**Michal Preisner – abstract of his PhD thesis**

**Title: Antenna arrays making use of membrane thin dielectric carries and their feed networks**

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The object of this work was a research on flexible antennas and their microwave feeding networks, made of thin, flexible dielectric and conductive membranes. Although research on such structures have already been initiated in the mid-50s of the last century, interest in flexible structures is constantly growing. The development of material technology has played an important role and was the driving force behind the development of thin-walled flexible structures. Modern materials and manufacturing technologies provide increasing opportunities to existing structures, as well as allow the introduction of completely new concepts, not used before in the microwave and antenna technology. Owing to flexibility and conformal shape of the membrane antennas, we gain the ability to use them in applications previously inaccessible to conventional antennas. For instance, they may be integrated with balloons, pontoon boats or other items made of flexible shells filled with pressurized gas. Because membrane structures are foldable and lightweight, they are often used in aerospace, emergency and rescue services, or serve as communication antennas for soldiers (e.g. antenna integrated with soldier’s helmet or his backpack).

Previous research has focused its attention mainly on the large-scale aperture antennas (parabolic reflectors, planar waveguide array antennas or reflectarrays), intended primarily for satellite applications. A common feature of such solutions is a favorable mass balance compared to the area or volume occupied by the structure itself and a very high accuracy of its aperture surface (often the order of tenths of a millimeter) . During his research, the author has focused on the development of small and compact flexible antenna structures which could be able to operate in a wide range of wireless communication systems. Most of the conducted analysis have been related to planar antennas. The goal of these studies was not to achieve the highest possible degree of flexible surface accuracy but offer solutions that will accept the existence of certain geometric inaccuracies, without significant degradation of their electromagnetic properties.

The range of the research covered many technological aspects, including the development of new shape forming methods of inflatable antennas. A special attention has been put to designing and manufacturing inflatable carriers and support structures (self-supporting structures, soft foam carriers and chamber carriers filled with compressed air), made of thin dielectric foils and intended for integrating with the flexible microwave printed circuits. A novel method of providing and stiffening planar geometry of the carrier with the use of thin dielectric ribbons has also been demonstrated. Besides, the author presented efficient ways to increase flexibility in the proposed structures (e.g. by laser cutting and milling of soft dielectric foams or by metallic surfaces perforation).

On the other hand, the thesis includes discussion of the latest flexible printed circuits technologies, folding techniques and forming the shape of the flexible membrane structures, as well as a detailed description of the currently available on the market flexible dielectric and conductive materials. It also addresses issues related to the design and implementation of microwave feeding networks, made on elastic and flexible dielectric substrates. A novel semi-rigid substrate with periodic EBG nature has also been proposed. In further sections of the thesis, the design, implementation and EM properties measurements of thin, flexible antennas and antenna arrays integrated with the previously constructed signal distribution networks have been presented.

In addition, the author has devoted much attention to the performance of theoretical analysis and numerical simulations (both mechanical and electromagnetic), concerning the occurrence of different types of geometric distortions in the proposed structures. The influence of such deformations is an essential component and one of the critical aspects associated with the proper functioning of the flexible membrane antennas. The rest of the work was devoted to extensive measurements of selected prototype antennas (realized in different technologies) under the existence of certain type of geometric distortions (bending the structure along both sides of its planar face on various cylindrical profiles). Presented results of rigorous statistical analysis have revealed the nature and extent of the individual EM parameters of the considered antennas, caused by the analyzed deformation. The properties degradation of the investigated antennas have also been observed during the cycle-repeated fatigue tests. Finally, in order to estimate the functioning quality of the proposed solutions in real-life applications, the results of the terrestrial radio link budget calculations has been shown.