Part VI
SHM: Systems

Abstract One essential part of research for SHM is the investigation of the actuation and sensing system. Size, shape and localization are the most important parameters influencing the successful damage detection. Since Lamb waves exhibit various modes which simultaneously propagate with different velocities it is desirable to selectively excite and receive a particular wave mode. The first chapter of this part therefore presents a design methodology for mode selective actuator-sensor configurations considering various parameters such as the dispersion and attenuation characteristics.

The second contribution to this part of the book is dealing with the design of a sensor-actuator network. It presents a novel methodology which is based on the wave propagation measured by an air-coupled ultrasonic scanning technique. The expected sensor signals commonly measured by piezoelectric patch transducers which are bonded to the surface are predicted enabling the design of an optimal sensor network.

However, piezoelectric patch transducers have a retroactive effect on the wave propagation in the structure. This effect is investigated in the third chapter of the current part of the book. The investigation addresses the comprehensive understanding of Lamb wave propagation and interaction with the medium based on experiments being performed with a scanning laser vibrometer which measures the out-of-plane component of the surface velocity. Moreover, the chapter summarizes basic interactions of fundamental S_0 and A_0 modes with different defects.

The present part of the book is concluded with a study on the integration of an SHM system into a full-size aircraft structure. The system is installed and used to inspect a full scale Door Surround Structure made from CFRP. The sensor network consists of 584 piezoelectric transducers. The manufacturing aspects of the complex integration of active systems are addressed. The structure was exposed to an impact

campaign with a total of 112 impacts, inducing skin delaminations and debondings of various structural features. A probability-based damage identification algorithm is applied for the damage detection. The results are compared with traditional non-destructive inspection measurements and show a good correlation between SHM and NDI in identification as well as location of the damages.