

University of Arkansas Microelectronics-Photonics Graduate Program

PhD Candidacy Exam – March 15, 2013

PROBLEM TO BE SOLVED

This is a decade of energy challenge, with wide potential markets for sustainable and reliable point-of-use energy harvesting systems. Energy is available freely from nature through solar energy, wave energy, wind energy etc. In addition energy is also available through mechanical (strain, vibration, structural, vehicle, etc.), thermal, light, electromagnetic, human body, chemical, and biological sources in various forms around us. Energy harvesting techniques include, but are not limited to, thermo-electric, photoelectric, pyroelectric, thermoacoustic, piezo-electric, electrostrictive and/or magnetostrictive techniques. For purposes of this solicitation, energy harvesting could include harvesting devices; new materials to convert, store, or transport energy; and/or transmission of power to point of use. These technologies are sought after in applications from space to earth environments, with each application potentially having significantly different cost/benefit tradeoffs.

Your CEO is interested in using your company's expertise in micro to nanoscale materials, processing, and devices to develop innovative, economically viable, energy harvesting technologies in any of the above areas. **Because the company wishes to be a leader into the marketplace with your new technology, thermoelectric and photoelectric technologies will not be considered for your proposal.** Using your educational background as your starting point, your job as CTO is to develop an energy harvesting technology to support the company's newly defined strategic plan. The company is anticipating this to be a rapidly expanding emergent market in the next five years, so developing cost competitive and practical technologies for your identified market application is required.

Your job as CTO is to deliver a complete proposal with your plan for the company to compete in this area to your CEO by **Monday morning, March 25th, by the 9 AM deadline.**

YOUR DELIVERABLE

Your task is to write an internal proposal for your corporate officers describing your approach to this issue. The proposal should include the following:

- Executive summary (one page)
- Risk assessment roadmap form (one page)
- Full proposal (15 pages maximum)
- Appendix A: Bibliography (no page limit)
- Appendix B: Ranked list of intellectual property documents examined (no page limit)

At a minimum, be sure you address all of the following:

Current Science and Technologies - What is already being done in this area by other researchers, companies and governmental institutions? Describe the current state-of-the-art for both the science and the implementation. Use diverse resources such as science literature, journals, conference proceedings, the internet, patents or other sources of existing public knowledge. *Cite all references you use and quote any word-for-word transfer to your report.*

Your Design Approach – What is the basis for your design approach to the problem? Why is your product better than existing products? What product attribute(s) allow market penetration to achieve profitability? Address scientific *and* engineering aspects of these questions.

Testing and Qualification - Describe a set of tests you will use to demonstrate that your approach is effective and that your implementation of the solution will launch successfully.

Cost Analysis – Identify cost and market issues that will impact the pricing strategy of the solution you have proposed. Consider such things as: the major cost items that would impact the implementation; which elements of your implementation solution would be handled in-house versus externally-sourced; major risk elements that could drive up costs if the primary path item fails; costs of IP licensing needed, etc. Provide justification and/or reasoning behind your decisions. Estimate manufacturing cost for the total system as the product reaches mature product stage, so the marketing team can determine potential market size. Avoid subcontracting manufacture or assembly of any proprietary component outside the company, because the CEO is concerned with potential IP leakage.

Intellectual Property – In Appendix B, list in rank order of importance *all* commercial, academic, and governmental IP sources that were consulted while formulating the answer, including reference data. For instance, include the patent number; title; inventor name; and assignee name for a patent. Discuss the 3 most significant IP documents affecting your approach to your solution in the 15-page document. Compare strengths and weaknesses of these approaches relative to your own. Recommend how these IP threats should be handled.

Most importantly - this is just a minimum list of issues you might consider. There may be many more. The point is that your proposal *should contain the evidence* needed to make an effective and compelling case to your CEO in order to insure that she/he makes the right decision.

Hint – Clearly state your hypothesized solution. Identify its innovation(s) and advantages relative to state of the art. Describe both existing data, and work needed to support each aspect of the hypothetical solution. Consider theoretical, fabrication, and characterization aspects: for each, identify software/equipment and methods to use, parameters to vary, anticipated outcomes, and possible alternatives in the event of unsatisfactory results. Discuss material, process, device, and systems aspects of your solution. *Refine* your hypothesized solution as you accumulate information and prepare the manuscript. **Remember:** clearly distinguish what is known from what is hypothesized or not known. What is needed to distinguish the important things to know?

Reference the 2013 PhD Candidacy Exam Guidelines document for general instructions.