

# Lessons Learned from Implementing Experience Factories in Software Organizations

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## 1. Introduction

The Experience Factory (EF) [BCR94] approach defines a framework for experience management and emerged from 25 years of building learning organizations at the NASA Software Engineering Laboratory (SEL). This collaborative effort between the NASA Goddard Space Flight Center (GSFC), Computer Science Associates, and University of Maryland [Ba02] evolved into being at the forefront in software process improvement. The results were reflected in reduced project cost, decreased development defect rates, and increased reuse [Ba02] creating widespread interest in the EF. In this paper we briefly introduce some of the projects where we applied the Experience Factory approach; we present some concepts, methods, and tools that we have used, and some lessons that we learned. Due to the sensitiveness of describing details of clients' strategic programs, we focus the discussion on those experiences gained from applying the EF concepts to our own organization, as they are also applicable to other organizations.

## 2. Experience Factory Application

A sample of projects where we have applied the concept of the EF is presented below.

*Fraunhofer Center for Experimental Software Engineering Maryland (FC-MD)* studies and transfers technologies resulting from university research to other organizations (<http://fc-md.umd.edu>). We view each projects as an experiment in understanding under what circumstances a technology works. We have started a series of projects for experience management to tailor and implement the EF concepts to organizations' needs. For validation purposes, we have also applied them to FC-MD.

*The Center for Empirically Based Software Engineering (CeBASE)* is a project funded by the National Science Foundation involving universities, research institutes, and industry (<http://www.cebase.org/>). CeBASE accumulates empirical data and provides guidelines for selecting technologies, recommending areas for research, and supporting software engineering education. In working with CeBASE, we have developed techniques that can be applied to any community of interest.

*The Software Experience Center (SEC) Consortium*, is a joint project between the FC-MD and the Fraunhofer IESE. The goal is to improve the software competencies of member companies by sharing experiences on software technologies. Fraunhofer contributes expertise to help analyze, package, and disseminate experiences. The Consortium is composed of five international corporations with significant investments in software: ABB, Boeing, DaimlerChrysler, Motorola, and Nokia.

*The NASA Goddard Space Flight Center* embraced in 2002 the concept of knowledge management (KM). Due to commonalities between KM and EF, we started a project as a part of their center initiative. The goal was to characterize current knowledge management practices, knowledge needs, and to suggest a strategy for satisfying those needs. We performed a study for identifying the current situation of KM activities as well as strengths and weaknesses of their results.

From these, and other studies, we have come to the following conclusions:

1. The “right” knowledge for solving a problem often exists somewhere within an organization, but the problem is to allocate time to search for it, to identify it, to get access to it and to learn from it.
2. Most organizations try to manage experience, but it is not easy to do so in an effective manner. Experience management is often not well planned. It is often hard to capture and store experience, and also to identify how and where to find useful experience, and how to best utilize existing expertise.
3. Cultural issues, political decisions and security concerns are often as big obstacles as technology is an enabler.
4. In organizations that have the ambition to capture experience, the main challenge is to organize and disseminate this experience, in order to learn from successes and to avoid known mistakes.
5. The benefits of experience management are gained and become visible over a long period of time, but the organization also needs immediate results.

### 3. Applying EF to FC-MD

As the observations above also apply to FC-MD, we implemented our own EF to address these issues. The organization at the time when this work started was fairly small, all employees were geographically collocated, and it was possible to reach everybody in the organization. On the other hand, there was not much of organizational knowledge to formalize and not much of experience to capture yet. We thus needed to implement EMS on a smaller scale and in a more lightweight fashion, to capture not only experience gained by project teams, but also individual experience. The goal was not only to gain long-term benefits, but also to show immediate benefits. We wanted to capture knowledge and experience that occurred in the daily work place, not necessarily as part of a project. We will discuss a selected set of technologies that we found useful and easy to implement, and have been used in the projects listed above.

**Creating a culture of a learning organization.** Acknowledging that no innovation can be implemented in isolation, we started by growing a culture for a learning organization. The culture is based on a set of organizational core values: 1) In order to improve, employees need to learn from past experience, and in order for employees to learn, the organization needs to create a learning environment; 2) the characteristics of a learning environment are that it is allowed to make mistakes and learn from them; 3) experience is not hidden or traded, but given to the employee who needs it; 4) experience is not used to evaluate people, but to help them; 5) people are encouraged to share experience and help others and are rewarded based on how much they share;

learning and improvement only occurs in an environment where it is possible to get and give feedback about the outcome of various activities. The EF creates feedback loops on several levels; examples of feedback loops are an honest dialogue between employees in the organization. 6) work is iterated and improved in steps. These core values were used in many different ways, for example, in the process of interviewing prospective new employees, thus giving the organization a chance to state upfront what was expected from its employees. This gives candidates a chance to withdraw the application if the core values deviated from the person's own values. It was never the case that the prospective employee withdrew the application; rather the effect was the opposite, as they thought the core values were very appealing.

**Sharing experience through project presentations.** We believe that there is so much to learn from each project that a post-mortem at the end of the project is not enough. Instead, the project presentation is an event for sharing experience and is part of the regular project work. Presentations can be held for a specific project many times during its lifetime. This enables people within the project to act on experience while the project is still in progress, making the experience immediately useful. The project presentation is delivered by the project manager. It has two parts: 1) a project description and a status report; 2) learning through a structured brainstorming session. The project manager prepares this session around our main areas of learning:

- What have we learned about running projects?
- What personal expertise was gained?
- What was the impact of the project on our corporate core competencies?
- What new business opportunities are now available, due to this project?
- What can be packaged as a marketable service?

During the brainstorming session, the project manager makes suggestions for each learning area, then the audience brainstorms on what else was learned and how this new knowledge can be used in different ways and leveraged at the organizational level. The process is designed as a journey from the specific project to more general results that can become part of the corporate knowledge and develop into future services to better serve our customers.

A benefit of the project presentation is that it becomes an experience package right away and becomes part of our experience base. It has, for example, all the necessary information for a new employee to get up to speed on the project.

**Populating the Experience Base.** If potential users do not find the content of the Experience Base (EB) valuable enough, the EB would soon die. This is especially critical when setting up a new EB. It is a difficult problem: for being useful the EB needs to be populated, but few people want to contribute experience to a useless EB. In order to avoid this situation the EB needs to be useful even when it is almost empty. This problem led us to considering the Answer Garden approach [Ac90] that supports the EB with a network of organized experts, making it useful immediately. If the experience cannot be found in the EB, there are other ways to get an answer, for example by getting in contact with experts who possess the experience. Another benefit is that the approach lets the EB grow organically, where there is demand for experience. We implemented the ideas of the Answer Garden in several ways and defined an approach called "knowledge dust and knowledge pearls" that was added to the EF [Ba01]. A concrete implementation is our frequently asked question mechanism. Employees at FC-MD search for FAQs and if they cannot find what they are

looking for then they can post a new question. A topic expert answers the question and submits it to the EB. One of our most experienced employees in the Human Resource department resigned and we interviewed her to capture some of her experience before she left. The resulting FAQs made the EB much more attractive as it now encompasses knowledge difficult to find elsewhere. By conducting this activity we captured experience that we otherwise would have lost.

**Seeding the Experience Base with online discussions.** The eWorkshop is a low-cost conferencing media that allows for immediate and automatic capture and analysis of a discussion. We used this tool during eWorkshops on defect reduction [Sh02], COTS, and Agile Methods in the CeBASE project. We invited top experts from all over the world to discuss, corroborate or refute hypothesis related to these topic areas. During the eWorkshop, the participants discussed the subject under the guidance of a moderator. The discussion was analyzed and summarized in real time and participants immediately reviewed the conclusions. After the eWorkshop, the conclusions were further analyzed and submitted to the participants for review. The result was thereafter turned into experience packages submitted to the CeBASE software engineering experience base.

#### 4. Lessons learned

*Work on overcoming the cultural obstacles to sharing experience.* The success of an EF requires “everybody’s” involvement so you need to get people to use and contribute to it. Sharing environments can be created by defining and living by core values that promote sharing, by actively creating forum for people to share, and motivating sharing by providing incentives.

*Cater to the needs of the users,* so that the experience sharing is beneficial to its users and contributors. Also, sharing experience needs to be useful quickly. Few people have patience to wait for years to build enough experience for it to be useful; they crave immediate gratification to stay interested, which means that the EF needs to enable short- and long-term benefits.

*Advocate for the existence of an EF champion within the development organization,* who explicitly supports experience sharing. If that champion disappears, the program is likely to fail. The program also needs a “practical” champion, i.e. a person who constantly overlooks all the activities and experience bases and makes sure they develop in the right direction, often by this person’s own practical intervention.

*Leverage what people are already doing, don’t try to change everything at once.*

It is better to ask people to add a little piece of information at a time, so that you can analyze later, and to ask them to change step by step, to enable learning.

*Use the minds of new employees.* They come in with a fresh mind and see “holes” easiest. Employees who have been around for some time “learn to live” with obstacles, lack of information, and faulty processes. They learn to work around them, in order to get the work done. New employees do not know yet how to work around a broken system and can easily tell what needs to be done.

Lessons learned from the SEL EF [Ba02] are similar: 1) critical success factors were appropriate funding, buy-in from project management, and top management

support; 2) the improvement and learning process must be a part of the daily activities and of the culture; 3) the EF group must have frequent interactions with the development organization, must quickly respond to the needs and changes of the development organization, must balance the need between providing rapid feedback to developers and take time to analyze and package the experience, and has to establish the experience base as something tangible that can be seen and used.

## 5. Conclusions

Most challenges of implementing an EF are related to cultural issues. Without a culture that enables organizational experience sharing, learning will never happen on a large scale. It might happen in pockets of the organization, thanks to individual employees who see the direct need of improving the work situation, but in order for it to happen on a larger scale, the organization needs to change.

However, changing the culture is necessary, but not sufficient! There must also be support of various kinds. We must provide support for questions such as: what experiences are worth keeping, where are they kept, how are they accessed, how are they used, how are they changed, how are they managed?

## Bibliography

- [AM90] Ackerman, M. S., Malone, T.: Answer Garden: A tool for Growing Organizational Memory. In: Proc. Conference on Office Information Systems, COIS90, 1990; pp. 31-39.
- [Ba01] Basili, V. R., Costa, P., Lindvall, M., Mendonca, M., Seaman, C., Tesoriero, R., and Zelkowitz, M. V.: An Experience Management System for a Software Engineering Research Organization. In: Proc. The 26th Annual NASA Goddard Software Engineering Workshop, 2001.
- [Ba02] Basili, V. R., McGarry, F., Pajerski, R., and Zelkowitz, M. V.: Lessons learned from 25 years of process improvement: The rise and fall of the NASA Software Engineering Laboratory. In: Proc. 24th International Conference on Software Engineering (ICSE), 2002; 69-79.
- [BCR94] Basili, V. R., Caldiera, G., and Rombach, D. H.: The Experience Factory. In: Encyclopedia of Software Engineering - 2 Volume Set, 1994; pp. 469-476.
- [Sh02] Shull, F., Basili, V. R., Boehm, B., Brown, A. W., Costa, P., Lindvall, M., Port, D., Rus, I., Tesoriero, R., and Zelkowitz, M. V.: What We Have Learned About Fighting Defects. In: Proc. 8th International Software Metrics Symposium, 2002; 249-258.