

Sensor technologies for infrastructure sustainability

Recent catastrophic events have created a new societal focus on the aging infrastructure of our cities and towns. This includes such items as pipeline degradation (leading to gas explosions or oil spills), construction materials degradation (leading to structure failures such as bridge collapses), and even degradation of critical equipment (leading to flooding from pump failures).

Your CEO is interested in using your company's expertise in micro to nanoscale materials, processing, and devices to become a leader in innovative high resolution sensor technology applied in predictive maintenance applications. Predictive maintenance is the concept whereby the performance of a system is measured and analyzed in real time and maintenance is performed only when needed rather than on a fixed time schedule (which is known as preventative maintenance). Successful implementation of predictive maintenance depends on infrastructure performance degradation being detected at a sufficiently early point that the maintenance can be scheduled to minimize interference with the system's functions needed by society.

Your CEO is interested in a disruptive new sensor technology to approach the infrastructure assessment market in one of two ways. First, using new technology for high resolution sensors that could be easily added to existing infrastructure elements. Second, for high resolution sensors that could easily be embedded in new infrastructure elements for full lifetime monitoring. It is critical that any proposed sensor utilize ambient energy for its full functionality and have the data transmission capability needed to become part of an integrated infrastructure network. These must be accomplished with the sensor being commercially viable to the company at a price point that a reasonable cost/benefit analysis would support widespread market adoption.

While the infrastructure element you choose for your company's first product will drive the critical attributes needed for that particular sensor, your CEO believes that it is imperative that your development proposal result in significant performance enhancements in many different sensor applications. This in turn would lead to a higher return on investment on the costs of implementing your proposal.

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 your Monday morning, March 31st 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)

Most Importantly – The significance and novelty of your creative solution, one that moves the boundaries of knowledge outward, will be the primary assessment focus of your review panel. The list below 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.

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 use quotes for 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.

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 2014 PhD Candidacy Exam Guidelines document for general instructions.