Numerical modelling is increasingly supporting the analysis and optimization of manufacturing processes in the production industry. Even if being mostly applied to multistep processes, single process steps may be so complex by nature that the needed models to describe them must include multiphysics. On the other hand, processes which inherently may seem multiphysical by nature might sometimes be modelled by considerably simpler models if the problem at hand can be somehow adequately simplified. In the present article, examples of this will be presented. The cases are chosen with the aim of showing the diversity in the field of modelling of manufacturing processes as regards process, materials, generic disciplines as well as length scales: (1) modelling of tape casting for thin ceramic layers, (2) modelling the flow of polymers in extrusion, (3) modelling the deformation process of flexible stamps for nanoimprint lithography, (4) modelling manufacturing of composite parts and (5) modelling the selective laser melting process. For all five examples, the emphasis is on modelling results as well as describing the models in brief mathematical details. Alongside with relevant references to the original work, proper comparison with experiments is given in some examples for model validation.