Chapter VII
The Era of Nanosatellites:
Pehuensat Development Status

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ABSTRACT

Nowadays, it is possible to achieve low cost and short production times space missions using satellites with a mass below 10 kg. These small satellites are described as nanosatellites. Current microelectronic technology makes it possible to develop nanosatellites for scientific experiments and relatively complex measurements (as well as for other applications), making it easy for universities and small research groups to have access to space science exploration and to exploit the new economic possibilities that emerge. This chapter describes an experiment developed in Argentina at the Universidad Nacional del Comahue to design and construct a nanosatellite called Pehuensat-I.

INTRODUCTION

Space science is an exciting activity that can greatly impact our society, particularly young students from elementary to university level. A satellite is one of the most complex and fantastic devices an engineer can design, develop, and build because it involves extraordinary challenges.

As a result, this type of project requires many interdisciplinary tasks that quickly generate enthusiasm and commitment for the different phases, which initially comprise of development, design, and construction, and later entail test, launching, operation, and possible recovery of these devices.
In the beginnings of space exploration, most of the missions were small, due mainly to a limited launching capacity, but as the fuels improved and the rockets power increased, more complex projects were possible. Historically, space exploration has tended toward big satellites with complex and expensive missions. The premises at that time seemed to be, the greater, more complex, and expensive, the better.

The methods traditionally used to place satellites, astronauts, and provisions in space are quite complicated as well as expensive and require long term preparation. Although big missions are able to economize through scale discounts, they are also more complex and rigid, due mainly to their long preparation and tuning period. In addition, it also appeared that limitations in the official budgets of the agencies dedicated to this activity caused a change in the space community tendencies; the need to have less expensive and simpler missions. Also, the number of institutions with limited budgets which were devoted to space science grew enormously when it became a curricular activity and the subject of research at many universities. Nowadays, the tendency is toward simple and fast execution space flights. The new paradigm turned slogan is, the faster, smaller, and cheaper, the better. The return to missions with small satellites was also due to advancements in technology. The development of small-scale digital technologies, and the reduction in the dimensions of the mechanic, optic, and electronic components made possible the beginning of the minisatellite age. This new age brings with it new application in fields such as tele-observation not only for monitoring the pursuit of the terrestrial objectives, but also for environmental control (e.g., the premature detection of field and forest fires), and of course in communications.

The great diversity in dimensions and objectives of space projects has led to a classification system and, although there is no unanimity about their intervals, the following criteria is generally accepted (ONU, 1998): Great satellites are those of more than 1000 kg and small satellites are those of mass inferior to that value. Also, the small satellites are divided into smaller categories:

- **Minisatellites**: 100 to 1000 kg
- **Microsatellites**: 10 to 100 kg
- **Nanosatellites**: 1 to 10 kg
- **Picosatellites**: 0.100 to 1 kg are also built
- **Femtosatellites**: Inferior to 100 g is an “open category being explored” category.

Sometimes, the small satellites are designed to operate together in formation (swarm, cluster, or constellation) and they are ideal for interinstitutional joint projects—even involving several countries—with concrete and complementary objectives for each unit.

Vanguard 1, weighing 1,4 kg, was the first nanosatellite, necessarily restricted as already said, by the launcher. Nowadays, this category is mostly limited by the budgets and chosen not only for being—as in our case the only possible option—but also because it offers a particularly tempting field of application for the incipient research groups of the space science.

The Universidad Nacional del Comahue (UNCo), together with other institutions such as the Asociación Argentina de Tecnología Espacial (AATE: Argentine Association for Space Technology), and the radio amateurs satellite corporation (AMSAT) Argentina, is working on space technology with the objective to form human resources in this discipline tending toward a higher curricular level and an improved regional development (De León, 1999; De León & Lassig, 1999; Lassig; Keil, Fernández, & Quiroga, 1999; Quiroga, Fernandez, Keil, Jurasic, Sierra, De Leon, & Alvarez, 2000a).

The tasks are made within the research project framework *Space Applications: Development of outstanding aspects in the electronic technology for space useful loads and microsatellites*. One of the fixed objectives of this initiative is to design, construct, and put into orbit a small satellite,
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