3.3 Best Practices for Executing the Strategic Plan

3.3.1 Executing the Strategic Plan is Vital

A research thrust leader's work doesn't stop when the strategic plan is formulated; that's only the beginning, a prelude to the real effort. Constant follow-up is necessary (e.g., continually checking progress and resource expenditures against the plan). Also, as noted earlier, research thrust leaders have to be willing to make adjustments to the plan if necessaryâ€"especially with respect to budgets, resource allocations, and schedules.
â€œMany [businesses] have plans; few execute them well. In fact, intensive research out of Harvard University indicates at least 85 percent of businesses do not execute their strategies effectively.â€• (Endnote 5.)
Below (sections 3.3.2â€“3.3.6) are five pragmatic approaches and one important open issue (section 3.3.7) for research thrust leaders charged with executing their strategic plans.

3.3.2 Create and Sustain Buy-In

The goal here is to show how a particular thrust fits into the overall strategic plan of the ERC and to convince thrust members of the importance of their roles in fulfilling the centerâ€™s larger vision and mission. To an extent, some buy-in may have occurred during preparation of the strategic plan. However, that buy-in may only be transitory as the real work gets underway and the relevance of a particular project to a distant vision or mission dims in the minds of participants. Accordingly, the research thrust leader must constantly reinforce the relevance to the ERCâ€™s goals and the consequent need for buy-in as the projects continue.
Budget and resource allocation issues must be part of this best practice (e.g., what dollar and human resources will be allocated, and when?). Ideally, research thrust leaders should participate in the center-level budget and resource-allocation processes and have a clear understanding of budgetary and resource-allocation responsibilities and authorities, from the top of the ERC downward. However, the extent to which this is possible depends on the ERC and university leadership. In any event, research thrust leaders must communicate clearly and often with the ERC director, colleagues, and subordinates about budgets and resource allocations.

3.3.3 Identify and Optimize Critical Paths

Critical path chains should be optimized to achieve the most efficient timelines, bearing in mind that some fundamental challenges may take time to resolve. Further, although interactions among team members are to be encouraged, extraneous interaction should be avoided so as to not complicate each critical path with unimportant connections. The project goals can be accomplished without all players in the thrust being engaged with every aspect of the work.
In addition, the thrust leader should ensure there is no overlap in deliverables, such as two research efforts producing the same results. Coordination of deliverables between thrusts is also important.
When necessary, research thrust leaders should support changes within the center to clarify the critical paths. Rationale for such changes could include achieving more realistic schedules, attaining better balance of budgets and resources along the paths, or implementing successful â€œworkarounds.â€•
To illustrate the last point, there might be a situation in which a research thrust leader has to decide how to keep a research team productive when waiting for a deliverable from another thrust. Alternatively, a thrust leader may be faced with developing workarounds when an outside deliverable fails to materialize. A best practice would be to request every project to have a Plan B if Plan A, which reflects input from another thrust, has a schedule slip or doesnâ€™t happen at all.

3.3.4 Establish Effective Communications within Thrust and with Rest of Center

Continuous and effective communications, both up and down the chain of command, are essential. With respect to levels of management above the thrust leader, communications must be clear, convincing, and concise. For levels parallel or below, in some cases research thrust leaders may need to rely on persuasion. Direct orders to other thrust leaders or independent researchers are likely to be seen as abrasive and fail.
Best practices to overcome communication difficulties include the following:

- Define the goals and milestones as a team.
- Use video-conferencing and web-based communication systems.

- Establish regular schedules for meetings.
- Record minutes for key meetings and decisions.
- Develop a knowledge repository.
- Always communicate with principal investigators and project leaders.
- Donâ€™t forget the telephone or face-to-face communicationsâ€”an e-mail can be misunderstood.
- Push to attend and interact at national meetings and professional society meetings (where ERC budgets permit).
- Schedule retreats for university students to show or present their work.

3.3.5 Monitor Progress and Deliverables

This topic addresses the following two aspects:

- Meetings and reports that illuminate various projects
- Metrics that measure progress and accomplishments.

Consideration here of meetings extends the preceding discussion of communications. Weekly or bi-weekly project meetings would be desirable, if possible, as would monthly meetings with center executives. However, a proper balance needs to be struck between meeting and doing. In other words, are the meetings worth the time spent? Meetings that involve thrusts across several universities are also challenging from travel and time standpoints.

On reports, research thrust leaders should establish and disseminate reporting schedules for interim progress, outcomes, and other deliverables. Monthly reports from individual researchers to thrust leaders along with quarterly reports from thrust leaders to higher levels of ERC management are probably sufficient. Caution should be taken to not overly burden the individual researchers who furnish inputs for such reports (i.e., they should not be too distracted from doing their projects). An online system might work well here.

Metrics for assessing performance are essential. As discussed in the previous section on strategic planning, the correct choice of metrics is very important. Much preferred are metrics that measure outputs and outcomes rather than inputs. It may not be possible to develop during strategic planning a complete set of worthwhile metrics, so research thrust leaders might be faced with this task during the execution phase. NSFâ€™s requirements for center metrics, in the context of both annual reporting and on-site reviews, must be taken into account here. The centerâ€™s Administrative Director/Manager is likely to be the most cognizant staff member regarding these requirements, and should be consulted.

Developing metrics in collaboration with other members of the research team as well as with top ERC leaders is most desirable; that way everyone in the management chain will know what to expect in the assessments. Once established, the metrics should be reviewed in light of project realities, timely feedback should be provided to project leaders, and there should be willingness
to adjust the metrics if a situation warrants. The project assessments would also be used to support recommendations for adjustments in budgets or resource allocations.

3.3.6 Adopt Effective Management Styles and Strategies

Several best practices regarding management styles are to:

- Use team-building approaches.
- Know and take account of backgrounds and capabilities of collaborators in the ERC.
- Develop and articulate a conflict-resolution strategy that everyone is likely to buy into.

Thrust leaders have to set research direction, so if people disagree on that direction an issue is raised on how to reach resolution. Depending on the issue, third party input (e.g., from some type of scientific advisory board or other technically savvy authority) can help resolve the matter. But clear articulation of the issue and what is done to reach agreement is important.

Note that possibly more contentious disagreements could arise on budgetary and resource allocations (see earlier discussion). Here the best practice would be to discuss the matter openly with participants in the team as well as other thrust leaders to gather information about various options for handling the situation. Then put it on an agenda for discussion with decision-makers in the ERCâ€™s leadership team.

Finally, uncomfortable personality conflicts might emerge between individuals at various levels. If these cannot be worked out by face-to-face dialog, one suggestion is to consider bringing in a conflict-resolution expert. At a certain point, such conflicts become a matter for center leadership to address.

3.3.7 The Issue of Compensation for Thrust Leaders

Thrust leaders expend much time and energy on their leadership tasks. Other than an occasional â€œgood-jobâ€• recognition from ERC management, their management work is not compensated. Should these leaders have some type of more tangible compensation for their important responsibilities? Several best practices are suggested below, but these are ultimately dependent on the ways individual ERCs and universities operate.

- Extra pay or vacation are at the top of the list of possible types of compensation for at least some of the considerable time and effort spent by thrust leaders to carry out their responsibilities associated with the ERC (e.g., through summer support or regular-year effort).
- Other forms of compensation could be making special training or professional-development opportunities available to thrust leaders; a variation could be a professional-development coach. (To help accomplish one or more of these possibilities, NSFâ€™s ERC Program office could be a resource to provide contact information concerning such opportunities.)

3.3.8 Examples of Adjustments to the Plan

It is useful to see examples of improvements that were made when strategic plans were being implemented. The first example below shows how fundamental elements of a strategic plan had to be modified based on lessons learned during implementation. (This experience also feeds back to Section 3.2, which contains a best practice of defining a structure that can accommodate adjustments.) The remaining examples, from ERC strategic plans described in subsection 3.2.7, show selected responses to various suggestions made by visiting reviewers after observing aspects of the implementation.

3.3.8.1 Changes to the Three-Plane Diagram

The example shown in Exhibit 3.3.8.1 starts with the original relationship between the planes of the diagram; it then explains why that relationship had to be changed. The example also illustrates this ERCâ€™s approach, after discussions with other ERCs, to achieving stronger faculty buy-in and team integration.

EXHIBIT 3.3.8.1

The Center uses a top-down, systems-vision approach in defining specifications and deliverables. The FREEDM system must be demonstrated with properly defined voltage and power levels for residential renewable energy generation and distribution. Research milestones and a quantitative matrix used to measure success will be defined by projected breakthroughs in three fundamental research areas: FREEDM system theory; post-silicon power devices; and advanced storage technology. To link the fundamental research results to the final system demonstration requires that several enabling technologies must be developed. Figure 2-2 shows the proposed sub-thrusts and their key relationships to the fundamental research, enabling technologies, and engineered systems planes. At the top plane, two subsystem test beds, IEM and IFM, are identified as integral parts of the ultimate 1 MW FREEDM System test bed. The new PHEV/PEV test bed is not shown. These test beds can only be developed by the integration of the five enabling technologies and by the synergistic team effort.

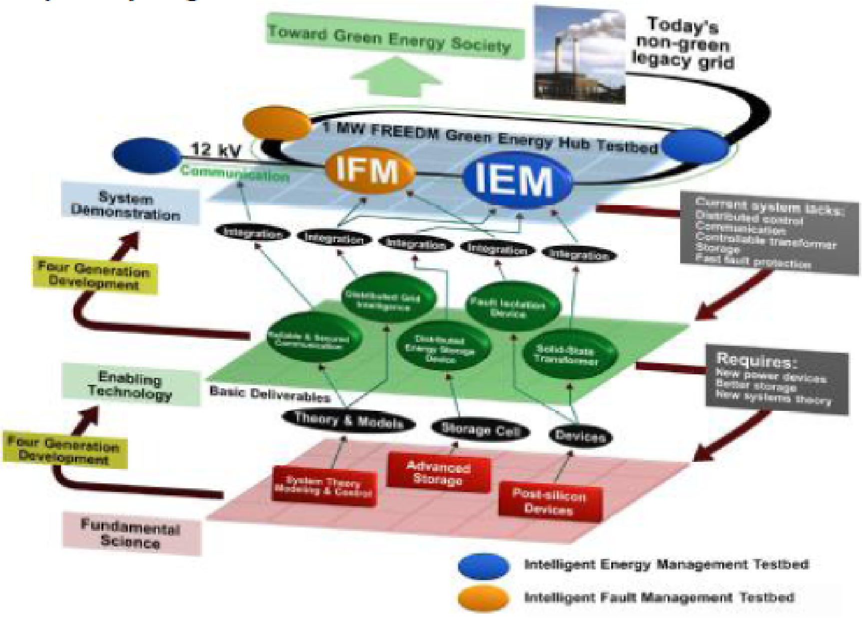

Figure 2-2. Original Center Research Area Strategic Plan

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At the end of the first quarter of the Center's research program in December 2008, we started to notice that the center research program integration through three horizontal planes/thrusts in fundamental science, enabling technology, and demonstration is not effective. For example, PSD subthrust and AS subthrust are both part of the fundamental science thrust area. But these two subthrusts do not have much need for interaction due to their very different technical fields. On the other hand, they have a much stronger interaction with the enabling technology subthrusts they support, namely SST and FID for the PSD, and DESD for the AS. Therefore we have realized that it is much more natural to achieve research program integration through vertical plan integration. This is especially true for our center because the center's system vision (FREEDM System) strongly depends on the test beds, and these test beds can only be achieved through a strong integration of technologies in the vertical direction. The test bed needs determine the requirements of the fundamental and enabling technologies, and what can be achieved in the fundamental and enabling technologies in turn determines what can be demonstrated in the test beds.

At the December ERC conference in Washington, DC, we have also learned a lot from other ERCs on how to revise strategic plan of the center and on how to use this process to achieve stronger faculty buy-in and team integration. Therefore, in January and February 2009, the Center's executive committee met several times through teleconferences, and discussed how to reorganize the center's research program. The committee then recommended the following strategic plan changes in February 2009:

- Add a PHEV/PEV test bed to emphasize our integration from fundamental storage research (AS), to DESD enabling technology, to DESD application inside the vehicle (PHEV/PEV).
- Eliminate the three thrust leaders and the horizontal integration concept, instead, empowering the leadership of the three test beds. Dr. Mischa Steurer will serve as the IFM test bed leader. This test bed integrates vertically DGI, RSC, FID, PSD and SMC sub-thrusts. Mariesa Crow will serve as the IEM test bed leader and drive the vertical integration of DGI, SST, RSC, PSD and SMC sub-thrusts. The new PHEV/PEV test bed will be led by Ewan Pritchard, a well known pioneer in plug-in hybrid vehicle technology who recently joined the Center. This will allow vertical integration of AS, DESD, and PSD sub-thrusts.

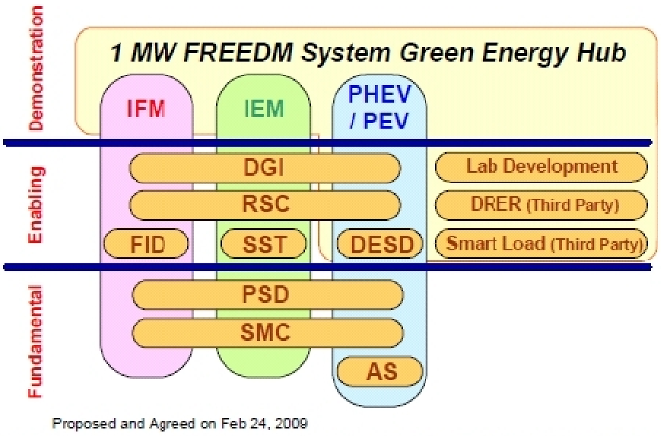

Figure 2-3, New Revised Center Research Area Strategic Plan

Figure 2-3 shows the revised three plane diagram, emphasizing the vertical integration among the various sub-thrusts.

The Center has recently further clarified the strategic relationship between the FREEDM Systems Center and NCSU's Advanced Transportation Energy Center (ATEC). ATEC was established in Feb 2008 by an investment from the state of North Carolina, Duke Energy and Progress Energy to facilitate the development of PHEV/PEV technologies. It has been agreed that ATEC activities will be considered core research projects of the ERC. The research activities in ATEC are mostly complementary to what are supported by the ERC, yet they both support a single strategic vision. ATEC will focus on advancement of PHEV/PEV hence will provide most of the funding in PHEV/PEV test bed. Additionally, ATEC's activities in motor drive and electric motor expand the center's activity into a very important area. A single industry membership will support both ERC and ATEC missions. A transportation working group will be formed under the FREEDM IAB to provide advice regarding ATEC specific activities. ATEC will remain as a Center of excellence at NCSU in order to develop technologies specifically for the transportation industry.

3.3.8.2 Communication and Interrelationships

The following example, responding to comments from a Site Visit Team (SVT) relates to best practices in the areas of communications and interactions that could identify commonalities.

Exhibit 3.3.8.2

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5.1.2 Response to Site Visit Report – Strategic Research Plan

- **The SVT recognized the complexity and dynamics of this framework in the execution of the research plan. While the topology has proven to be quite useful, the SVT recognized that just as the components of the framework are dynamic and based on biological principles, so should the strategic execution of the framework. In this spirit, the SVT recommends that the communication among the leaders in the Center be frequent and include examination of the overall strategy as well as the day-to-day operations. The temporal frequency of looking at this strategy is important and leaving it solely to semi-annual retreats may not satisfy the dynamic nature of all of the moving components of this complex center.**

We readily acknowledge that examination of the overall strategy should occur on a regular basis. In fact, we held a PIs meeting specifically to discuss and refine our strategic vision in between the semi-annual retreats this year and we likely continue to hold such meetings as the Center progresses.

- **The SVT suggests that, as part of this frequent strategic analysis, the SynBERC team examine the inter-relationships of Parts, Devices, Chassis, frequently and look for where there is commonality in moving advances between different levels of biological complexity (as represented by bacterial, yeast, plant, or mammalian systems).**

This is a good suggestion. In addition to considering how our foundational engineering research ideas can be applied across the kingdoms of life, we also anticipate extending our work on engineered biological abstractions to still higher levels of biological organization, such as synergistic relationships among organisms, including tissues and ecosystems. For example, Radhika Nagpal of Harvard is being recruited onto our SAB; she is an expert on developing programming abstractions for controlling pattern formation in systems comprised of thousands of independent agents (e.g., cells).

3.3.8.3 Keeping the Entire ERC Team Coordinated

Here the example (Exhibit 3.3.8.3) illustrates the need to ensure that all elements of the team continue collaborating and working together in a coordinated fashion.

EXHIBIT 3.3.8.3

- **The SVT did not see sufficient evidence of integrated, coordinated activities. Human practices researchers have been working on IP, biosecurity, and health and safety issues; the IAB called for policies in these areas; and scientific/engineering researchers have been active in development of policies, for example, with Bio Bricks and the proposed IP policies presented at the site visit. These efforts seemed to be disconnected from one another. It was not clear how work in one area would be informed by, and inform those in another area. The SVT also could not see anyone who was responsible for assuring that there was active, ongoing collaboration in moving any of these issues forward. For example, someone to assure a policy is in place that is responsive to IAB concerns about security, or IP.**

It is true that we have many activities proceeding simultaneously and that these could be better coordinated. We have addressed many of the coordination issues in other sections of this report. With respect to the Human Practices Thrust, Rabinow is now the sole thrust leader. We hope that having one thrust leader, as opposed to two, will help to improve coordination in the Human Practices thrust. We have designed the Thrust 4 research cluster on safety, security, and preparedness as a conceptual strategy for integrating and coordinating efforts. Our proposed project on "Globalized Forms of Preparedness and Risk Management for Synthetic Biology" will extend and formalize this integrated approach. We have submitted an FTE request to conduct this project.

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- **The Human Practices Thrust seems to be treated in a different way from the other research Thrusts. The SVT didn't see evidence of an active, ongoing exchange of ideas between scientists/engineers and humanities/social scholars in the human practices arena comparable to the sharing of ideas/equipment/platforms associated with other research areas. Is there a real give and take between scientific/engineering and human practices researchers?**

We generally agree with this diagnosis, although it should be noted that in the very first line of the SVT's report, Human Practices was not listed as one of the Center's Thrusts. Further, as the SVT points out in the report "Science/engineering researchers do not seem to fully appreciate that there is an opportunity – of the same kind as in other technical areas – to provide world class leadership in an influential, emergent area of [human practices] research." In general, it is often difficult to engage scientists/engineers in human practices aspects of their work, maybe because they view it as a distraction. However, in general, we believe that SynBERC's investigators are more engaged in ethical issues of synthetic biology than other scientists have been in the ethical issues of their own scientific disciplines. Nonetheless, SynBERC needs to improve in this regard, and we intend to do so. Rabinow will propose to Keasling a structured formula to address these issues.

3.3.8.4 An Important Element of Research Not Being Addressed Adequately

In this example (Exhibit 3.3.8.4) it was learned that changes had to be made to include more attention and investment so that one important element of research (in this case, packaging) could be addressed adequately.

EXHIBIT 3.3.8.4

- **Packaging, a critical element to component integration, is not being adequately addressed.**

  We are aware that this critical element needs additional attention and investment. While much of the actual packaging research is in fact ongoing within MIRTHE's industrial partners, who have the requisite resources and incentive to optimize packaging, a smaller core of our industry members have approached MIRTHE to address packaging issues. When the opportunity arose to compete for ERC Innovation Awards in 2009, we proposed – and were awarded – a program termed "MIRTHE Industry Experts in Packaging." Through this program MIRTHE is able to retain a significant fraction of time and effort of two industry experts, who have long-standing experience in semiconductor device packaging (a more detailed description of the program can be found in Volume II). The program commenced January 2009, and new (used) packaging equipment has been ordered; the new packaging lab-building will proceed through the spring of 2010. With improved equipment, and – more importantly – industrial-level packaging expertise we expect to greatly enhance MIRTHE's packaging capabilities.

  Furthermore, MIRTHE's basic research in component integration in Thrust 3 has seen great progress through this reporting period; hence promising true packaging innovations originating from the center soon.

3.3.8.5 Monitoring Progress and Deliverables

This last example (Exhibit 3.3.8.5) reveals that a site visit team discovered that achieving the centerâ€™s system-level goals would not be possible without further advances in component-level technologies. One element of the response was to continue bringing new faculty into the center to provide needed expertise. The earlier that monitoring of progress during implementation (a best practice) can identify shortfalls such as this, the earlier that corrective actions can be put into place.

EXHIBIT 3.3.8.5

- **System level goals are not possible without further advances in component level technologies, i.e. detectors, passive optics, integration, and thermal management;**

  We agree with the SVT's assessment of the need for advances in component level research; this is why an entire plane (the lowest one) of MIRTHE's strategic plan is dedicated to component development. We believe we have been able to demonstrate continued improvement in performance of our systems as individual component performance is enhanced. The QEPAS sensors are an example of an area where we are already making great strides towards our system level goals for medical and environmental applications. Nevertheless, it is clear there are fundamental technology barriers which must be overcome to achieve some of the particular proposed goals. One of our strategies to achieving this is continuing to bring new faculty into the center because of the need for expertise in specific areas (e.g. detectors) to meet system goals.

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