

Integrated Architecture for Vehicle Body Development and Production Centered on Manufacturing-Induced Physical Properties

Ichiro Tanaka¹⁾ Hiroyoshi Horibe¹⁾ Takayuki Fujii¹⁾ Eisei Higuchi¹⁾ Mitsuhiro Takayama²⁾

1) Honda R&D Co., Ltd.

4630 Shimotakanezawa, Haga-machi, Haga-gun, Tochigi 321-3393, Japan

2) Cyber Physical Engineering Collaborative Innovation Partnership

2-14 Kandajimbocho, Chiyoda-ku, Tokyo, 101-0051, Japan

KEY WORDS: Vehicle development, Computer-aided engineering, Body in white, Production, Environment [B2]

Recent advances in digital engineering have enabled the prediction and evaluation of vehicle performance, manufacturing processes, production systems, and environmental impacts. At the same time, vehicle development faces increasing demands for shorter development cycles, higher cost competitiveness, and reduced environmental burden. Although these activities are strongly interrelated in vehicle body development, a framework for treating them consistently from a physical perspective has not yet been fully established. Various integration methodologies, including Concurrent Engineering, DSM, MBD, MBSE, and Digital Twin, have improved development efficiency by linking organizations, activities, models, and Cyber-Physical systems. However, these approaches primarily focus on information exchange and model linkage, while less attention has been paid to the physical entities commonly referenced by multiple models.

Although performance assessment, production engineering, and environmental evaluation belong to different domains, they fundamentally deal with the same vehicle body. Through manufacturing processes, the body acquires physical states such as geometry, thickness, residual stress, residual strain, and material properties, which directly influence product performance, production conditions, and environmental impacts. In this study, these physical states formed through manufacturing processes are defined as manufacturing-induced physical properties and positioned as a common language, or shared physical representation, for cross-domain integration.

Figure 1 presents the proposed architecture. At its core is a vehicle body property model that generates and stores manufacturing-induced physical properties, connecting performance models, production equipment and process models, CO₂ assessment models, and actual production systems. The proposed architecture has two key features. First, performance, production, and environmental evaluations are connected through common manufacturing-induced physical properties, enabling decision-making based on a consistent physical foundation. Second, the architecture provides a linkage path between Cyber Space and Physical Space. Engineering results obtained in Cyber Space realize their full value when they are reflected in actual products. The proposed framework therefore enables a continuous connection from digital analysis and evaluation to physical manufacturing and product realization. Application studies confirmed that manufacturing-induced physical properties can serve as a common basis for consistently connecting performance evaluation, production equipment, and environmental assessment, while process and equipment conditions derived in Cyber Space can be reflected in actual production systems.

This study proposes an integrated vehicle body development and production architecture centered on manufacturing-induced physical properties. The novelty of the approach lies in explicitly defining the physical entities commonly referenced by multiple models and positioning them as the core of integration. The application results demonstrate the feasibility of connecting existing analytical models and actual production equipment through the proposed architecture.

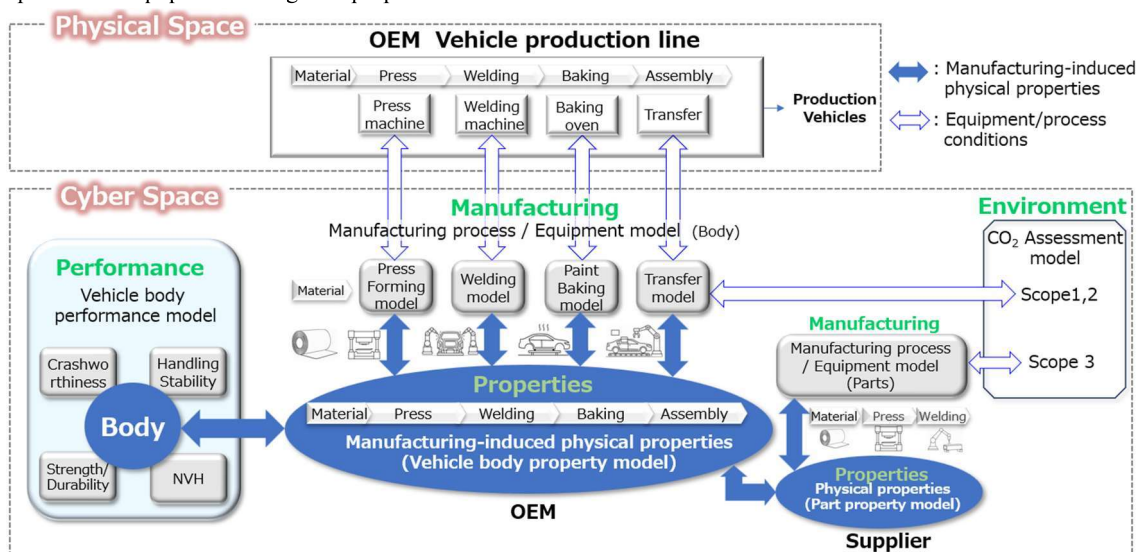


Fig.1 Overall Architecture Centered on Manufacturing-Induced Physical Properties