

HT: Well, I think I have said all I can say about this you call molecular engineering, peculiar term. I do hope that we can also do the work we're doing in bio fields. I do hope we can manage to understand better what is happening between chemicals, pharmaceuticals, and living cells and how this interaction really takes place. I do hope we can understand that, and with some friends, we also have a small party to try and contribute there.

But what else can I say? I did say a lot about fundamentals, and business, selling and so on. You also asked me a little bit about what was important during my life. I would say that maybe I really learned how to combine science and industry, to develop new things, new products, new knowledge. And so I think I learned more about that during the war years and the following years in Sweden because there you had a number of people doing very important scientific work in the fields we are interested in, and you had some industrial groups which were admirably using basic work, basic engineering work also, and creating very important businesses.

So I think that I also owe a lot of things to people in businesses in Sweden for what they taught me about this interplay. So my last words should be, all people interested in each field must again, and again, ask themselves how to come from fundamentals, to knowledge, to industry.

MM: Okay, well, it was a pleasure and an honor to conduct this interview on behalf of Annual Reviews, Dr. Topsøe, and I want to thank you very much for the opportunity.

HT: Thank you very much. I also enjoyed this discussion, which might be called an interview. I hope that we managed to say something that would be of particular interest to young people, and I do hope that what your publication is doing will also be very useful to help that in the future we can be competitive, because if one country or one area of the world runs ahead of all of us, and we can't compete with them, then we'll have a dangerous situation. So let me express this hope.

MM: Okay. Thank you very much again, sir. It was an honor and a pleasure.

HT: It was a pleasure speaking with you. Thanks very much, old friend.

MM: Thank you, thank you.

DISCLOSURE STATEMENT

The interviewer and interviewee are not aware of any affiliations, memberships, funding, or financial holdings that might be perceived as affecting the objectivity of this review.

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