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Physicists in Industry (17)

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Culture Shock

Most physics graduates (around 90%) take a job outside the university after completing their studies, preferably in industry. There, a different culture of behavior awaits them than the one they were used to at university. Complex problems, which they previously had to solve on their own, are now dealt within a team under strict deadlines, with everyone being assigned a specific task segment. Instead of publishing as much as possible, as was previously the case, they now have to maintain silence towards the outside world. Instead of long-term visions, seemingly banal but immediately implementable small steps to optimize a technology or minimize the costs of a development project are the daily tasks. For many industry newcomers, this culture shock understandably leads to uncertainty and, looking back, they would have been glad to have been prepared for the new situation during their studies. In the past, the SPS took this concern into account by organizing the symposium series "*Careers for Physicists*" so that relevant information from industry could reach students in higher semesters. Nowadays, it is the session presentations at the SPS annual meeting, organized by the SPS section *Physics in Industry*, where speakers from start-ups report first-hand on their products, primarily to get young people interested in their company, but also to report on their corporate culture.

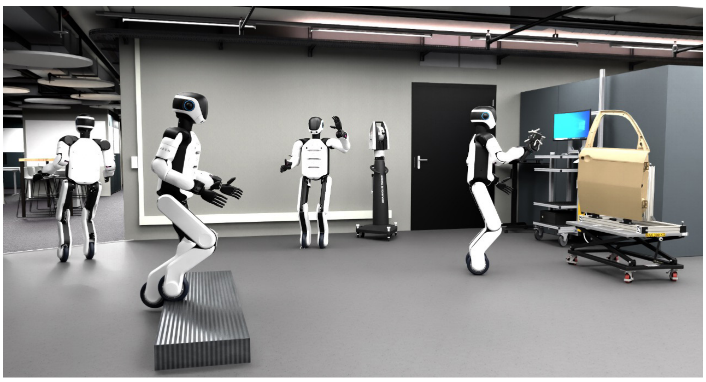
Physicists as Technology Developers

In the following, we will not look at the role of physicists in a start-up, but in a large company that has been established on the market for many decades and plays a leading role on the global market with its cutting-edge products. Large companies of this kind must therefore be open to innovation, which makes them attractive to graduates. Physicists are then employed either in a central R&D department to further develop a new technology, the feasibility of which has usually previously been demonstrated by an institute, to product maturity, or in the business units to integrate newer technologies into products or processes. In the first case, typical tasks are, for example, for a new type of lidar technology: What are the application limits? When does the system noise outweigh the measurement signals and can reliable information still be extracted from the noise even with very weak input signals? Do additional measures such as permanent internal calibration make sense in order to minimize systemic errors? In addition, it must be clarified whether the new technology can only be used situationally or in the instruments of *all* business areas, for example in civil surveying and medicine, where the highest resolution is required, as well as for defense instruments, where robustness is the top priority in the application? This last point is important for a large company to know whether the other business areas can compensate if one business area experiences an economic downturn.

Physicists as Product Developers

Physicists can also contribute their strengths in various areas when transforming a technical innovation into marketable products. The starting point for every new product launch is always a careful consideration of the intersection of the three fields (a) development effort, (b) range of applications and (c) market access. In the case of (a), it must be possible to estimate what difficulties are to be expected, what specialist skills need to be provided and what time frame is required? For (b), it must be clarified which other possible applications are conceivable and which instrument variants would be required? Finally, under (c), the question must be asked whether market access has already been secured, i.e. whether market acceptance can already be seen and whether customers are ready for the innovation? Linked to this is the question of whether your own company is already in a position to handle the entire production logistics, including customer advice, in terms of sales?

As an industrial physicist, you traditionally work more in the development area (a), whereby the manufacturing process must always be taken into account in every product development. For example, the design of a complicated optical system must not only deliver the specified imaging performance, but the minimization of manufacturing tolerances must also always be included in the ongoing optimization calculations. This requires a detailed knowledge of the manufacturing processes. Young physicists should therefore build up sufficient knowledge and self-confidence at an early stage in order to convince experienced production manager when it comes to investing in new and more precise machines, which will be a tough battle. In the second task (b), application analysis, physicists will have to be more involved in the future than they have been in the past in order to develop and specify the widest possible range of variants for the planned innovation and patent them as soon as possible. Physicists are ideally suited to this challenging task as they think in analogies, i.e. they can recognize fundamental similarities between different applications.



Humanoid robot from Hexagon Leica. State-of-the-art technology allows a wide range of practical applications. Image: courtesy of Hexagon

Point (c) is even more difficult, as psychology comes into play here alongside physics. Sales and distribution are generally very conservative, which is a consequence of their close relationships with regular customers, who are also usually conservative. When it comes to major leaps in innovation, there is mistrust, uncertainty and, unfortunately, often resistance to advice. In today's fast-moving world, ignoring quantum technologies, for example, can lead to existential problems for companies virtually overnight. They are therefore well advised to use the specialist knowledge of their physicists in customer support, because once customers see the advantages and lose their inhibitions, their own sales department can no longer resist them.

Physicists as Science Managers

In large companies, it is often customary to participate in external R&D programs in which a consortium of universities and other companies investigates new technological approaches that could be of interest for the company's own next-generation products. Programs of this kind include, for example, government-organized basic research programs in which the partners assess the industrial applicability of a research result. This is an appealing task for physicists, but it does not make them popular within their own companies, as it requires the best developers to be seconded, who are then missing elsewhere, involves a lot of unproductive effort, and ultimately it is unclear whether expectations will be met. If they are, patent disputes are often to be expected. However, such programs are enormously important, and in Asian countries they are mandated by the state. In this phase, companies must see themselves as colleagues and not yet as competitors. Another area where the expertise of physicists is in demand is in R&D programs for ESTEC, the technogy center of ESA and, increasingly, in military projects (see box).

Influence of the Corporate Culture

The extent to which physicists can and are allowed to use their skills in the intersection of the three areas mentioned depends heavily on the corporate culture. If a large company is run by lawyers or financial experts, more weight is always given to conservative sales, which brings in money, than to innovative R&D, which costs money. However, this only works for a while. In earlier times, technology giants such as Siemens, Volkswagen or BASF were traditionally always managed by a Dr.-Ing. or Dr.-rer.-nat. Their expertise allowed them to recognize the value of a technical or functional innovation from the outset and promote it accordingly. This requirement was then transferred to all subordinate management levels.

Nowadays, other paths are being taken and many companies offer different paths for personnel development: the so-called Y-models are well-known, in which physicists decide early on whether they prefer to work as an expert on technology projects in R&D and pursue a career as a group or laboratory manager, or whether they decide early on to pursue a career in company management. However, this requires MBA training, which can also be acquired during the professional career. The advantage of a career in corporate management is that you become universally deployable in the company, you can become more strategically involved with each level upwards, and you also earn more. The disadvantage is that you lose specific specialist knowledge and are quickly replaced, transferred or even dismissed if the targets set for the group, department or business unit you manage are not achieved. This significantly higher risk could be one reason why only a few female physicists choose this career path in corporate management, which has nothing to do with discrimination, but merely with a personal weighing up of benefits and risks.

Physicists as Top Managers

The question is whether we should not return to the previous situation, where technology companies were led or at least decisively shaped by physicists? In view of the rapid changes in the industrial world brought about by quantum technology, quantum biology and quantum informatics, strategic decisions must increasingly take into account the latest findings in the atomic field with regard to assessing potential opportunities and risks. Lawyers and financial experts lack the necessary internalized knowledge and their decisions are based on generally accessible information, which is not enough in view of the complexity. Physicists should therefore make a much greater effort to take on higher management functions in order to set the right course in good time as the half-life of new technologies becomes ever shorter. It should be discussed whether management skills should not be part of university physics training.

At ESA, as well as at big companies, system development nowadays largely runs in parallel between the various R&D departments. This means that even a preliminary design or a construction draft is assessed simultaneously at certain intervals by the test, production, assembly and application engineers. To this end, meetings are held in so-called Concurrent Design Facilities, where the design or the draft runs through all subject-specific programmes and where all engineers present can see how it meets the specifications set by them. Any proposed modification can be immediately implemented and verified if e.g. a mechanical modification at a larger optical payload may cause an unfortunate coupling between a specific acoustic resonance mode of the solid rocket boosters, and the payload's eigenfrequency of e.g. 45 Hz, which could cause serious vibrational problems at the launch.

More info can be found for example here: https://www.esa.int/Enabling_Support/Space_Engineering_Technology/CDF