Chapter 8

Case Study: Knowledge Harvesting During the Big Crew Change

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Many companies face a historical difficulty in their workforce age demographics. As increasing numbers of senior employees edge closer to retirement, new employees are recruited to fill their places. The loss of experienced personnel combined with the influx of young employees is creating unprecedented knowledge retention and transfer problems that threaten companies' capabilities for operational excellence, growth, and innovation. We need to exploit practical, effective retention and transfer processes and tools to minimize business disruption and accelerate competency development.

A few years ago, in a discussion of critical issues facing the oil industry, Chevron's CEO Dave O'Reilly outlined the following goal for global talent management:

> We will no longer be talking about the big crew change. We will have taken the steps needed to ensure that a trained, global workforce and a pipeline of future leaders are in place.

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In this chapter, we present a high-level description of how Chevron is turning talk into action, particularly highlighting a new tool in our knowledge retention arsenal: knowledge harvesting.

8.1 Business Case

The impending crew change was first brought to the attention of the oil industry more than 20 years ago. Our challenging business presents many possible career opportunities to motivated employees, and most individuals are satisfied pursuing a career within Chevron. The major source of attrition, therefore, is retirement rather than leaving to work for other companies. As a result, our hiring rate resembles a sine wave; we hire a large number of people every 20 to 30 years, they enjoy a rewarding career, and then we bring on the next crew.

So why are we, like many other industries, not better prepared for changing age demographics? One reason is the huge generation of baby boomers making way for the much smaller group of GenXers. In addition, the oil business has changed significantly in the last 20 years. Organizations downsized during the 1980s and 1990s as the economy slowed and technology increased personnel efficiency. This downsizing reduced our bench strength and limited the time available for mentoring by senior staff. The number of graduates with earth science and geophysics degrees dropped as other disciplines gained popularity. As a result, today's hiring cycle is vastly different from what current leaders and supervisors experienced when they were hired.

The following scenarios illustrate some increasingly common knowledge retention challenges:

- Key experts will retire in the next few years, sometimes without skilled replacements ready to take over their responsibilities.
- Critical knowledge and experience is at risk when experts transfer or retire, and there is insufficient time, staff or budget to reinvent it.
- Critical processes are difficult to document since they require considerable experience to run safely and efficiently.
- A large number of newly hired employees need accelerated competency development.
- Successors inherit cabinets full of files from people who have left the organization; however, the inheritors receive no explanation of their value and have little opportunity to rediscover their importance.

An experienced workforce is essential to delivering the organizational capability to operate and expand any business. However, the way we work has evolved, and we must account for this shift in our training and knowledge retention methods. Gone are the days when work could be portioned into individual assignments. Today, we

rely on multidisciplinary project teams and integrated processes or supply chains to accomplish most of our results. Professionals and managers have a deep (but often narrow) knowledge of complex technical and political systems. They rely on relationships with colleagues for the knowledge necessary to accomplish their tasks.

Modern industry's wide distribution of expertise requires a more sophisticated approach to capturing, documenting, and sharing knowledge. If companies fail to address these new approaches to analysis and networking, knowledge drain will create significant business disruption.

8.2   The Learning Life Cycle

Knowledge and experience gained by an expert throughout his or her career is extremely intricate and difficult to distill. Therefore, retention efforts should not be exclusively focused on end-of-career events. Business divisions and corporate human resource or workforce development groups should collaborate in creating an employee learning life cycle that spans the entire career. Chevron informally connects many of such knowledge retention processes as part of employee learning and development.

New hires benefit greatly from on-boarding processes that introduce them to their work and help them begin to form their personal networks. Chevron has created early career-focused learning processes ("Horizons") in a number of disciplines such as earth science, petroleum engineering, and information technology. As part of the annual performance planning process, each employee develops a personal learning action plan directed toward specific competencies. Belonging to a community of practice (CoP) in your discipline is a good way to learn from colleagues to solve day-to-day problems or to tap into documented expertise such as best practices, tools, and career development roadmaps with relevant training resources. No matter what your discipline, the best way to learn is by doing—gaining experience through a series of project assignments.

Subject matter experts (SMEs) play a prominent role later in their careers as coaches or mentors. They may also develop personal work profiles to help identify the critical at-risk expertise that should be captured and transferred to newer crews. In some cases, the life cycle of the SME extends into retirement, when a former employee may return to work on specific project assignments or serve as a mentor.

8.3   Knowledge Retention and Transfer Processes

The goal of knowledge retention is first to identify the critical skills, experience, and relationships that are at risk when experts retire or transfer, and second to ensure that younger employees who assume subject matter experts' (SMEs') responsibilities acquire the know-how necessary for continuing success. Many companies possess

Table 8.1   Knowledge Retention Processes and Tools

Nature of Expertise	Competent Performers		Experts	
	Weeks	Months, Years	Weeks	Months, Years
Explicit	Documentation, Interviews	Best-Practices, Training Courses, Embed in Processes and Tools	Not applicable. Expertise is developed over years of hands-on practice.	
Tacit	Outsource, Retiree Program, Knowledge Harvesting	Communities of Practice, Mentor/Coach, Knowledge Harvesting, Peer Reviews, Expert Systems, Job Shadowing, Rotational Assignments	Outsource, Retiree Program, Knowledge Harvesting	Mentor/Coach

knowledge management strategies. Considering their business goals, they deploy processes or tools such as communities of practice (CoPs), best-practice repositories, or after-action reviews. These processes are easily adaptable for retention and transfer.

Not all processes are equally useful for a particular expert or discipline. We have developed a matrix (Table 8.1) that organizes processes and tools in three dimensions: competency goal (competent or expert), time available (weeks or months to years), and the nature of the expertise (explicit or tacit).

The following offers additional explanation of the knowledge retention toolset.

- *Competency*: The greatest impact to a business comes from accelerating the development of new hires to enable them to perform competently with minimal support. However, companies cannot ignore the need to maintain a smaller group of experts that maintain a competitive edge in a technical discipline. Studies have shown that it can take at least 7 to 10 years of concentrated study and practice to become an expert. It may require decades to reach world-class capability. The quest for expertise needs conscious and continuous nurturing.
- *Time Available*: Has your key expert given a 2-month retirement notice, or can you plan for a deliberate, complete transfer of knowledge?

◼ *Nature of Expertise*: Knowledge gained through years of experience (tacit) can be hard for an expert to articulate.

8.4 The Role of Knowledge Harvesting

Most of Chevron's knowledge retention processes are results of past knowledge management initiatives. Our biggest shortcoming was in the area of capturing vital expertise in a short timeframe, typically just before retirement. This need is addressed by knowledge harvesting.

Knowledge harvesting is one component of an overall knowledge management program, which in turn is one part of a set of processes related to organizational improvement. The following figure depicts the interrelationships.

Most experts have great difficulty articulating precisely how they produce complex work results. They have internalized their analytical approach over many years and tend to automatically respond to unique situations in nontransparent ways. To help experts make their expertise more explicit, Chevron evaluated and adopted a mature, proven interview-based process developed by Knowledge Harvesting Inc.

One prominent aspect of knowledge harvesting is a collection of methods for eliciting information about four types of knowledge: declarative knowledge, procedural knowledge, contextual knowledge, and social knowledge. Each type of knowledge is associated with a type of information (Table 8.2).

Following is a brief description of the stages of the knowledge harvesting methodology.

1. Focus helps you identify the knowledge in your organization that is most urgent and important to capture. It is important to understand the breadth of the work as well as the organization's priorities.
2. The Find stage provides guidance on locating experts and existing support information. Documents are studied. Excerpts are gathered.
3. Elicit shows you how to conduct effective harvesting sessions. The goal is to carry out effective interviews with the subject matter experts.

Table 8.2 Types of Knowledge and Information

Type of Knowledge	Information Harvested	Value, Use
Contextual knowledge	Signals	"Knowing when, knowing why"
Declarative knowledge	Support information	"Knowing about"
Procedural knowledge	Guidance	"How to"
Social knowledge	Collaborative norms	"Knowing how to work with others"

4. Organize instructs you on how to make sense of the information collected through interviews and documents. In this stage, identify patterns and organize the knowledge into logical groups of signals, support information, and guidance.

5. During the Package stage, you determine the best vehicle for packaging the knowledge so that it can be transferred to others. Determine how best to apply the know-how. If working with a retiring worker, often the packaging stage results in a living system which offers guidance, structure, and a living resource for present and future performance support.

6. Evaluate provides tools and guidance for measuring the effectiveness, efficiency, and adaptability of the knowledge assets or living system.

7. Adapt provides tools and guidance for adapting harvesting results to better meet the emerging needs of target learners.

8.5 Case Study: Capturing and Transferring a Complex Technical Process

One Chevron business unit faced an increasingly common challenge: the average age of its technical staff was well over 50 years. Many were nearing retirement, and few new employees were ready to take their place. Dave, a chemist responsible for analyzing fuel product quality, had announced plans to retire in a few months. He played a key role in support of refining, marketing, and supply/trading business units. While several other members of the technical staff were familiar with his analytic methods, they lacked his more than 20 years of experience in fine-tuning the method, creating numerous reports that extracted and formatted key information relevant to specific requests, and learning how to recognize and interpret patterns in complex analytical results.

The Knowledge Harvesting project began by developing Dave's work profile. This high-level summary helps Dave and his stakeholders prioritize the unique, critical results that will be at risk when he retires. The contents of a complete work profile are shown in Table 8.3.

The following sections describe key aspects of the knowledge harvesting work that we accomplished with Dave.

8.5.1 Focus

The expert's major deliverables are a good place to initiate the Focus stage of knowledge harvesting. We assembled a fairly complete list of Dave's deliverables using his most recent annual performance plan and several project plans. We then asked Dave's key stakeholders (customers, colleagues, and managers) to select the work results that matter most to their business. We identified three critical knowledge areas:

Table 8.3   Contents of a Work Profile

Work Profile Content	Description
Deliverables ("results")	What are your major work results (products, services, and expertise)?
Key stakeholders	Who are your customers and other stakeholders?
Suppliers and personal network	Who helps you get your job done and what do they provide?
Tools and information resources	What resources are required to help you accomplish your work?
Projects	What are your major projects?
List of work process and subprocesses	Map out your work processes and subprocesses. What is your role?
List of safety issues	What safety practices or procedures are relevant to your work?

1. Product quality and performance evaluation.
2. Purchased fuel qualification.
3. Refinery processing effects on hydrocarbon stream.

As the critical knowledge areas were identified, we aligned them with the business' goals, pertinent operating as well as support processes, and performance indicators.

8.5.2   Find

Harvesters must be skilled at asking good questions, because they typically do not have in-depth understanding of the expert's domain. During the Find stage, the expert is asked to provide background information to help the interviewer grasp key concepts. Dave provided examples of recent analytical reports matching the critical knowledge areas. Dave's documentation was used to produce a hypothesized list of his thinking processes as well as ideas for how to embed the knowledge into work processes.

From this information, a starter set of interview questions were developed for the Elicit stage of the process. Table 8.4 gives a few examples of questions.

8.5.3   Elicit

The core strength of the harvesting process lies in helping the expert articulate how good work results are produced. During a week-long engagement, we asked Dave

Table 8.4   Examples of Interview Questions

Orientation	Examples of Questions
General questions	What knowledge do you think is most likely to vanish when you retire? What is unique about your background compared to other employees in positions like yours? What are some key lessons you have learned? Any illustrative stories to tell? For those key projects in your career, which ones were successes and why, in your opinion? Which ones were failures and why?
Technically oriented questions	What are the common problems? How do patterns differ between common and unusual or rare problems? Are there other signals you look for to help interpret the data? How do you know when the results are suspect? Are there any special techniques for streamlining the process? How do you use knowledge of manufacturing processes and product specifications to help troubleshoot quality and performance problems?
Questions about target learners	What suggestions do you have to facilitate the transition to new employees? When you started in this position, what do you wish you had been told?

to walk through a number of customer requests. Rather than simply capturing how he worked, we sought Dave's explicit guidance about the details of his thinking and decision making. In particular, we captured information about why certain steps were important and what signals indicated when and how to act.

We quickly recognized one central element for much of his work—his hydrocarbon analytical method. He would ask the customer a set of framing questions designed to illuminate particular characteristics of the fuel sample (for example, grade and source) and available information about the refinery processing used in its manufacture. This information helped him to select the appropriate analytical reports to run. Armed with the necessary knowledge, Dave was then able to look for specific patterns in spreadsheet reports that would create an accurate representation of the complex hydrocarbon mixture present in the sample. Considering the composition of the mixture, Dave was able to explain current quality and performance problems as well as predict future ones.

An understanding of an SME's work may need to include components of which the expert is not even aware. Several days into the interviews, we asked Dave to

review a six-step process that we constructed. He rejected it; he said that the process we had described did not properly represent his methods. Instead of carefully following all the steps we had identified, he consciously thought through the first few steps, generated the required data and jumped directly to the interpretation. Over his 20 years' experience he had internalized so much of his thinking that he could easily recognize patterns and associate them with problems he had worked on before.

However, when we asked Dave to work through several new examples using our elicited process, he found that it captured his mental model quite accurately. He was able to expand some of the alternatives in the initial process steps to cover problem areas that we had not previously discussed. We then shared the process with a few peers and two technicians, who commented that the captured process helped them better to understand their work.

Sometimes a variety of media can prove useful in eliciting and transferring appropriate knowledge. In our experience (and that of many colleagues), videotapes of interview sessions typically fail to add significant value for new learners; video documentation is more difficult to catalog and search. In Dave's case, however, we found a very useful video approach.

While discussing Dave's process for analyzing data, we watched him navigate through spreadsheets to reveal how the relative values of columns of numbers corresponded to specific types of hydrocarbons in the sample. We found it extremely useful to record Dave reviewing his analysis of the spreadsheets using screen capture software. The resulting set of 5-minute vignettes was immensely effective; even the experienced technicians were able to gain significant insight into the data they produced. Finally, Dave's replacement found these videos invaluable to his competency development.

A mental model which entails complex thinking processes is a common characteristic of deep expertise. It explains why an expert may find it so difficult to share the work process, and why newer employees often struggle to develop competency. Once the thinking process has been converted to an explicit approach, it becomes a practical learning aid. This method is the end goal of knowledge harvesting. A new hire will not become a competent performer overnight. The mental model has distilled the expert's years of experience into a framework that the successor can use better to organize each new work request and, through experience, accelerate the ability to associate patterns, decisions, and interpretations.

8.5.4   Organize, Package

The most labor-intensive part of the process includes transcribing the interviews and reviewing documents provided by the expert. The harvester assembles the content in a context that aligns with the needs of the target learners. One must explore several key categories of knowledge assets. First is documentation about the work results.

This includes step-by-step guidance covering the what, how, when, and why. We also identify the expert's personal network, including customers and their typical requests, as well as other internal or external experts that can provide key information outside the expert's discipline.

Examples of deliverables created during this project are listed below. Having this information will clearly facilitate turnover, especially when the expert is no longer available.

■ Work profile which details key job responsibilities, project summaries, categorized list of customer requests, and a list of upcoming projects with succinct explanations and a quarter-by-quarter schedule for the next few years

■ "Living system" of learning and performance-support resources with in-depth analysis and interpretation of hydrocarbon composition data (including video), procedures for handling common requests (e.g., sample collection and characterization), and a systematic analytical approach

■ Model depicting the interrelationships among the variables of hydrocarbon analyses

■ Explicit links between projects, work results, customers/suppliers/experts, and tools

■ Cross-company/functional view of activities and decisions that occur over the life of a fuel sample including important resources, key contacts (personal network), analytical process documentation, and a catalog of useful information resources

8.5.5   Expert's Review and Comments

The contributing expert's verbatim comments were as follows:

■ *This would not have worked if I was asked to write this up without the interviewer. He enabled me to just sit and talk. I didn't have to figure it out. His probing questions were essential in helping me come up with relevant examples and explanations. A form or template wouldn't have helped much.*

■ *We covered the whole scope of what I do that is uniquely mine as a fuel chemist and how I operate within the framework my business unit and with our customers. This exceeded my expectations.*

■ *It was helpful that in the past we were encouraged to write up and regularly review project statements. This was good background for my work profile. The overall knowledge capture we did covers not only the high-level context of my work but also low-level details of how to do it.*

■ *The videos were very powerful. I've been asked to write down my thought process and how I synthesize my responses and guidance as I analyze a hydrocarbon*

analysis report. The screen capture tool allowed me to do this in a very short time. I couldn't have done it any other way.

■ *One shortcoming is the short timeframe. This knowledge asset will need to be edited, validated and extended and will improve when allowed to mature with use by my successor.*

8.5.6   Peers' and Stakeholders' Evaluation and Comments

The expert's peers and stakeholders evaluated the knowledge harvesting deliverables and offered these comments:

■ *This will be a big help to enable us to create an initial assessment for the customers. The videos are particularly useful. In reviewing the work I concentrated on the value for newcomers. Would the language be understandable? I found that you don't need to be a Ph.D. to understand the documents; they were very clear. (Technician)*

■ *It is a little like taking a college course. But in this case, I am applying it directly to my job. (Technician)*

■ *The overall package looks like a very powerful approach. It is important to have the replacement available for some overlapping period to ensure continuity of the work (Note: In this case, we did not have that opportunity to include the replacement in the knowledge harvesting interviews). Dave's work is detailed and subtle. It may take a year to get the new person adequately up-to-speed. (Supervisor)*

■ *It is valuable to have the new protégé participate in the harvesting process. This significantly accelerates associated mentoring. The protégé picks up the ability to ask good questions. (Knowledge Harvesting Interviewer)*

■ *I was skeptical about the value of this project. That they were able to get to the heart of the systematic analytical approach is fantastic and exceeded my expectations. I'm impressed with what has been developed in the short amount of time. (Manager)*

■ *This won't teach someone to be Dave. There are still many intangible nuances that he has developed over years of experience; these are the hardest, perhaps impossible, things to transfer. In terms of the fundamentals, it looks like we have something very valuable. We need to consider this for future opportunities. (Manager)*

■ *Utterly invaluable. (Dave's successor, hired several months after Dave retired)*

8.6   Chevron's Experience with Knowledge Harvesting

Chevron's experience with knowledge harvesting began in 2006. The following sections offer information about our lessons learned as well as the value achieved.

8.6.1   Lessons Learned

Table 8.5 lists Chevron's observations about knowledge harvesting.

8.6.2   Knowledge Harvesting—A Useful Addition to Chevron's Knowledge Retention Toolkit

Business-critical knowledge ranges from well-documented practices to hard-to-articulate experience. New employees also have differing preferences in their styles

Table 8.5   Chevron's Observations about Knowledge Harvesting

Observation	Description
Expert's attitude	The expert needs to be interested in sharing expertise and have patience when dealing with the interviewer's questions. We have found that most experts are genuinely engaged by the process.
Expert's preparation	Experts who have good job documentation practices can significantly facilitate the work.
At-risk expertise	We have captured experts' systems thinking (mental models) as well as detailed guidance based on signals that trigger experts' decision making. This information goes beyond what is typically captured in knowledge documentation, and its complexity requires a skilled interviewer. In particular, knowledge harvesting works effectively with complex knowledge and should be considered for SMEs who possess critical at-risk expertise.
Focus	Having a neutral third party familiar with the business and the technical domain will help make sure the elicitation is focused on the most vital topics.
Interviewer's persistence	Continued probing to get more details and examples on how and why certain complex thinking tasks were accomplished resulted in valuable information.
Interviewer's assimilation time	Understanding the constructs and jargon of a new discipline takes time. This may not fully occur until after interviews are completed. In some situations, spreading interviews over several weeks or months may help with awareness and allow subsequent interview sessions to probe deeper into the subject matter.
Capture tools	On-screen videos with voice-over is another effective capture tool to use when an expert should provide explanations of how certain information tools fit into everyday workflow.

of learning. There is no one-size-fits-all knowledge retention solution; a variety of methods will be necessary to educate the next generation of Chevron employees. A good set of processes and the appropriate guidance for when to use them is an important management resource.

Two reasons explain why knowledge harvesting is becoming an important part of our toolkit. One reason is time: the number of SME retirements will escalate over the next few years, and our existing transfer tools are not well-adapted to short turnover cycles. A more important reason is the end result: the distillation of years of expertise into a learning framework that helps new practitioners think through their work and more quickly identify patterns and associated interpretations and decisions.

This knowledge transfer process does not scale very well. Knowledge harvesting is an intricate process and is not appropriate for every employee. Managers typically know which individuals have critical expertise. Knowledge harvesting engagements should focus on these experts who contribute to operational effectiveness.

There are however two harvesting tools which can be implemented broadly without requiring extensive knowledge transfer skills:

- Asking good questions is a teachable but overlooked capability. It can improve knowledge transfer in mentoring engagements.
- Work profiling can be broadly applied throughout the organization. Work profiles provide an excellent focal point for discussions which occur during planned job turnover.

A full suite of knowledge retention processes coupled with the leadership vision to know where and when to use them will help Chevron minimize business disruption and maximize competency development in the years ahead. Making expert thinking visible benefits all employees, not just the "next crew." Competency and solid, risk-based decision making are critical to performing safely and with excellence.