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## Preface

Transmission technology has significant impact on fuel consumption, drivability, weight and cost of vehicles. The relevance of these properties increased recently; and interacting with the entire powertrain and vehicle, the transmission becomes increasingly important.

For a long period, little innovation has been applied to transmission technology. Generally, until the beginning of the 80's of the previous century, just manual transmissions and step automatic transmissions with planetary gear sets and hydraulic control dominated the transmission market. Automatic transmissions focused on the operational comfort. Neither fuel economy nor sportiveness could compete with manual transmissions.

Evolutionary steps towards more gear ratios, for both, manual and automatic transmissions, were motivated by drivability and fuel economy. A first major leap in innovation was the introduction of electronic control to supplement the hydraulic control of conventional automatic transmissions. The additional degrees of freedom and functionalities aimed to improve comfort and interaction with the internal combustion engine. One of the features was an improved control of the torque converter lock-up clutch for reduced fuel consumption.

In the 90's of the last century, transmission technology—especially the step automatic transmissions—was challenged by the introduction of continuous variable transmissions for higher torque applications. This led to massive redesigns and optimizations for step automatic transmissions and as a consequence, the benefits of the newly introduced continuous variable transmissions vanished and were finally overcompensated. Step automatic transmissions regained their leading position. Further, competition was created by the introduction of dual clutch transmissions. Automatic shifting transmissions are also demanded in markets which had traditionally been dominated by manual transmissions. As dual clutch transmissions allow re-utilization of manufacturing equipment installed for manual transmissions, they are major driver of this change.

The competition between the different transmission types was and is very beneficial. Modern automatic shifting transmissions can outperform manual transmissions in both, fuel economy and drivability.

Also the evolution of engine technology drives changes. Engines torques increase and fuel economy map flatten, which lead to new requirements for modern transmissions. Automatic shifting transmissions offer broader range of potentials to meet these requirements.

A further boost for transmission technology is given by the introduction of hybrid propulsion. Further degrees of freedom combining transmission, electric motor and internal combustion engines lead to multiple architectures and solutions. It has to be considered and understood that the different measures to improve fuel economy are not cumulative; adding up the different potentials is not possible. Utilizing the methods of systems engineering allows us to find optimal solutions and it is required to include the entire system during the design process to realize the potentials.

This explains the importance of transmission technology. Yet, does it justify another transmission book as there are plenty good ones already available?

We consider three levels of competencies in transmission technology: know, how to execute transmission designs, know, how to design transmissions and the competence to apply system engineering methodology on transmission concepts and designs. We believe the first two levels are well represented in existing publications.

Our desire is to focus on the latter in this transmission book. The competencies on transmission systems and accordingly the development methodology is our motivation. This starts deriving the needs for transmission technologies in automotive applications and includes the interactions with surrounding systems of the powertrain, the entire vehicle and the environment of the vehicle. Introducing the multiple components and sub-systems on an abstract level provides an ageless competence applicable for traditional, state-of-the-art and future transmission technologies. We would be honoured if we motivate the investigation and realization of new transmission concepts with this book.

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Fischer, R.; Küçükay, F.; Jürgens, G.; Najork, R.; Pollak, B.

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