ASYTRAIN: a New Methodology for Teaching and Learning Antennas

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***Abstract*—This paper presents ASYTRAIN, a new tool to teach and learn antennas, based on the use of a modular building kit and a low cost portable antenna measurement system that lets the students design and build different types of antennas and observe their characteristics while learning the insights of the subjects. This tool has a methodology guide for try-and-test project development and, makes the students be active antenna engineers instead of passive learners. This experimental learning method arises their motivation during the antenna courses.**

***Index Terms*—education; antenna design; measurement systems**

I. INTRODUCTION

The traditional approach on teaching antennas consists on theoretical classes that start introducing the radiation problem and follow presenting the analysis methods and properties of the most frequently-used linear and aperture antennas [1], [2].

The orientation of this theoretical approach is focused on professor teaching instead of student active learning, a new pedagogical trend used in other engineering areas to motivate the students to learn the insights of the subjects. The motivation of the interest of student in this new teaching philosophy is originated by the students confrontation with real-life elements, where the analysis methods and properties can be directly applied and observed. Moreover, this way of proceeding involves the students in practical tasks and projects, making sense about engineering during the learning process instead of be passive learners.

The new methodology to teach and learn antennas presented in this paper is based on four project development steps as follows:

- A short theoretical presentation of: each antenna type of the experiments that the students can perform and, the available simulation software.
- The design and simulation of the antennas under study, using student-friendly software instead of complex commercial one.
- The actual construction of the antennas using modular kits, especially designed for student antennas development.
- Finally, the measurement of a developed antenna with low-cost portable equipment in the students labs or classrooms.

The advantages of this methodology are clear. In the first step, the student work is focused (antenna type, available simulation software packages and constraints of the modular kits). In the second step, the students avoid the overwhelming aspects of the commercial software by employing streamlined packages (available in ASYTRAIN or antenna books, or developed by them under the teachers supervision) to design and simulate the antennas. The kits of the third step significantly reduce the building time of the antennas and allow the students to test multiple configurations of each type. The low-cost portable commercial measurement equipment for antenna training (LabVolt [3], Lucas Nille [4] and ours [5]) that can be used in the forth step lets the students observe, during the classes, the properties of their antennas and modify their designs in situ. Finally, our methodology has an additional advantage (usually forgotten in the traditional teaching approach): the students also 'see and touch' the mechanical designs the most common antennas.

II. ASYTRAIN DESCRIPTION

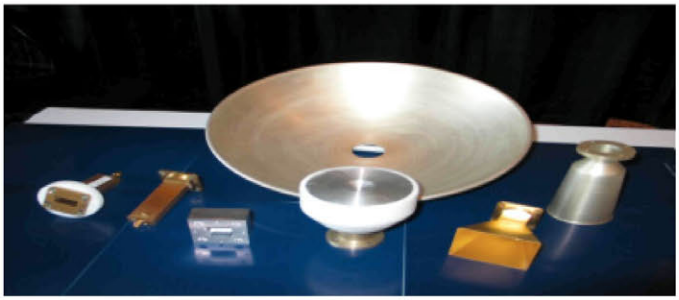
ASYTRAIN antennas and didactic material has been designed and developed by the professors of Radiation Group of the Polytechnic University of Madrid in Spain, based on the overall teaching experience acquired during the last 40 years.

The material is structured in two levels. The basic level, targeted to undergraduate students lets them visually observe the spherical characteristic of the radiated waves; its polarization; the directivity, gain and beamwidth concepts; radiation patterns; etc., using the most simple antennas (dipoles, monopoles and axial mode elliptical antennas in L-Band). The same types of observations can be performed over aperture antennas as horns and prime reflectors in X-Band. The advanced level, targeted to graduate students, includes the design modular kits (Fig. 1) in L-Band (adjustable balun-dipoles; 3 monopoles broadside, endfire and phased arrays; Yagis and log-periodic dipole antennas) and X-Band (high phase error conical horn with lens and offset reflector antenna), and the didactical material (introduction to the antenna type, design and analysis software; and antenna building instructions).

The ASYTRAIN system consists of:

- Several design software packages, such as SABOR [6] (for horn and reflector analysis), MOMENTOS (for dipoles, Yagis and dipole panels), 4NEC2 (for general linear antennas), ARRAY (for linear and planar grid arrays) and SLOTS (for resonant and non-resonant slot WG arrays).

(a) ASYTRAIN basic L-Band antennas



(b) ASYTRAIN basic X-Band antennas

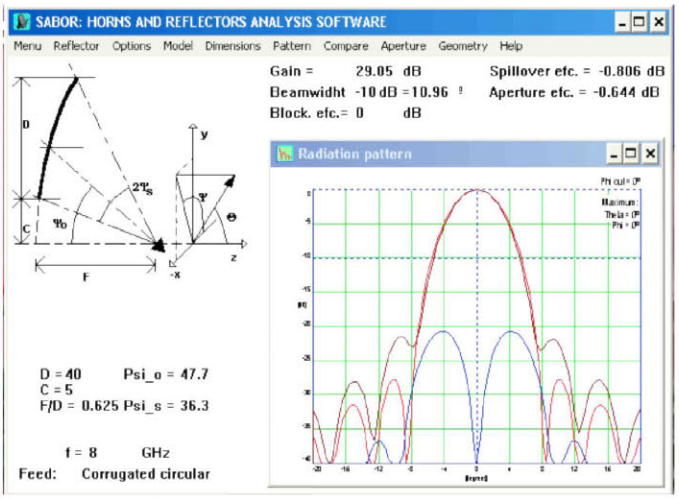
(c) ASYTRAIN Controller

Figure 1. Design modular kits and measurement sytems

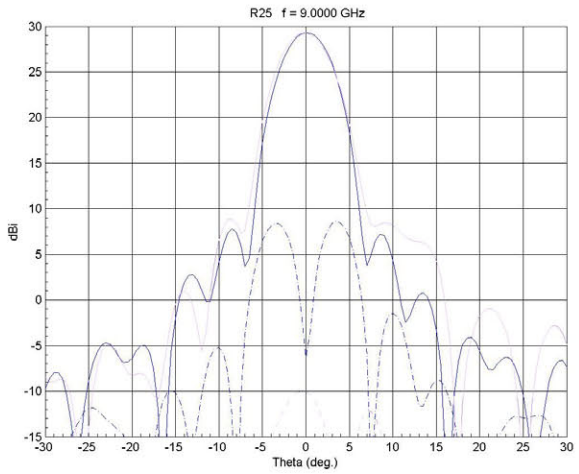
- The previously mentioned antennas and modular kits.
- The ASYTRAIN controller (Fig. 1c), with a step motor azimuth positioner, and both a Tx/Rx L-Band and X-Band measurement system.
- The measurement software, which has to be installed in a Windows PC, and that is connected to the ASYTRAIN controller using 2 USB ports and one RS-232 port. This software performs the data acquisition, the analysis and result representation, and supports the measurement of VSWR and antenna gain versus frequency, and co&xpolar patterns.
- The didactical material for the teachers and students on the introductory level experiments and the design and construction of our modular antenna kits.

III. EXPERIMENTAL EXAMPLE: THE OFFSET REFLECTOR

The introductory material details the geometric definition of this reflector type, how its works and its main radiation properties [7], such as generation of intrinsic cross-polar radiation in the antisymmetric plane with linear polarization, beam squint in the same plane with LHC and RHC, axial feed defocusing, lateral feed displacement, etc. The student has to design a horn appropriated for the offset reflector under study using SABOR and use the horn as the feeder to analyze the reflector radiation properties (see Fig. 2a). Finally, the student employs the measurement system to verify the properties study in the analysis step (see Fig. 2b).



(a) Simulated intrinsic crosspolar generation



(c) ASYTRAIN Controller

Figure 2. Analysis and measurements of the offset reflector

IV. CONCLUSION

This paper presents a new didactical material to organize introductory antenna design courses, following an active learning methodology. The material includes linear antennas for the radio bands (up to UHF) and aperture antennas for the microwave bands.

ASYTRAIN not only does include measurement equipment for training antennas, but it also includes the didactical material for university antenna courses, the modular kits for building different antennas, and multiple design software packages. These new/improved elements, not included in other existing training courses, is especially designed to involve the students in the learning process and to help the teachers to prepare a wide range of antenna courses, including some advanced topics

for doctorate studies using other kits not described in this paper (see ASYTRAIN options in [5]).

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