1 Phase 2: Developing Your Solution

1.1 Purpose

The next step in research is the process of developing your contribution. Where the first phase identified a broad subject area of interest, this part should zoom in on a very particular aspect of this interest. The researcher should find a problem that is more than just exploratory, it needs to be testable. The importance of the word "testable" can not be stressed enough. The significance of a research project can only be accepted once the results are verifiable and extendable to the rest of the community. Then once a specific problem has been selected; your team will go about the process of developing its own algorithms.

The second phase of the paper is where you will do the most writing. It is in this phase that you finalize your research and lay the foundation for your own experiments to take place. The paper ABSTRACT is used to help find the author's intended audience. When a researcher pulls up papers for reading and evaluation, the ABSTRACT provides a descriptive summary that let's the reader know if closer examination is needed. The PROBLEM STATEMENT section is rearranged to make room for the OBJECTIVE STATEMENT. The addition of the OBJECTIVE subsection results in no additional content for that subsection itself. It is just an extra heading used for organizational purposes. Each section, PROBLEM STATEMENT, ANALYSIS, and LITERATURE REVIEW, receives an additional subsection which adds content corresponding to the further elaboration of the problem at hand. The most important part of this phase is the addition of the OBJECTIVE STATEMENT or hypothesis which in one sentence, sets what the experimental goal for the rest of the research will be. Finally, the ALGORITHM extends the work of the sub-problem by explaining how your solution works in the simplest of terms, in the most detailed of terms, and with visual examples.

1.2 Organization

- Abstract [new]
- Problem Statement [updated]
  - Objective [new]
    - Problem
    - Objective Statement [new]
  - Motivation
  - Sub-problem [new]
- Analysis [updated]
  - Problem
  - Sub-problem [new]
- Algorithm [new]

- Literature Review [updated]
  - Problem
  - Sub-problem [new]

1.3 Content

1.3.1 Abstract

The abstract, a brief section of 200 to 400 words, should address all of the important elements of the narrative that follows. It should include the contect and significance of the student your propose, the hypotheses you will be exploring and the means you will use to test them, and the impact (both scientific and otherwise) and implications of the proposed work. The abstract is, in other words, a road map of the proposal, omitting only such things as the details of methods and materials, and the bibliography. By convention, no literature is cited in the abstract.

A useful rule casts the skeleton of an abstract in just three questions and a payoff assertation:

- "'What's the problem?"'
- "'Why hasn't it been done before?"'
- "'Why can we do it now?"'
- "'The purpose of this research is..."'

Using this method, you can quickly jot down the most important issues you need to cover in your abstract. From them, you can embellish, modify, and rearrange these thoughts until you have covered all the bases.

Another good way to practice abstract writing is to cover up the abstract of a journal article from someone in the field whose writing you (or others you respect) admire. Read the paper, and then write an abstract for it. Compare what you have written to what the author wrote. Carefully study both abstracts, your and theirs, for strong and weak points. What is it that makes one abstract better than the other? How could one or the other be improved? Could either be shortened? This critical evaluation of your writing and its comparison with the writing of others who already writing well, will be a tremendous help in leanring how to write compelling abstracts.

It should be noted that sometimes the author may find it easier to write the abstract after they have completed all the other parts of phase 2.

1.3.2 Problem Statement

Objective

Objective Statement An OBJECTIVE STATEMENT expresses an idea that the author hopes to support with theoretical arguments and experimental evidence. It is the proposition that for the rest of her/his research that she/he will want to maintain, analyze, and prove. It will perform three tasks:

1. Set the argument to control and focus the entire paper
2. Provide unity and a sense of direction
3. Specify to the reader the point of the research

For example, starting with the topic "the Traveling Salesman Problem". The subject area can be narrowed further to be "Genetic Algorithms applied to the Traveling Salesman Problem". This provides enough information to craft the statement, *This paper intends to prove that Genetic Algorithms are flexible and capable enough to provide a near optimal solution with minimal run-time cost to the Traveling Salesman Problem.* This one sentence communicates to the readers what to expect for the rest of the paper and restricts the focus of the author to a specific topic.

Not all research has the same end goals and not all OBJECTIVE STATEMENTs have the same purposes. If an author is struggling to sum up all of her/his ideas and intentions into one sentence, one easy fix is to write an answer to a question that hasn't really been asked.

- What is the point of the research?
- What should this paper do?
- Can the reader be told of a new or different problem?
- Can the reader be told of a new or different solution?
- What is the new slant or approach to a known problem or solution?
- Is this a radical or mainstream approach?
- What is the theory that spawned this research?

The OBJECTIVE STATEMENT should be a declarive sentence. When written properly, the author should be able to answer yes to all of the following questions. Does the OBJECTIVE STATEMENT...

1. Express the author's position in a full, declarative statement which is not a question, not a statement of purpose, and not merely a topic?
2. Limit the subject to a narrow focus that grows out of research?
3. Establish an investigative, inventive edge to the discovery, interpretation, or theoretical presentation?

4. Point forward to the conclusion?

5. Conform to the title and the evidence that will be gathered? [Source: Writing Research Papers]

Sub-problem Thinking back to the Computer Science problem abstraction layers, from top to bottom there is the general problem, problem variant, solution strategy, solution variant, and implementation variants. The previous phase focuses on the general problem and its variant. This phase zooms onto the solution strategy and variant. The actual solution to the problem at hand is known as the sub-problem. It is known as the sub-problem because each solution has pitfalls and complexities of its own that must be addressed independently.

In the research proposal the author chose a field of interest. The two fields that were named were finding information on the World Wide Web and book sorting. The SUB-PROBLEM selects a new algorithm or an algorithm from another field of study and applies it to a new area. For instance the algorithm for developing the Dewey Decimal identification for a book might provide good heuristics for a search of an unsorted heap. This improbable theory should be formally defined in the OBJECTIVE STATEMENT and then backed by further elaboration in the SUB-PROBLEM. The SUB-PROBLEM description is written just as the PROBLEM description before it. In this case, much less elaboration is needed as most of the algorithmic pudding will lie in the analysis and pseudo-code to come later. One to two paragraphs should suffice.

1.3.3 Analysis

Sub-problem There isn't too much that is interesting or unique to add here. The SUB-PROBLEM ANALYSIS should be in very much the same format as the PROBLEM ANALYSIS. However, it is at utmost importance for the author to make sure that the heart of the analysis examination is placed on where the objective lies. If the problem is new then the majority of analysis should be on the PROBLEM ANALYSIS and if the solution is known and only being applied to this new problem, then the SUB-PROBLEM ANALYSIS should only be touched on lightly. Oppositely if the solution is new or a slant of an existing solution, then the SUB-PROBLEM ANALYSIS should be indepth and thorough with only a light coverage of the problem it solves.

1.3.4 Algorithm

There are three parts to the algorithm section. The first thing most authors open up with is a layman's descriptions of their algorithm. It describes–without much detail– what their algorithm does and what makes it different/better than the work of others. Next, the details of the algorithm are exposed using pseudocode. You will not need to include code for the entire algorithm; instead focus on explaining and fleshing out the aspects on which your work is creating. That is, only write pseudocode for what is new or anything that might be necessary to help understand your creation. Finally, once your algorithm has been explained and detailed, it greatly helps the consumers of your work if you include some diagrams that visualize what is happening. Again, its

not as important to diagram the whole solution you've created as it is to show what it is specifically that you've uniquely done.

1.4 Literature Review

Sub-problem Almost a verbatim repeat from the SUB-PROBLEM ANALYSIS, additional content added to the LITERATURE REVIEW is determined by where the weight of the research is placed. In its entirety, a completed LITERATURE REVIEW should cover 7 or 8 reputable papers. If the problem is where the new and exciting research topic lies, then the LITERATURE REVIEW should discuss mostly this topic. At minimum the uninteresting or known aspect of the research, whether it be the problem or solution should still contain at least 2 pertinant surveys of well-known or conducted research. The over-arching question the author should answer in her/his LITERATURE REVIEW is what do these previous works do for this research?