

INTRODUCTION OF ANSYS IN THE ELECTRONICS ENGINEERING EDUCATION PROCESS

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Abstract: This work deals with integration of ANSYS software into Master Degree Programme „Microelectronics“, within the frame of subject „Modern microelectronics technology“. Software ANSYS is a long spectrum tool, but his usage in electronic field isn't anywhere described yet. That's why we are focus here on his potentialities, which can be used for education process. Implementation of simulation software into lessons can guide students to understand better basics of microelectronic science. And furthermore, they can't do the simulations right without theoretical principles.

Keywords: ANSYS, Simulations, Education

1. INTRODUCTION

The most of today's universities are dealing with decrease not only just a number of students, but also in their technical skills. Potential students are no more interested in only classic contents of subjects; consequently schools have to offer something additional. There are many ways how to reach this, some universities relay on a great amount of foreign languages, some extend a number of optionally subjects. This ways lead to an enlargement of a teacher staff, which's not often from the technical field. This article shows the way, how to keep student's interest up without leaving their branch of science.

2. ANSYS SOFTWARE IN EDUCATION

As was mentioned earlier, it's necessary to find a new way, how to grip students and attract their attention to microelectronics. Major parts of today's high school students don't have specific idea about their future work. Often they are only concerned about work on computer and the professional education is second rate. Simulation programmes fulfill this requirement, because work starts with orientation in GUI (Graphic User Interface), modeling of structures and consequently with a concrete scheme and with a theoretical background.

2.1. FINITE ELEMENT ANALYSIS

The ANSYS program is based on method called Finite Element Analysis (FEA). This method rests in discretization of continuous faces. By this, we receive finite count of elements, which we can describe by mathematical equations.

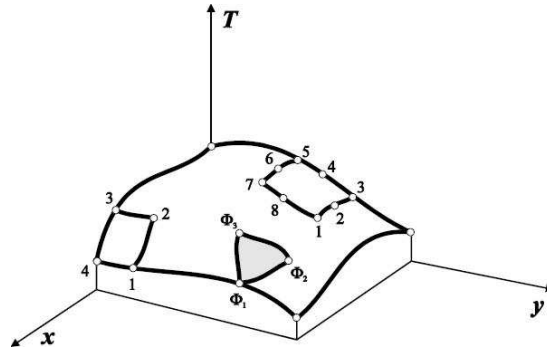


Figure 1: Cross section of board for an explanation of FEA [1].

Physical properties, such as displacement, strain, temperature, etc., could be replaced by a three-dimensional coordinate function, which is called an approximate function. On figure 1 is a function $T(x, y)$, which describes temperature distribution on rectangle board. This unknown function is replaced by function Φ in single nodes. Function Φ has to have same number of terms as his nodes. Thereby, for triangular element we can write tertiary polynomial [1]:

$$\phi = a_1 + a_2x + a_3y, \tag{1.1} [1]$$

This polynomial is approaching to the function $T(x, y)$. Coefficients a_i , equation (1.1), are taken from polynomial solution for all three nodes of triangular element, i.e. solving system of three equations in three unknowns [1]:

$$\begin{aligned} \phi_1 &= a_1 + a_2x_1 + a_3y \\ \phi_2 &= a_1 + a_2x_2 + a_3y \\ \phi_3 &= a_1 + a_2x_3 + a_3y. \end{aligned} \tag{1.2} [1]$$

Rectangular board with four nodes is described with biquadrate polynomial [1]:

$$\phi = a_1 + a_2x + a_3xy + a_4y^2. \tag{1.3} [1]$$

Higher polynomials for different number of nodes are taken from Pascal triangle (Figure 2).

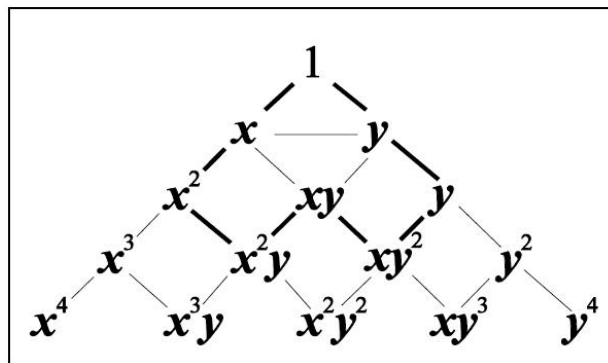


Figure 2: Pascal triangle [1]

2.2. STARTING WITH PROGRAM

In first lessons students will be introduced into the main interface and they will be creating simple structures. On them they could simulate basic physical principles like thermal distribution, mechanical deformation etc. In next step will be models and simulations more complicated. This includes also material settings, where will students meet physical properties, which are used in electronic field. Main steps in modeling are described in Figure 3.

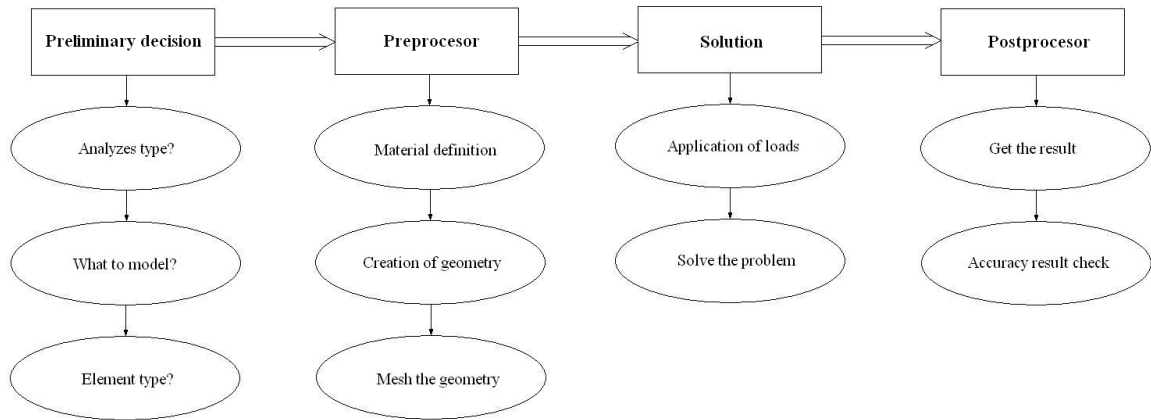


Figure 3: A sequence of main steps in ANSYS [2].

Every lesson should be consisted of two parts, theoretical and practical. At the beginning of the lesson teacher will explain basic principles of simulated task. This will include description of problem in reality and its implementation to the simulation program. Examples should be corresponded to student skill level and their specialization. This theoretical part will be followed by practical part, in which will students simulate given problem. Results from simulations have to be described by each student.

2.3. IMPLEMENTATION OF ANSYS IN ELECTROTECHNICS

Bases of ANSYS software lay on technical branches. In this article we are focused on electronic field. As was mentioned earlier, we can use all types of simulations here. Main analyses are thermal, mechanical, electric and their combination. All of this we can use for contact reliability, joint stress, heat up of components and others. Possible options are wide and depend on our specialization. After basic introduction as a modeling structure, setting parameters or using right type of simulation, students can reach results, which they need to interpret right. This could be sometimes troublesome, because students need to know a theoretical background.

After finishing some predefined models, follows the final step, which is a simulation of a concrete problem. This can choose student himself or he can link to past or present works. In this step the structure and material properties has to be defined precisely. Definition of right material constant can be tricky, because some values can be various for different temperature like solder. This fact is solved in program by definition for variable temperatures, but it's on the user to set them right.

If we are talking about material properties, it's necessary to fill values correctly into program. We can meet with a big problem here, because in ANSYS, there is no predefined unit system. It's user's responsibility to type them in right units. Every value is connected with the proportion of the structure. It means, that if we use millimeters in building model, we need to define all material properties with reference to the millimeters. By that, we use for example MPa for pressure, instead of Pa. If we create a structure in meters, than we can use classic SI system. Table 1. shows described procedure.

Property or Load	Unit System as classified by the ANSYS command /UNITS				
	SI	CGS	MPA	BFT	BIN
Mass	[kg]	[g]	[tonne]	[slug]	$\frac{[\text{lbf}][\text{sec}]^2}{[\text{in}]}$
Length	[m]	[cm]	[mm]	[ft]	[in]
Time	[s]	[s]	[s]	[sec]	[sec]
Temperature	[K]	[K]	[K]	[°R]	[°R]
Velocity	$\frac{[\text{m}]}{[\text{s}]}$	$\frac{[\text{cm}]}{[\text{s}]}$	$\frac{[\text{mm}]}{[\text{s}]}$	$\frac{[\text{ft}]}{[\text{sec}]}$	$\frac{[\text{in}]}{[\text{sec}]}$
Acceleration	$\frac{[\text{m}]}{[\text{s}]^2}$	$\frac{[\text{cm}]}{[\text{s}]^2}$	$\frac{[\text{mm}]}{[\text{s}]^2}$	$\frac{[\text{ft}]}{[\text{sec}]^2}$	$\frac{[\text{in}]}{[\text{sec}]^2}$
Force	[N]	[dyn]	[N]	[lbf]	[lbf]
Moment	[N][m]	[dyn][cm]	[N][mm]	[ft][lbf]	[in][lbf]
Pressure	[Pa]	[Ba]	[MPa]	$\frac{[\text{lbf}]}{[\text{ft}]^2}$	[psi]
Density	$\frac{[\text{kg}]}{[\text{m}]^3}$	$\frac{[\text{g}]}{[\text{cm}]^3}$	$\frac{[\text{tonne}]}{[\text{mm}]^3}$	$\frac{[\text{slug}]}{[\text{ft}]^3}$	$\frac{[\text{lbf}][\text{sec}]^2}{[\text{in}]^3}$

Table 1: Tables of consistent units [3].

2.4. CONNECTION BETWEEN EDUCATION AND INDUSTRY APPLICATION

Mentioned process above was tied up mainly with education or with final labor. Students can learn how to work with the program during the first year and then they can choose an application of their interest. Present circumstances challenge them to connect their work with some industry application. This could be a great possibility how to get some funding, because many of today's companies need to simulate prototypes or some components, which are sometimes quite simple. Students don't expect great deal of money as it could be with specialized firm. These orders are also very useful for universities, because it's not a fictionally problem, but real one and the results can be published in magazines. Only disadvantage is the time, which is practically always longer then with companies specialized in ANSYS.

One of possible structures could be BGA package. It fumbles with a negative effect called thermo mechanical stress. This stress is caused by different material usage like FR4, alumina, solder etc. From simulation we can find out that main stress lays on solder balls, as we can see in Figure 4. The strain of single joints isn't the same for entire set [4]. Stress increasing with temperature could be better seen in animation or on a chart. Animation could serve as a complex overview of the problem and charts or values are better for an industry application or for a science.

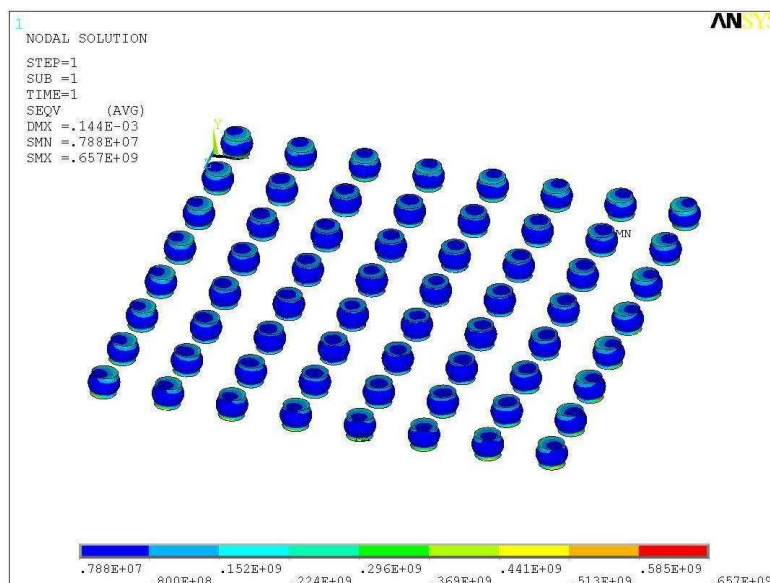


Figure 4: Thermo-mechanical stress of BGA.

3. CONCLUSION

Simulation software is a very useful instrument for educational process. An implementation is inexpensive and modeling could hold students interest. Simulations can be also used as instrument for bachelors or master thesis, whether as a full contents or as a validation. Results can be also applied in a career or in a research.

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