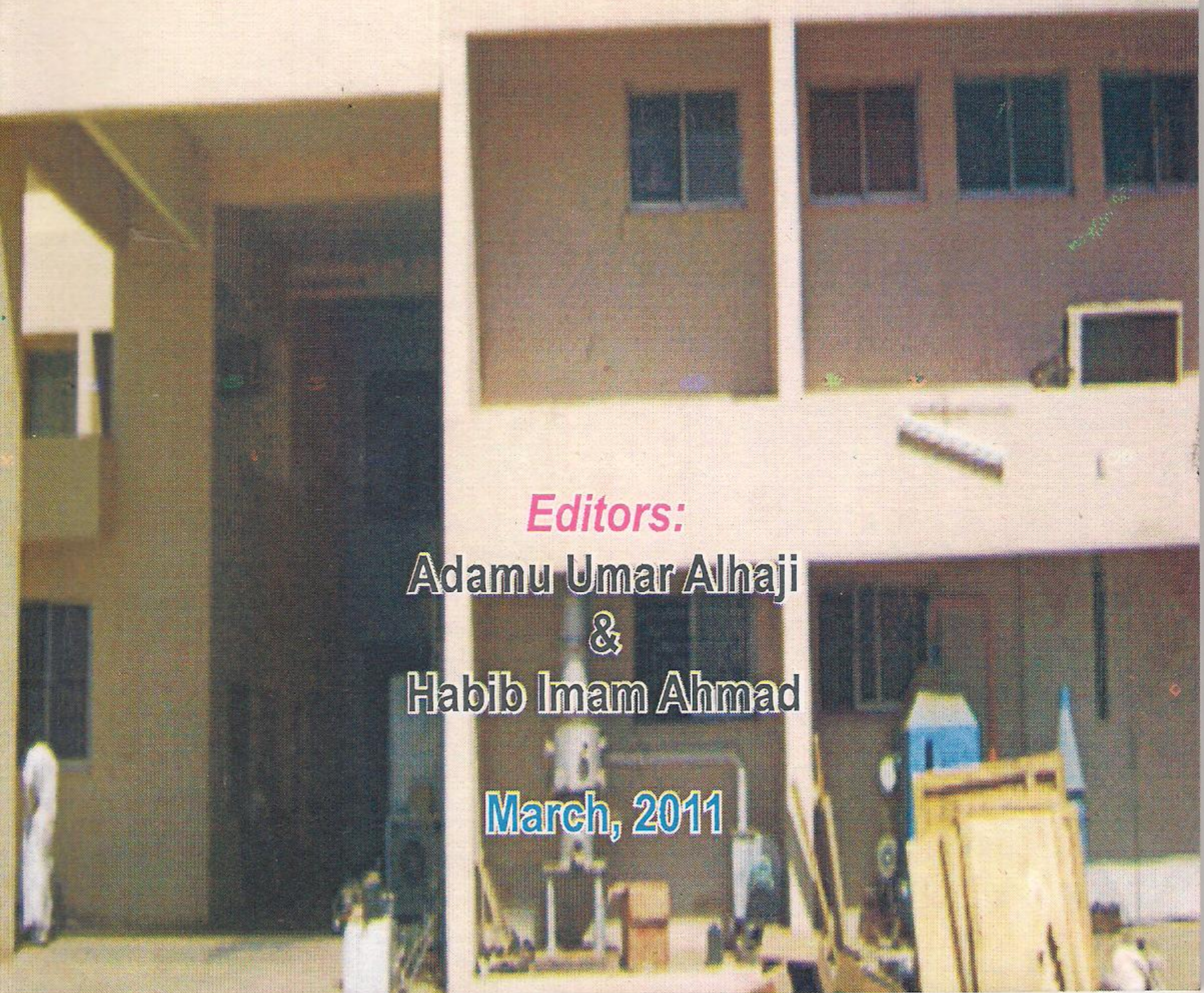
FACULTY
OF
TECHNOLOGY

Fundamentals of Research Proposal and Methodology in Engineering



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March, 2011

Comments and Suggestions for future Edition should be Sent to the Dean Faculty of Technology Bayero University, Kano

A Publication of Faculty of Technology, Bayero University, Kano, Nigeria

ISBN 978 – 8203 – 36 - 0

First Published, 2011

Ahmadu Bello University Press Limited, Zaria,
Kaduna State, Nigeria.
Tel.: 069879121, 08065949711.
E-mail: abupresslimited2005@yahoo.co.uk
Website: www.abupress.org

CHAPTER TWO

FUNDRAISING STRATEGIES FOR ENGINEERING RESEARCH

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1.0 Introduction

In contrast to science research, which primarily seeks new knowledge about the natural world, engineering research concentrates on the man-made world to expand the knowledge base and to identify and prove the physical principles on which advances in design and production can be based. This requires strong interactions between engineering research and science research, and the boundaries between them are often difficult to discern. Indeed, both require exactly the same types of intellectual activity; basic research aimed at improving our understanding of the underlying phenomena, and applied research aimed at developing the practical implications of the new understanding. In engineering, basic research provides the underlying competence on which applications research is based. For example, the evolution of the modern computer from electron tubes to transistors and then to integrated circuits is the result of engineering research that converted newly understood physical principles into practical working systems. Taken together, engineering and science research are crucial in a world in which competition through technology has assumed a commanding role in the interactions among nations.

Engineering and engineering projects have been an integral part of the human experience since the beginning of

civilization. Until quite recently, however, advances in engineering practice were gained by slow and laborious trial-and-error procedures. Then, at about the turn of the last century, modern methods of engineering research firmly based on scientific principles were brought to bear on a wide variety of problems. Engineering knowledge and the technological developments based on it have grown rapidly and continuously ever since. Structures of every kind residential and commercial buildings, bridges, dams, and tunnel have become larger, stronger, safer, and easier to build through research into their design and construction. As a result of engineering research in materials, mechanics, electronics, and manufacturing processes, machines efficiently and reliably carry out functions once performed by humans and animals. Modern transportation systems; automobiles, trucks, trains, ships, and aircraft are outstanding examples of the contributions of engineering research to such technological advances. Conversion technologies to utilize energy sources in their evolution from wood to coal to oil and to nuclear power are based on knowledge provided by engineering research. Research in electrical and electronics engineering have made our telephone, radio, and television systems possible, and have led to today's worldwide communication networks linked by satellite. Modern information and data processing systems are closely related developments.

Thus, engineering research is simultaneously a generator, stimulator, assimilator, integrator, translator, and promoter of new scientific and technical knowledge, all with the primary objective of making the production of goods and the provision of services easier and more efficient and their use and maintenance less costly

Any research in any Engineering discipline should be able to address the following issues:

1. **What are *motivations* for this work?** For a research paper, there is an expectation that a problem has been solved that no one else has published in the literature. This problem intrinsically has two parts. The first is often unstated, what I call the **people problem**. The people problem is the benefits that are desired in the world at large; for example some issue of quality of life, such as saved time or increased safety. The second part is the **technical problem**, which is: *why do the people problems not have a trivial solution?* There is also an implication that previous solutions to the problem are inadequate. *What are the previous solutions and why are they inadequate?*
2. **What is the proposed *solution*?** This is also called the **hypothesis** or **idea**. There should also be an answer to the question *why is it believed that this solution will work, and be better than previous solutions?* There should also be a discussion about *how the solution is achieved (designed and implemented)* or is at least achievable.
3. **What is the work's *evaluation* of the proposed solution?** An idea alone is usually not adequate for conducting a research. Questions that need to be addressed include: What argument, implementation, and/or experiment make the case for the value of the ideas? What benefits or problems are identified?
4. **What is your analysis of the identified problem, idea and evaluation?** Is this a good idea? What flaws do you perceive in the work? *Is this really going to work, who would want it, what it will take to give it to them, and when might it become a reality?*

5. **What are the *contributions*?** How did this research contribute to humanity? What are the other outcomes?
6. **What are *future directions* for this research?** Not only what future directions should the research indicate, but what possible leads are available for advanced research in the area?
7. **What questions are you left with?** What questions would you like to raise in an open discussion of the work? What do you find confusing or difficult to understand? By taking the time to list several, you will be forced to think more deeply about the work.
8. **What is your take-away message from this paper?** Sum up the main implication of the paper from your perspective. This is useful for very quick review and refreshing your memory. It also forces you to try to identify the essence of the work.

Armed with these at the back of our mind, let us focus attention on how can we make practical these issues within broad process of seeking for funding for research.

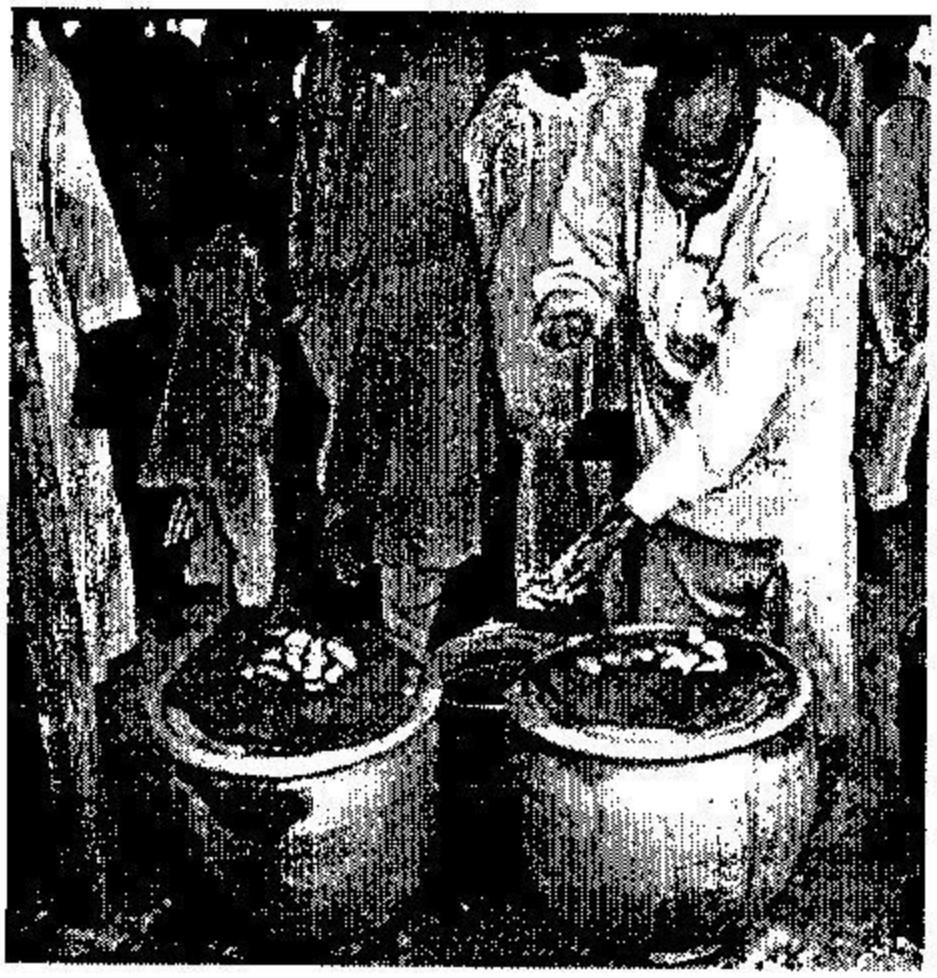
2.0 Local Entrepreneurship as Anchorage

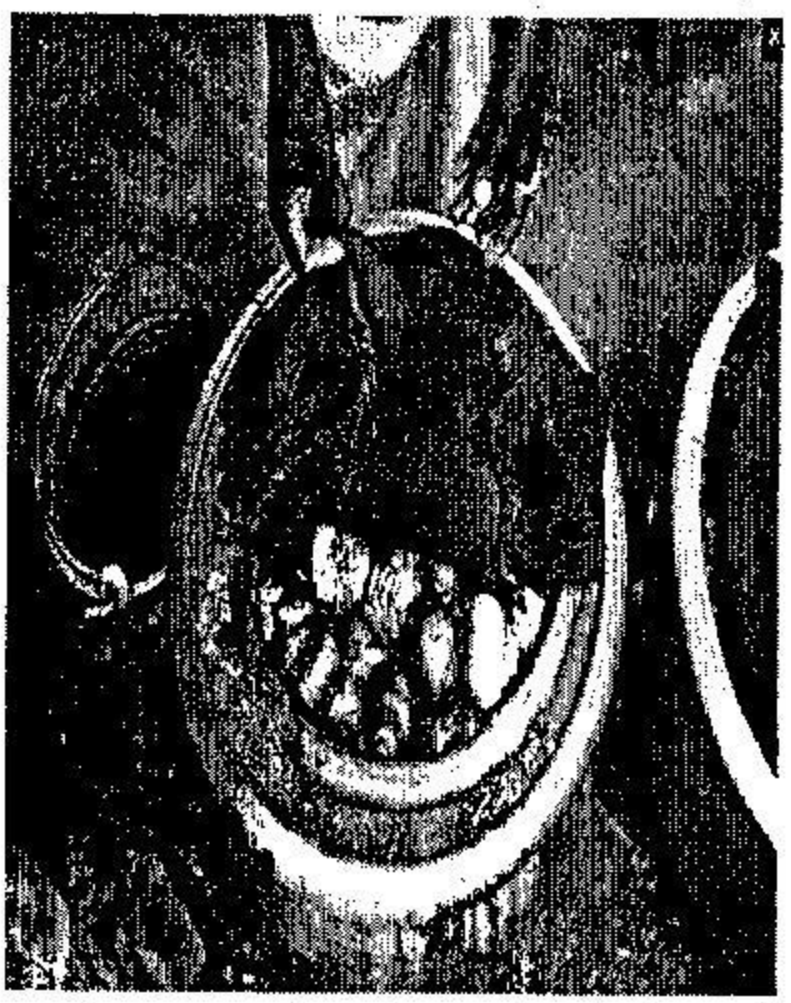
I will start with a general discussion of how to obtain funding for a particular engineering research project. To give myself greater scope, I would not focus attention on a specific process of obtaining funding to do an immediate research, but on raising funds to embark on a large sustainable research project – such as the construction, mass production and distribution of a particular product. As an anchor – or lead focus – I will use the example of Mohammed Bah Abba, an indigenous technologist from Dutse, Jigawa State.

In 2000 Abba was given the Rolex Award for Enterprises – and a cash reward of $75,000 (over N800,000 at the time) and

Rolex watch (which costs more than $5,000). Abba's invention was very simple. He called it "pot-in-pot" desert fridge. It is consisting of two earthenware pots of different diameters, one placed inside the other. The space between the two pots is filled with wet sand that is kept constantly moist, thereby keeping both pots damp. Fruit, vegetables and other items such as soft drinks are put in the smaller inner pot, which is covered with a damp cloth (as seen in the following illustrations).

"Pot-in-pot Desert Fridge"





The phenomenon that occurs is based on a simple principle of physics: the water contained in the sand between the two pots evaporates towards the outer surface of the larger pot where the drier outside air is circulating. By virtue of the laws of thermodynamics, the evaporation process automatically causes a drop in temperature of several degrees, cooling the inner container, destroying harmful micro-organisms and preserving the perishable foods inside. Egg plants stay fresh for 27 days, instead of thc usual three. Tomatoes and peppers last for up to three weeks. About 12,000 units sold at 40 cents (in 1999). The invention was very popular with rural dwellers throughout Jigawa and neighbouring Niger republic.

Established in 1976 to foster a spirit of individual enterprise around the world, the Rolex Awards recognize pioneering projects that demonstrate innovative thought and contribute to the betterment of humankind. Although Mohammed Bah Abba received **$75,000** for the Rolex Award, yet he did not receive a single kobo from Jigawa State government...or any government for that matter. His feat was reported in TIME (29 Aug 2002) and many websites...but not any media in Nigeria.

3.0 Sanyin Tulu Enterprises, Inc.

It is very clear that Abbas's invention clearly has great social benefits, but is cumbersome to make on a large scale. Abba needs to raise funds to commercialize the production of his invention. A factory needs to be set up to mass-produce the invention, to make it affordable to rural dwellers that live in harsh environment. HOW will Abba go about raising funds for R&D to sustain his enterprise?

Although Mohammed Bah Abba has a company (Mohbah Rural Horizons, located in Kano, Nigeria), I would rather use an imaginary research company, ***Sanyin Tulu Enterprises, Inc.*** and attach it to Abba. Then continuing with my anchor analogy, I would want to take us through the key strategic areas that Abba will have to consider in order to obtain funding for research in his company.

Step 1: The mission — why are you here

The first step is to draft your mission statement. The best mission statements all have a few things in common:

- They're clear, concise, and easy to understand.
- They capture and hold the reader's interest.
- They include a call to action that gives the reader a reason to respond now.

Your mission statement should draw readers in and hold their attention. Start out strong. Be compelling. Describe the issue you're addressing; then tell your solution; then specifically describe your organization and show how it uniquely addresses the problem you opened with. The process looks like this:

Big picture (problem)
Zooming in (solution)

Close up (the specific ways in which your organization addresses the problem)

Getting a clear view of your mission

Perhaps even more important than what the outside world will think of you is what your organization understands about itself. Drafting a careful case statement helps bring a wide range of thoughts into a focused purpose, which enables everyone connected with your organization — donors included — to get a better picture of what you do and what you need.

For example, you know that it's your organization's mission "to provide effective engineering solutions to rural dwellers to improve the quality of their lives". But when asked about the mission of your organization, here are some examples of how a few different board members respond:

> **Big picture**: Perishable goods cannot be preserved in dwelling environments without electricity. This encourages bacterial activities and leads to health risks.
>
> **Zooming in:** Provide them with cheap affordable locally-provided solution to food preservation
>
> **Close up:** Sanyin Tulu Enterprises, Inc. has built prototypes of a "desert fridge" made up of 100% locally sourced materials. This innovation, based on indigenous technology, will revolutionize the way food is preserved and lead to higher quality of life for rural dwellers.

The resulting mission statement should look something like this:

*Everyday **rural** dwellers face problems of lack of facilities to preserve **their** food thus giving room for bacterial growth in **perishable** goods. With no regular supply of electricity, **and** costs of even second-hand fridges quite high, Sanyin Tulu Enterprises, Inc. is poised to provide a mass-scale **cheap**, affordable desert fridge constructed from earthenware that will make it easier for rural dwellers to improve their food preservation.*

Step 2: The goals: What do you want to accomplish?

After you've established the "why" of your organization — the mission — you need to think about the "what." What are you trying to accomplish? Sanyin Tulu's response to the need it focused on in the mission statement makes up the goals it wants to achieve. These might include:

- To make rural dwellers healthier
- Assist the government in poverty alleviation strategies
- Improve the quality of life of rural dwellers

When you first begin working with the mission statement, goals, and the objectives, the different areas may seem to mix not too neatly together in your mind. This is normal. There is an important, albeit subtle, difference in each of these very important areas:

- The mission statement explains the need that your organization addresses.
- The goals are general ways in which your organization seeks to respond to that need.
- The objectives list the specific, measurable ways your organization will meet its goals.

And although not a defined section in your case statement, your organization's accountability needs to come through loud and clear throughout the entire document. Your donors and other major stakeholders will get a sense of your accountability, especially in the sections about the leadership of your organization, evidence of financial responsibility, and long-range planning. Although your organization will have only one mission statement and a few goals, you may have several objectives for each of your goals.

Step 3: The objectives: How will you reach your goals?
While Sanyin Tulu's goal may be to make rural dwellers healthier, its objective would be to institute change in the way perishable food objects are stored. Objectives give you a way to tell the people who read your case statement how you will accomplish the goals you defined. Make your objectives specific, measurable, and attainable. Let us take one example of a goal and see how Sanyin Tulu might translate it into achievable objective. This objective might be

> To produce an affordable food preservation device that would help rural dwellers in food preservation within the price range of N150.

Here are some questions you should be able to answer "yes" to as you write your objectives:

- Are your objectives brief?
- Are your objectives measurable?
- Did you set a date by which the objectives will be achieved?
- Do the objectives answer the question "How will we meet this specific goal?"
- Have you included specific program information?

Step 4: Programs: What, exactly, do you provide?
This is where Sanyin Tulu tries to convince investors of its major assets. What can they list as being proud of?

As we have seen from the Mission Statement, Sanyin Tulu wants to provide a service towards making a healthier living for rural dwellers, using a very simple technology. The over-riding product Sanyin Tulu wishes to develop as part of its long-term strategy of Research and Development is the mass production of its "desert fridge" range of products.

Step 5: Governance: What is the anatomy of your board?
Not all prospective donors know about board memberships, but you can be sure that any donor considering giving you a large gift, or any foundation reviewing your grant proposal, will want to know how your organization is governed. Who comprises your board? What different areas and interests do they represent?

Be sure to include the following things in your Governance section.

- The legal status of your organization. Are you registered with the Corporate Affairs Commission?
- Have you applied for patient rights on the product?
- An overall picture of your board, including number of members, how members are selected, terms of service, and committee structure
- Specific information about key people on your board
- Information about the administrator, or executive director, of your organization

What is a board supposed to do? You may be surprised to see how different one board is from the next — a variety of personalities and methodologies comprise the bigger picture

of an engineering research board. Painting with broad strokes, however, the board makes sure that the organization keeps on track with its philosophical, legal, and financial goals, but for the most part leaves the day-in, day-out running of programs and services to staff members.

Step 6: Staff: Who are the people behind your services?

The next important step is to include information on who actually provides the services to the people you serve. In this section of the case statement, include both general information about how your staffing system is set up and specific information on the duties of key roles. You may want to include summarized job descriptions to give readers an idea of which tasks go with which roles.

In addition to the general talk about responsibilities of your staff members, you need to talk about the staff members themselves. It's a good idea here to stick to the key staff members in your organization — people in roles unlikely to change often, such as the executive director, the director of development, and so on. Also introduce key volunteers and people who have been ready, willing, and able to take on leadership for your organization's cause.

Staff will be an important section in all grant proposals you submit. Along with those proposals, you will want to attach the CVs of key people in your programs. As you create your case statement, you may want to request copies of those resumes so you have them on hand later.

Step 7: Location: Where do you live and work?

The Location section describes where you provide the services you offer. You may have a traditional office in a traditional part of town. Whatever your location, describe it. Explain how

the location is right for the services you provide. Show how it helps you meet your goals. And include any plans for improvement and/or enhancement you have for the facility (and be sure to illustrate how that will speed you on your way to meeting your service goals).

In the Location section, include

- Your address and information about your neighborhood as it relates to your mission.
- Specific information about the location's unique applicability to your function. The number of people who can be served at your location.
- Plans for improvement and/or expansion.

Sanyin Tulu may have a problem here. Although it is a rural-technology firm seeking additional funding to expanding its operational base, yet its offices are located in an extremely urbanized area. One would therefore expect its laboratories and workshops to be based in rural areas for ease of access and shipping; while its corporate offices are located in urban areas for easier fundraising initiatives and strategies.

Step 8: Finances: Is your organization financially responsible?

Are you a numbers person? If not, don't hesitate to ask someone who is to help you with this section. The way in which you communicate the finances of your organization has much to do with the credibility your potential donor perceives.

Summarizing your financial picture

Although the Finance section includes your current financial statements, one of the most important things a donor looks for is an explanation — a summary — of your financial picture.

Your summary should include:

- The way in which your organization now receives income
- The expenses you have
- Your current financial picture
- Your projected financial picture

The most important thing to remember about your Finance section is to write it in understandable terms. Not everybody is an accountant, but everybody knows that 1+1=2.
Where do you get your funds? You may get project grants (Sanyin Tulu already has received $75,000 from Rolex Foundation), have special events (e.g. launching of Sanyin Tulu desert fridge initiative) etc., Where do your funds go? Your expenses may include your staff salaries, your location costs, costs of current programs, expenses for special projects, and more expenses for special projects, and more. Potential donors would want to know all these details to determine your credibility.

Step 9: Development: What will you do in the future?
What are you doing to ensure your organization's future? Do you have a development plan in place? What does the five-year plan for your research look like? How does your organization evaluate itself? How do you know when you've met your goals?

Anyone thinking of contributing to your cause wants to know that you will be around tomorrow. The development plan you describe in this section shows your prospective donor the following things:

- That your organization has a vision for the future
- That you have a specific plan for carrying out that vision

- That you have checks and balances in place to ensure accountability
- That you have credible people monitoring programs, finances, and growth
- That you have a means of evaluating your own progress and revising goals as needed

This section requires big-time board input. If you're the lone development person or a volunteer putting together a case statement for the first time, you may not know how these things work in your particular agency. Not all organizations have a system of self-evaluation, although everyone seems to agree it's a much-needed facet of nonprofit management. If you're in the dark about these things, request a meeting with your executive director and/or board chairperson. Asking and answering questions about the way your programs get evaluated may just start a domino effect that causes your board to think about these things seriously for the first time.

Step 10: History: What successes are you building on?

Many charitable organizations — especially those that have been around for a long time — would want to tell you their history. They'll keep you rooted in your seat for hours, describing great people, events, and influences that came about because of their existence in your community. They'll be glad to show you photos of past volunteers and produce a timeline of significant achievements.

There's only one thing wrong with this approach — it puts your donors to sleep.

Today's donors want to know the highlights that show you have momentum and accomplishments to build on, but their focus is all about today's issues. History is all well and good

and is important as a means for gauging how your organization has lived up to its promises in the past, but people giving money today want to know where the money will go today. They want to join with you in solving a need today. And they're also interested in doing something today that will help make things better for tomorrow. For this reason, the History section comes at the end of the case statement, not that it's unimportant.

There's power in history — a reconnecting energy that summons the best of the past with the hope for tomorrow. Your past successes are essential in convincing donors that their money will actually accomplish something (Sanyin Tulu could always use the Rolex Award as a mark of its international significance). But the viability of your current request doesn't lie in its past. You're raising money today because there's a need for what you do — today. Speak to that need. Put real faces on the need, describing people whose lives improve because of your mission.

3.1 Polishing Your Case Statement

It's time to sit down and write that case statement. This part is pretty much like any writing process: You have to craft a well-written draft, evaluate it objectively to make it tighter and stronger, and then run it up the flagpole and see who salutes. Then you go back and tighten it some more.

Each of these steps makes for a more powerful and direct written tool for your agency and takes the load off of you so you don't have to write in a vacuum.

3.2 Discovering ten tips for writing a great case statement

After you have the framework for what goes in to your case statement, you need to polish it up and make it readable. Here

are some tips that should help:

- **Make it clear.** Focus your mission statement, goals, objectives, and program information so readers get a well-defined picture of what you're saying.
- **Make it urgent.** With so many causes competing today, you need to give your reader a reason to care about your cause now. What's urgent about the problem your agency seeks to solve? Be sure that the reader knows why today is the time to act.
- **Make it complete.** Remember the five Ws for news stories — who, what, when, where, and why — and include them in your case statement. Be sure to include these facts in the Executive Summary, as well. That section may be the only part decision makers read, and the answers to those questions are the ones they will want to know first.
- **Make it interesting.** Tell stories when you can — both success stories and heart-tugging stories capture the emotions of your reader. Hearing about how parents used your counseling services to help their teenage daughter recover from a suicide attempt is much more effective than listing teen suicide statistics.
- **Paint images in your readers' minds.** Remember that visual words and action words activate your reader's imagination. Did your client smile when she received her graduation certificate? Say so — paint the smile in your readers' minds.
- **Don't overdo it.** Tugging on heartstrings requires an even hand. Don't gush or overstate. People can only hear so much about Trina's lost limbs and then they start to turn away. Explain, describe, but don't go overboard on the heart-wrenching stories.
- **Do your homework.** Make sure that the facts of your

statement — financials, program design, staff info, and plans — are accurate and well researched. Have a complete set of case information for board members to review well in advance of the next meeting. That way, people can come to the meeting with a complete set of data, some opinion about what they've read (don't expect a standing ovation the first time out), and a few suggestions of their own. If you have all the facts in place, others can concentrate on helping you shape what you started with.

- **Summarize.** Using understandable language is an important part of an effective case statement. Don't let your budget speak for itself — it won't! Write a budget narrative, to explain in real-world terms what your numbers mean. Don't hesitate to summarize and clarify when some good old-fashioned straight talk will erase a few question marks in the reader's mind.
- **Include a call to action.** After you get your readers all worked up about your programs and your agency, don't just leave them sitting there — give them a way to help. Your case statement should include ways the reader can join with your cause. Make sure that you talk about how much that new program cost, what you need in the way of hardware to start it, what talents you'd welcome, and more. Invite people to participate.
- **Reread, revisit, and revise.** This case statement business isn't a walk in the park. Even if you've been writing for a while and you're fairly confident in your communication skills, you'll find that writing a good case statement takes an open mind, a willing heart, and a very small ego. It's meant to be a team effort — something that is forged only after considerable conversation and, sometimes, debate.

3.3 Evaluating your case statement

After you've finished the draft of your case statement, put it away for some time and reread it with fresh eyes. When you do, read it with the following ideas in mind:

- Is the need compelling?
- Are your goals communicated clearly?
- Do your objectives seem realistic?
- Are your programs described fully?
- Does your board appear competent and ready for growth?
- Is your staff well equipped and capable?
- Does your location provide what you need to carry out your services?
- Is your financial section complete and written in understandable terms?
- Does your board have a method of evaluating itself and the organization's progress?
- Does your History section tell the lively story of your organization or research project?

4.0 Conclusion

Engineering research depends on a continuity of effort in order to be productive. Thus, fluctuations in funding support that can occur when federal agencies must respond to short-term crises, and the interruptions in continuity that result, can create serious problems for both basic and applied research efforts, whether they are carried out in universities, industry, or federal and national laboratories. The establishment of Universities of Science and Technology, as well as Ministries of Science and Technology in many States (e.g. Kano and Zamfara States) is a clear indication of the need to provide a supportive base for engineering research.

Two caveats, however, must be recognized. First, the funding made available to the new research centers raises questions about the adequacy of funding support for interdisciplinary research at colleges and universities that do not have such centers. Second, research administrators must strike a balance between research by individuals and the collaborative research of the new engineering research centers. The latter caution introduces the issue of adequate funding for small-scale research projects involving a single investigator and perhaps one or two graduate students. This individual research can be highly effective because it is the ideal scale on which to first explore areas of high-risk engineering research.

On the other hand, history suggests that individual researchers in academia have often been more highly and more frequently rewarded than their colleagues who engaged in collaborative research efforts such as those envisioned in the engineering research center concept. Thus, an important issue for university administrators is developing and maintaining balanced support and promotion incentives among those investigators involved in small-scale, disciplinary, individual research and those participating in large-scale, multidisciplinary, team research.

Reference

Chapi, Paul G. (2004). *Research Projects and Research Proposals: A Guide for Scientists Seeking Funding.* Cambridge: The University Press.

Commission on Engineering and Technical Systems (1986). Directions in Engineering Research: An Assessment of Opportunities and Needs. Fitzpatrick, Joyce J. and Defler,

Sandra S. (2000). Fundraising Skills for Health Care Executives. New York: Springer Publishing Company, Inc.

Mutz, John and Murray, Katherine (2006). *Fundraising for Dummies*. Indianapolis, Indiana: Wiley Publishing, Inc.,

Report of the Engineering Research Board. National Research Council, Washington, D.C.: National Academy Press.