TABLE 1:
Qualities expected in a design engineer and that engineering courses should be helping engineering students to develop.

The Engineer or Engineering Student should be able to...

	QUALITY	competency	attitude
1.	**Communicate, negotiate and persuade**	Skills in oral presentation, report writing, formulating persuasive arguments, effective communications	Embracing the importance of informing, updating, listening to and persuading colleagues.
2.	**Work effectively in a team**	Skills in team organization, setting meeting agendas, meeting facilitation, taking on leadership role	Real buy-in to team efforts (as opposed to individual "star" mind-set). Concern for team spirit, and mentoring and nourishing others. Willingness to take on leadership role and develop vision.
3.	**Engage in self-evaluation and reflection**	e.g., skills in journaling, matching local problem to big picture	Valuing taking time for reflecting on progress, learning from both mistakes and successes.
4.	**Utilize graphical and visual representations and thinking**	Skills in the appropriate use of sketching, geometric and physical modeling and CAD at various stages of design process	Sensitivity to the various uses of sketching (both as a thinking and communications tool). Awareness and support of how others use visual representations in their work. Drawing also provides a focal point for idea generation. Graphical representations are a central piece of vocabulary for engineering.
5.	**Exercise creative and intuitive instincts**	Skills in both right-brain and left-brain thinking.	It is o.k. to take risks and go with intuitive feelings. Design is a creative enterprise that involves imagination. Value willingness in self and others to act in the absence of complete knowledge and certainty.
6.	**Find information and use a variety of resources (i.e., resourcefulness)**	e.g., skills in database searches, interviewing potential customers	Learn from the past and from all of the information available, borrowing ideas is o.k., be curious and delight in learning.
7.	**Identify critical technology and approaches, stay abreast of change in professional practice**	Skills in project definition and planning, knowing "hot" publications in a given field, awareness of Professional Society activities	Planning is a valuable activity, along with reviewing the continued validity of the plan and revising as necessary. Learning does not end at graduation; joy for continued learning.
8.	**Use of analysis in support of synthesis**	Skill in identifying when analysis will provide insight into the quantification of a design or into strengths/weaknesses of a design. What type of analysis is appropriate?	Analysis is a valuable tool in the engineer's "toolbox." Analysis should support design decisions but not necessary drive them.

9.	**Appropriately model the physical world with mathematics**	Idealization of complex geometries/loads into simple components that can be analyzed, but realization that the map is not the territory (per Prof. Rolf Faste, Stanford University)	The output from a mathematical model is only as good as the input. Mathematical models can provide valuable insight into product performance.
10.	**Consider economic, social, and environmental aspects of a problem**	Understanding of basic issues in these domains	Sensitivity to and concern for the inter-dependence of domains. Valuing non-technical issues.
11.	**Think with a systems orientation, considering the integration and needs of various facets of the problem**	Understanding issues of importance to product success, including other engineering fields, psychology, aesthetics, etc.	Sensitivity to quality and how encompassing it is. Very few products are single-faceted, and everyone involved in a product needs to be concerned about effective integration of subsystems.
12.	**Define and formulate an open-ended and/or under-defined problem, including specifications**	Gantt charts, QFD, needfinding, etc.	Valuing the contribution of up-front time spent in defining the real problem. Sensitivity to human needs and service to humankind.
13.	**Generate and evaluate alternative solutions**	e.g., brainstorming, mind-mapping, visual thinking, kinesthetic thinking	A very good design is likely to "happen" the more ideas that are generated up front. Don't become married to your ideas. Gleefully defer judgment!
14.	**Use a systematic, modern, step-by-step problem solving approach. Recognize the need for and implement iteration.**	Skills in project definition and planning, mind-mapping. Ability to use or formulate an appropriate problem solving procedure.	Planning is a valuable activity, along with reviewing the continued validity of the plan and revising as necessary. Design is not a random process (but neither is it an exact science), but recognition that intuitive leaps do happen. Value and reward flexibility in thinking. Willingness to abandon or modify and approach if it is not working
15.	**Build up real hardware to prototype ideas**	Basic machining and laboratory skills, understanding of time and cost issues related to prototyping, and knowledge of rapid prototyping skills.	A physical prototype can provide insight into a design that a two-dimensional geometric presentation can not. There is not 1-to-1 correspondence between a prototype and the final product. Willingness to do a rapid prototype and to iterate
16.	**Trouble-shoot and test hardware**	e.g., design of experiments, data analysis, diagnostic skills.	A well designed experiment can lend insight into design decisions. Characteristics such as doggedness, attention to detail, "can do" attitude.