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Engineering Education in Graduate Schools - Consideration from Industry Side -

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This paper reviews the recent situation faced by industries in RF/microwave engineering field and tries to discuss and propose possible candidates for enrichment of engineering education in graduate schools.

1. Issue Statement (Current Situations of Engineering in Industries)

Latest development in wireless applications such as cellular phones and WLAN has been greatly expedited by world-wide use of internet capability. Resultantly shortened distance and time of communications inevitably tends to unify world-wide market of technologies. This change of market pictures subsequently have demanded changes of business models and R&D strategies in engineering, some of which are listed below.

1. Globalization of Market and of R&D
2. Increased pressure for Time to Market and Performance/Cost
3. Total Solution players vs. Key Technology players
4. A reduced number of surviving world-wide players

Targeted markets of products are increasingly globalized, while there may remain the need for regional customization on common product platforms. The GSM cellular phone, for example, is already one of de-facto world-wide standards for wireless communications. With increased competition for the same market, pressures on product design and development have become higher to achieve shorter time to market and better performance/cost, which leaves space for business survival only to a limited number of players. Players also have to strategically choose to be either a total system solution provider or a key technology provider. R&D projects in industries, thus, have come to require timely decision making and the collaboration and coordinated efforts with academia and among private enterprises across world geography and demography.

These circumstances make R&D activities in RF/microwave engineering more challenging and demanding to achieve business success with technical innovation.

Key features of a good RF/microwave project in industries would include:

1. Technical innovation fit to society/market needs
2. Management of Diversities (in personality, culture, race, gender, religion)
3. Enhanced efficiency in engineering R&D and in technology transfer to manufacturing
4. Strategic R&D with clear business model shared by project members

Good skills in planning and execution, accompanied with technical expertise, are required in project management since an engineering project in industries is constantly challenged by problems with potentially multiple solutions or even with no solution. Schemes and concepts such as concurrent engineering, QFD, SWOT, KT-method, TRIZ and MOT are some examples of systematic approaches widely accepted in industries for the efficiency enhancement and R&D strategies. The diversity management, on the other hand, poses a rather great challenge particularly to Japanese industries because of its non-engineering nature and because of apparently conceived homogeneity of the society.

2. Reality Gap of Electrical Engineering in Industries

There also remain additional issues directly related to RF/microwave engineering, as described below.

It is quite well known at least in Japan that students have become less interested in electrical engineering, particularly in RF/microwave engineering. Schools also have come to offer curricula with less emphasis on RF/microwave engineering. These facts have resulted in a misfit of a pool of new hires against industries' needs for high-frequency analogue circuit/wireless technology engineers, despite of a burst of wireless society represented by cellular phones, WLAN and internet. On-the-job training or extended education, thus, has become inevitable in industries after hiring. A statistics shows that more than half of RF circuit designers in Japanese industries do not have educational background in the field. Due to the lack of expertise in the directly related field, new graduates with Master's or Ph.D. degrees are often not ready to make immediate technical contribution, which leads to less-than-desirable efficiency of a project and contradicts the industries' needs described in the previous section. This "reality gap" between graduate education and industries' expectation would be a great loss to engineering society as a whole

3. Consideration on Graduate Education in RF/Microwave Engineering

It is highly expected that graduates with Master's and particularly with Ph.D. degree should be able to accept a limited degree of project management responsibility at the time of hiring. The following, therefore, are expected to have been fulfilled by students at the end of graduate schooling.

- 1) Technical expertise needed for a project: Promotion of innovation-oriented approaches for problem solving is indispensable, as well as accumulation of technical knowledge.
- 2) Exposure to practical engineering projects
- 3) Project management skills with insights into business and marketing

Toward these goals, a curriculum setting with interdisciplinary training and increased coordination with industries should be seriously considered to enhance the efficiency of engineering society and to attract good students to the RF/microwave engineering field. Listed below are some candidate proposals for graduate education in RF/microwave engineering.

- 1) Course works on project management skills: Coordination with business schools may be needed.
- 2) Experience of practical engineering project: A small design project coordinated with industries may be effective. Shared wafer runs using industries' process lines for IC designs are good examples. Course requirements may include summer internship in industries or other research institutes, preferably abroad to experience social diversities.

Fortunately some of these approaches have been already adopted by some universities to serve as precursor to others.