Diversity: Academia-Industry Collaborations on Modeling and Simulation to enhance Scientific Capability Development – The Novartis Experience

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Objectives

Academic and industry collaboration for the advancement of science has a long history and track record of success[1]. Research published in the Proceedings of the National Academy of Science, shows (with mathematical algorithms) that, depending on the task at hand, groups of diverse problem solvers can outperform high-ability specialist groups[2]. We investigate and share our experiences on how the unique but complementary contributions and perspectives of each partner within modeling and simulation can create a fruitful synergism based on their diversity.

Results

Diversity for improved problem solving

- The Modeling & Simulation (M&S) group within Novartis Pharma AG has been built with a strategic intent to capitalise on diversity. It consists of highly educated individuals (most with PhD or MD) with a large range of different core scientific qualifications (engineering, biology/pharmacology, mathematics/statistics, clinical medicine and computer sciences). **Figure 1** shows a list of educational backgrounds of the M&S group personnel. These are reflected in our collaborations with academia as our internal diversity enables us to work with a variety of academic partners (see example projects in **Table 1**).

Figure 1. *Broad spectrum of educational backgrounds filling different roles in the department*

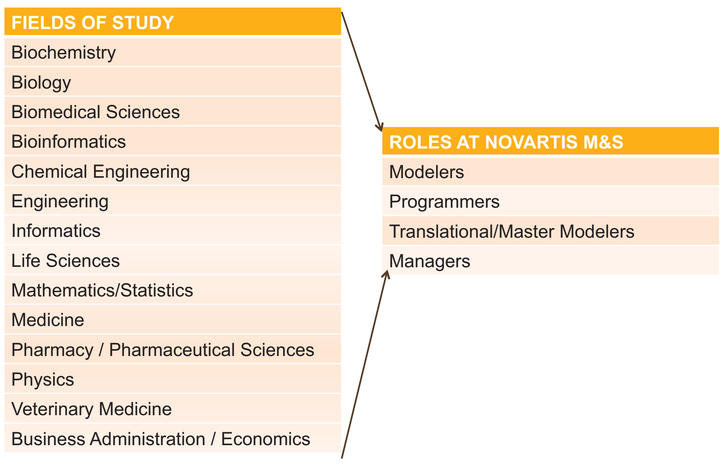
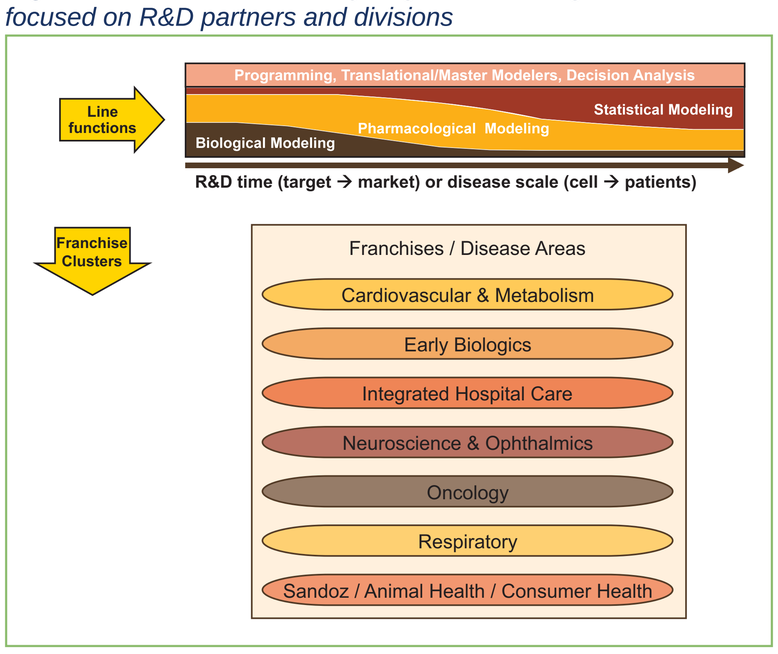


Table 1. *Examples of modeling and simulation collaborations between academia and Novartis M&S*

Project Topic	Research theme	Potential Mutual Benefits/Examples of Projects
Complex PK/PD model	Inter-species Extrapolation by Mechanism-Based PKPD Modeling	Prediction of the clinical risk for cardiovascular effects using inter-species extrapolation with a systems biology based PK/PD modeling approach
Complex PK/PD model	Applications, Methodology Development and Training in Pharmacometrics	Development of Whole-body physiology-based pharmacokinetic modeling for use in clinical drug development: New modeling approaches, model evaluation techniques and software approaches
Model Library	Reuse of Drug and Disease Models	Development of models and model libraries for clinical readout, towards quantitative assessment of dose-response (e.g. for psoriasis drug development)
3D biophysical simulation	Novel Drug Delivery Systems	Integrate understanding of the delivery system impact on the dose-exposure-effect relationship (PKPD), with application to ocular and pulmonary delivery
Statistical method development	Model-based Bioequivalence Assessment	Investigate model-based statistical approaches to bioequivalence/biosimilarity including longitudinal data analysis
Statistical method development	Analysis of Multivariate Ordinal Responses	Investigate the possibility to handle multivariate ordinal responses with latent variable approaches, e.g., on pain scores
Decision analysis	Health Economics and Decision Modeling	Mathematical modeling of healthcare economics, with emphasis on pharmaceutical decision-making
Scientific capability development in emerging countries	Training and Support to Universities	Provide support to train scientists in emerging countries to apply their skills to healthcare issues of their local concern

- To provide focussed support to the different therapeutic areas of interest to Novartis, the M&S group is organized into groups of associates with diverse skill sets, aligned around a common therapeutic area focus - called M&S clusters (**Figure 2**). The high diversity within each M&S cluster ensures that we can address very different questions from the project teams with very different data analytic methodologies, thinking styles and problem solving approaches for the specific modeling and simulation tasks at hand.
- Besides the differences in scientific backgrounds, all members of the M&S team have had different durations of work experiences in academia and industry. Everyone has seen different approaches applied to various different projects and can build on this for their current work. This is also of great advantage for the academia-industry collaborations as the assessment of work and career paths are different in the two systems. This induces differences in the way of working and provides complementary approaches for the projects.

Figure 2. *M&S structure is a synergistic matrix organization focused on R&D partners and divisions*



- Finally, there is the diversity provided by the demographic differences and personality types. These are very important as the tasks to address are too complex to be solved by an individual, therefore team work and communication within the team is essential. This can be furthered and hindered by the social capabilities and differences of the team members. Also, private experiences can prove valuable when these can be mapped to provide an innovative path to a solution for the respective questions. The M&S group is currently located in 3 different sites and consists of individuals of more than 25 different countries. Our collaborations include partners in Europe, USA, South Africa, Australia and New Zealand.

Diversity in M&S collaborations

- Scientific background – fields of study, expertise
- Work experience – various industry origins (including telecommunications and banking) and academia
- Demographic – gender, ethnicity, nationality, age
- Personality-types

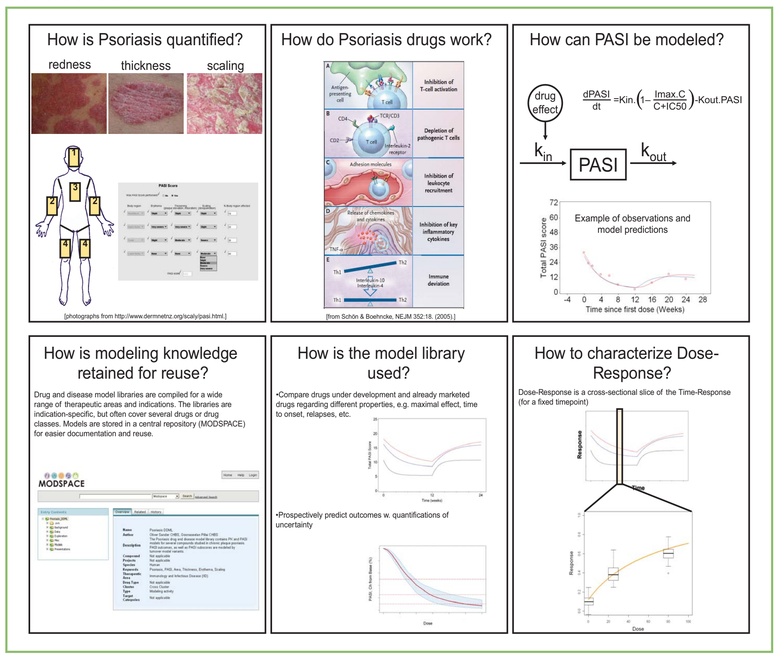
Leveraging diversity: Academic collaborations of Novartis M&S

The academic collaborations come in different flavors. It could be set up as collaboration with a university (focusing on a department or a professor) providing open, flexible support as an educational grant or fellowship. In this setting M&S is providing not only funds, but also data, internal knowledge and application-relevant questions to the scientists at the academic institution (see examples in **Table 1**). Another possibility is for senior Masters or PhD students to do a 3-6 months internship within the M&S group and/or PostDocs to take over a 2-years visiting scientist position. In addition, senior researchers may also join the M&S group for a sabbatical. This flexibility of options provides a valuable framework for knowledge transfer between academia and industry and scientific capability building for both partners.

Three examples are listed below

- Collaboration with a specific academic department/professor
  - Academic collaborations with Centers of Excellence, leading to state-of-the-art scientific research on drug-development related questions
  - Direct interactions on research topics with the scientific leaders in the field for quick knowledge transfer in both directions
  - Supervisor is free to guide the research project in any scientific direction as deemed necessary
  - Very well suited for PhD students
- Extend/Partner with existing academic collaborators to share capabilities with emerging countries
  - 2011 Conference on "Modeling and Simulation Applications to Diseases affecting HealthCare in Africa" was hosted by the University of Cape Town, South Africa and Novartis. Various local and international scientists offered their expertise to promote collaboration among academic institutions within and outside the region, and with the industry. (Access to presentations is available on request.)
  - Uppsala University has recently offered to reserve free seats at its Uppsala Pharmacometrics Summer School for candidates from emerging countries – with attendance being facilitated by travel grants from Novartis[3].
- On-site sabbaticals in industry or in academia
  - Novartis hosted several academic faculty for sabbaticals in residence at the company's site. These have ranged from short-tem (2 months) to long-term (1 year) periods. Longer-term stay has allowed the academic partner to fully integrate into the industrial approach to modeling and simulation in support of new drug development.
  - Sabbaticals of industry M&S associates into academia for short stays (usually <1 month) have also been conducted. This is usually associated with a specific drug development problem for which the industry scientist spends time with the academic mentor to provide significant focused advancement of the project. **Figure 3** shows an example of the output from such collaboration.

Figure 3. *The psoriasis platform: An example of a drug and disease model developed within an academia-industry collaboration[1]*



Challenges for academia-industry collaborations and across diversities

The advantage of diversity as described above can only flourish when the terms of collaboration are clear and the partners acknowledge their different viewpoints and priorities. This challenge can be related to the social interactions, where team building is essential to overcome isolation of team members and cultural misunderstandings. Also at the technical level it is necessary to ensure standards for communication and understanding such that people with diverse backgrounds can share their knowledge using the same language. From a legal point of view the expectations of the partners have to be clarified including ownership of created intellectual property and possible funding regulations.

To overcome diversity challenges one has to ensure:

- Integration essential for managing diverse viewpoints and arising conflicts
- Standards for communication and understanding
- Intellectual property agreements, funding, clarity of project terms and goals...

Benefits

The main overall gain is for the scientific community, and ultimately the patients. The collaborations provide the means of fast, direct and highly efficient knowledge transfer and thereby contribute substantially to scientific capability building – within industry, academia, and the emerging countries. In addition to this, and the evidence that teams of diverse problem solvers outperforming high-ability focused problem solvers, there are additional benefits:

- Academia benefits via access to data, relevant research questions to development of new drug treatments, and opportunities for funding.
- Industry benefits via access to research into cutting edge methodologies, linkage to key scientific leaders and to well-trained scientists – who may also be future employees.
- Publications emanating are mutually beneficial - indicating productivity for academia, with increased visibility and credibility for the industry collaborators among the company's stakeholders (e.g. scientific community, Health Authorities, and patients).
- Investment in M&S in emerging countries requires modest investment for Pharma companies compared to the large infrastructure, costs of building drug discovery and clinical research laboratories.
- Scientists in emerging markets obtain high scientific application-related support at their home institutions providing support for the development of the local research institution.

Conclusions

Our experience shows the value of academia-industry collaboration in modeling and simulation based on the diversity of our team members and the diversity presented by and in our academic partners. Due to its success M&S Novartis is committed to continue and expand in the future.

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