LMBE STRATEGIC WORKFORCE SUCCESSION PLANNING

by

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Abstract

The Lower Mainland Biomedical Engineering department (LMBE) has been the largest biomedical engineering department in Canada since the consolidation of the four Health Authority (HA) in-house biomedical engineering departments. It provides knowledge-based services one of which is the maintenance management of medical device used on patients. Its human capital or workforce, with its technology expertise, is their key resource in achieving operational goals.

In the next few years, the LMBE department will face loss of talent and expertise as some of its 184 employees will retire and leave the organization. The department wants to find out how significant these replacement needs may become and how they could impact and affect its operations. LMBE hopes to get a clear picture of the issue, making sure that the properly qualified employees are prepared and in place for their assignments.

This analysis outlines the opportunities for the LMBE to develop a sustainable business advantage through improved planning, development and usage of HR management. An internal strategic analysis of its resources and capabilities serves as background information leading onto the recommendations and plans.

The recommendations are 1) focused training based on expected retirement forecasts or 2) reorganization of the LMBE plus training or 3) a combination of both. In the first option, a detailed training plan for the first two years is done with the number, length, and cost of training needed. It represents a short-term solution. The second option is a longer term recommendation which will require a more detailed implementation plan with associated costs involved. This solution is recommended but the implementation plan is deferred until it is approved. The third option is a combination of both first and second options.

Executive Summary

Due to the aging workforce, the LMBE faces a severe loss of talent within the next 5 to 10 years. Currently 35% of the 184 employees are over the age of 50 and in 10 years' time, 39% of the employees are projected to retire. The retirement estimate is based on age plus number of years of service, in conjunction with best estimates as a result of personal interviews with stakeholders.

At the moment, there is no formalized workforce succession planning in the department or anywhere in the field of Biomedical Engineering and this project was started in order to establish the process. Using human resources management theory, resource-based view strategic theory and Strengths Weaknesses Opportunities Threats (SWOT) analysis, three recommendations are presented.

The "focused training based on expected retirement forecasts" recommendation is the first option. In this recommendation, the skill sets of the Biomedical Engineering Technologists (BMETs) and supervisors are categorized into 27 distinct categories that absolutely need factory level service training. Then on a year by year basis, the number of skill sets that are lost due to anticipated retirement is tabulated. Based on that, a detailed recommendation plan for the first two years, 2012 and 2013, is presented.

The second option is the "reorganization of the LMBE plus training" recommendation. It is more difficult and time-consuming to implement and has higher upfront costs. However it will produce a long term solution to the succession planning process.

According to the findings, the 39% retiring employees, representing 72 people, will take away 20 sets of Leadership Management skills, 15 sets of Hemodialysis expertise, plus 20 or more Anesthesia and Ventilator expertise skill sets. These represent the most severe loss of areas of expertise. Other areas of expertise that will also have a significant loss include the Hyperbaric Unit, Laser, and X-ray skill sets. In addition, Provincial Health Services Authority (PHSA) – Children's and Women's (C&W) team will also have a significant 82% loss of BMETs.

In establishing the recommendations for hiring for replacements, Biomedical Engineering performance benchmarks and workforce succession benchmarks are consulted. It is shown that LMBE in general operates at a very lean level. LMBE is below the industry level in terms of number of devices / Full Time Equivalent (FTE) and number of beds / FTE. With these in mind, it is recommended that the

number of FTE as well as the amount of training to be provided to both new FTE's and retiree replacements both be increased.

The recommendations plan also has an in-depth two year training cost and time-line plan with a worksheet that will need to be updated on a yearly basis with new training and employee hires. The process plan goes into detail on the steps involved with developing talent and promoting staff from within.

When recommending the training and succession process, careful thought is placed on the next generation Y's attitudes and work habits. Due to this changing pattern, the succession planning process becomes a complicated and difficult thing to do. Not all young workers stay and work until their retirement. Retaining talent and youth within the company has been tougher. One of the recommendations takes a twist in the traditional sense by suggesting flexible work sites to provide younger workers with interesting alternatives, work-life balance and incentives to stay. In addition, it is highly recommended that LMBE management provide growth opportunities such as job specific learning opportunities and mentoring programs for the next generation.

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Table of Contents

List of Figures

List of Tables

Glossary

BCCA	BC Cancer Agency
BME	Biomedical Engineering
BMET	Biomedical Engineering Technologist, Biomed
C&W	Children's & Women's Hospital
DI	Diagnostic Imaging
ECRI	Emergency Care Research Institute – a US based non-profit medical technology resource organization
F&P	Facilities & Planning
FH	Fraser Health
FHA	Fraser Health Authority
HA	Health Authority
HEU	Hospital Employees' Union
HAS	Health Services Association
HSDA	Health Service Delivery Area
IMIS	Information Management & Information Systems
LMBE	Lower Mainland Biomedical Engineering
MOF	Ministry of Finance
MOH	Ministry of Health
MOU	Memorandum of Understanding
PHC	Providence Health Care
PHSA	Provincial Health Services Authority
QoS	Quality of Service, including Response Times, Uptimes, Downtimes, On-call, Overtime, Status Reports, Quality of Work, etc
R&D	Research & Development
SLA	Service Level Agreement
SPD	Sterile Processing Department
HSSBC	Health Shared Services British Columbia
VCHA	Vancouver Coastal Health Authority

1. Introduction

1.1. Background

The Lower Mainland Biomedical Engineering (LMBE) department is a government funded non-profit organization within the greater public healthcare organization. It was formed in late 2009 and merged from four Biomedical Engineering departments in the Lower Mainland, which used to be within Fraser Health (FH), Provincial Health Services Authority (PHSA), Providence Healthcare (PHC), and Vancouver Coastal Health (VCH) authorities.

The newly formed LMBE looks after healthcare technology management, providing a wide range of technical and engineering expertise. From repairing and servicing devices to planning and implementing new technologies, it serves three BC Health Authorities and one faith-based organization spread out over a large geographic area. Now it is looking into planning its labour workforce for the next five to ten years.

Biomedical Engineering is the application of engineering principles and design concepts to medicine and biology. This field seeks to close the gap between engineering and medicine. It combines the design and problem solving skills of engineering with medical and biological sciences to improve healthcare, monitoring, and therapy. Most acute care and tertiary hospitals have an in-house Biomedical Engineering department that looks after the actual implementation of medical equipment and technologies in hospitals.

Compared to many other engineering fields, Biomedical Engineering has only recently emerged as its own discipline. Regulatory issues are of particular concern to a biomedical engineer, as it is among the most heavily regulated fields of engineering. As such, the repair and maintenance of this area of medical device falls under the realm of biomedical engineering technologists (BMET). The FDA is the principal healthcare regulatory authority in the US, whereas Health Canada approval is what all devices being used in Canada have to go through. As a result, biomedical engineers and BMETs must routinely consult and cooperate with regulatory law and other experts to have their stamp of approvals before releasing a piece of medical equipment for patient use in a hospital.

The LMBE department is run by Biomedical Engineers, BMETs, and administrative staff. Biomedical engineers are highly educated professionals who often hold a Master's (M.S., or M.Eng.) or a Doctoral (Ph.D.) degree in BME or another branch of engineering with considerable potential for BME

overlap. As interest in BME is increasing, many technical colleges now have two year diploma programs that graduate BMETs. These are the "bench" technologists that make up the bulk of the workforce of the LMBE department. The administrative workforce that looks after the clerical duties of the department do not have college degree requirements, however, a few of the admin staff hold Bachelor's degrees as well.

Biomedical Engineering, along with Information Management & Information Systems (IMIS) and Facilities & Planning (F&P), is one of the three cornerstone services that provide all the Lower Mainland hospitals with its technology expertise. Together, these departments hold the key expertise and resources to manage and plan technology in health care. The Lower Mainland hospitals that have Biomedical Engineering departments are in the Health Authority (HA): Vancouver Coastal Health (VCH), Fraser Health (FH), Provincial Health Services Authority (PHSA), and faith-based health care organization Providence Healthcare (PHC). Each of these entities has many smaller hospitals within. For example, VCH has Richmond Hospital (RH), UBC Hospital (UBC), and Lion's Gate Hospital (LGH). Regardless of which HA or which smaller hospitals the LMBE looks after, there are lots of beds and with these beds come the devices that are used on patients.

The following lists the health care entities in terms of population served, number of sites, approximate number of beds, and number of LMBE staff.

Table 1: Number of sites of the 4 HA's

		VCH			FH			PHC			PHSA		LMBE
Population Served		1.1M			1.5M								2.6M
# Hospitals		9			13			7			1		30
	Hospital	*# Beds*	*City*	*Hospital*	*# Beds*	*City*	*Hospital*	*# Beds*	*City*	*Hospital*	*# Beds*	*City*	
	1) Bella Coola	*16*	*Bella Coola*	*• Abbotsford Regio*	*300*	*Abbotsford*	*• Holy Family*	*76*	*Vancouver*	*• BC Children's*	*142*	*Vancouver*	
	2) Lions Gate	*335*	*North Vancou*	*• Burnaby*	*309*	*Burnaby*	*• Mount Saint Jose*	*240*	*Vancouver*				
	3) Powell River	*33*	*Powell River*	*• Chilliwack Gener*	*104*	*Chilliwack*	*• St. Paul's*	*500*	*Vancouver*				
	4) Richmond	*175*	*Richmond*	*• Delta*	*38*	*Delta*	*• Brock Farhni*		*Vancouver*				
	5) RW Large M	*9*	*Bella Bella*	*• Eagle Ridge*	*102*	*Port Moody*	*• Youville*		*Vancouver*				
	6) Squamish Ge	*25*	*Squamish*	*• Fraser Canyon*	*10*	*Hope*	*• St. Vincent's Sites*		*Vancouver*				
	7) St. Mary's	*32*	*Sechelt*	*• Langley Memorial*	*166*	*Langley*	*• Marion Hospice*		*Vancouver*				
	8) UBC	*143*	*Vancouver*	*• Mission Memorial*	*20*	*Mission*							
	9) VGH	*990*	*Vancouver*	*• MSA General*	*202*	*Abbotsford*							
				• Peace Arch	*475*	*White Rock*							
				• Ridge Meadows	*125*	*Maple Ridge*							
				• Royal Columbian	*402*	*New Westminster*							
				• Surrey Memorial	*370*	*Surrey*							
Approx # beds	9,000			9,825			1,483			500			
Approx # equipment	25,473			33,497			6,868			14,727			
Geographical a	58,560 km^2			>60,000 km^2			Hard to reach			Smallest			
# techs	64			66			17			11			
# sites	10			21			7			1			
Skills	HBU			Lots of Generalists			HU, Per			Lots of specialists			
Highlights	R&D			Modality based			Heart transplants, huge renal			Laboratory equipment. 2			

The inventory of equipment looked after by LMBE is being captured in the Computerized Maintenance Management System (CMMS). LMBE gets its budget of $27 million through the HA which is funded through the Ministry of Health. The LMBE department's Executive Director and three Directors seek to consolidate medical device management and standardize organizational structure, including personnel management. The redesigned LMBE organization will provide the opportunity to realize economies of scale, increase efficiency in the delivery of service and most importantly, increase patient safety.

The LMBE organization plays a key role in maintenance management of equipment used in the hospitals. Every business needs equipment to deliver its outputs and hospitals are the same. Equipment is an asset that is critical for business activities. The workforce that looks after the equipment is also an asset that is crucial for business success. Thus LMBE plays an important role in the hospital system to ensure that enough people are dedicated to the role of equipment maintenance. Not only does equipment maintenance fall under the umbrella of LMBE, but so does planning for new capital acquisition of equipment, acting as a technology resource, and the overall implementation of the equipment through its

entire life cycle from purchasing to usage to disposition stage. Workforce planning of the LMBE is therefore very important in the sense that we need a huge number of both tangible and intangible, such as knowledge, assets in order to ensure the delivery of service to patients.

1.2. Purpose of this Strategic Analysis

We will first conduct a Strategic Analysis of the LMBE organisation using the resource-based theory - identifying core competencies of the individuals. Then in order to assess the strategic "fit" or "unfit" of our employees to the organisation, we will do a SWOT analysis of the LMBE, comparing it to its strategic operational goals and looking at outside Benchmarks in terms of both work and process of workforce planning. Finally, we will recommend and implement a plan for workforce succession.

As mentioned in the previous section, due to the high degree of education and knowledge acquired by the biomedical engineers and BMETs in the LMBE organization, there has been considerable concern over what will happen when the workforce expertise leaves due to retirement. Retirement is being targeted as a focus due to the fact that historically, the turnover rates in the biomedical engineering departments are low as it is a highly unionized industry. Most people work until they retire in the hospital environment. In the last 3 years, there has been a gradual increase in the number of biomeds retiring in each of the HA organizations. Below is the average age of biomeds in the lower mainland hospitals. It is a projection of the aging population based on birthdates. The maximum projected year is 2021. It is noted that any Biomed can choose to retire as soon as they reach the age of 60. In BC, there is no restriction on how long a Biomed can continue to work after 60 as long as age does not impede the regular job duties.

Figure 1 Aging Biomed population in lower mainland BC

While this project seeks to provide a framework for decision making when identifying and assessing knowledge and expertise that will need to be replaced, it will also align with the Strategic Operational Plan (or goals) of the LMBE organization defined in Section 2.3. The objectives are to ensure that proper staffing management is being achieved and opportunities for growth are provided. Both short-term and long-term workforce needs will be addressed and presented in the succession plan.

The project also aims to identify the risks going forward and to prepare the LMBE department for the challenges and opportunities associated with talent departure. It will ensure that the department has qualified employees ready to fill those positions when a vacancy occurs. LMBE's ultimate goal is to move away from a reactive practice to a proactive system.

1.3. Importance of this Project

The importance of a Workforce Succession Planning project is that it:

- Enables the organization to assess its talent needs by establishing competency models or job descriptions
- Allows leaders to identify and tap in key people who are available to fill critical work functions
- Provides avenues for how to develop talent and potential
- Defines career pathways through an organization and ensures a more focused development
- Provides for higher return on investment from employees
- Encourages and manages cultural change and diversity
- Increases commitment and loyalty
- Moves towards becoming a learning organization
- Leads to the appropriate promotion and pre-selection of people to meet organizational goals

1.4. Research Overview

The research methods involve a series of collection of considerable amounts of information from databases, research, and direct sources. The main research is through fact-finding interviews with key stakeholders, supervisors, and directors. The interviews outline workforce operational needs, identifying what succession plans (i.e. development programs) and what gaps currently exist. They also identify the key resources and competencies held by the individuals who will retire. Through online research on best practices around the region, certain benchmarking processes are determined. The research results are used to find out what succession planning practices are used in the biomedical industry as well as other industries. From there, a 5 year and 10 year Training Plan is also recommended for the organization.

2. Internal Analysis (WHO, WHAT, WHERE)

(Rothwell, 2010) describes succession planning as a process of identifying a particular successor for a post and succession management covers a broader set of activities which ensures a suitable supply of successors for key positions. This paper will first adopt the Resource-Based View of business strategy to look at workforce planning. The resource-based view focuses on the internal resources of the organization and how they contribute to competitive advantage. Then we will proceed to using the Competence-Based View to assess the organization's core competencies. Finally we will discuss the theory of Human Resource Management (HRM) and how it helps an organization meet its strategic goals by attracting and maintaining employees while managing them effectively.

LMBE currently does not have any succession planning in place. Almost all of the interviewees have expressed the need to have some form of workforce planning in order to ensure performance of the organization. An HRM strategy typically consists of the following factors:

- "Best fit" and "best practice"
- Close co-operation between HR and the top/senior management
- Continual monitoring of the strategy, via employee feedback, surveys, etc.

We will first need to find out 1) where the people are, 2) who they are, 3) what kind of expertise they have, and 4) when they will retire and how do we replace them? All the fact findings are done through collection of Human Resources (HR) files, verification of details, and through observations and interviews.

The following internal analysis is completed based on 20 interviews with key stakeholders in the organizations. These stakeholders are considered management level personnel: directors, supervisors, and managers. It is felt that qualitative, face to face, semi-structured interviews, rather than online surveys, provide a more in-depth picture of the internal framework. Therefore, a sampling kind of interview is done, where key individuals representing different technologies/ teams are invited for the interview process. The 20 personal interviews were conducted to collect opinions and perspectives. It is believed that personal interviews are a good technique to gather data as it provides the opportunity for participants to describe their situation and roles in a personal manner.

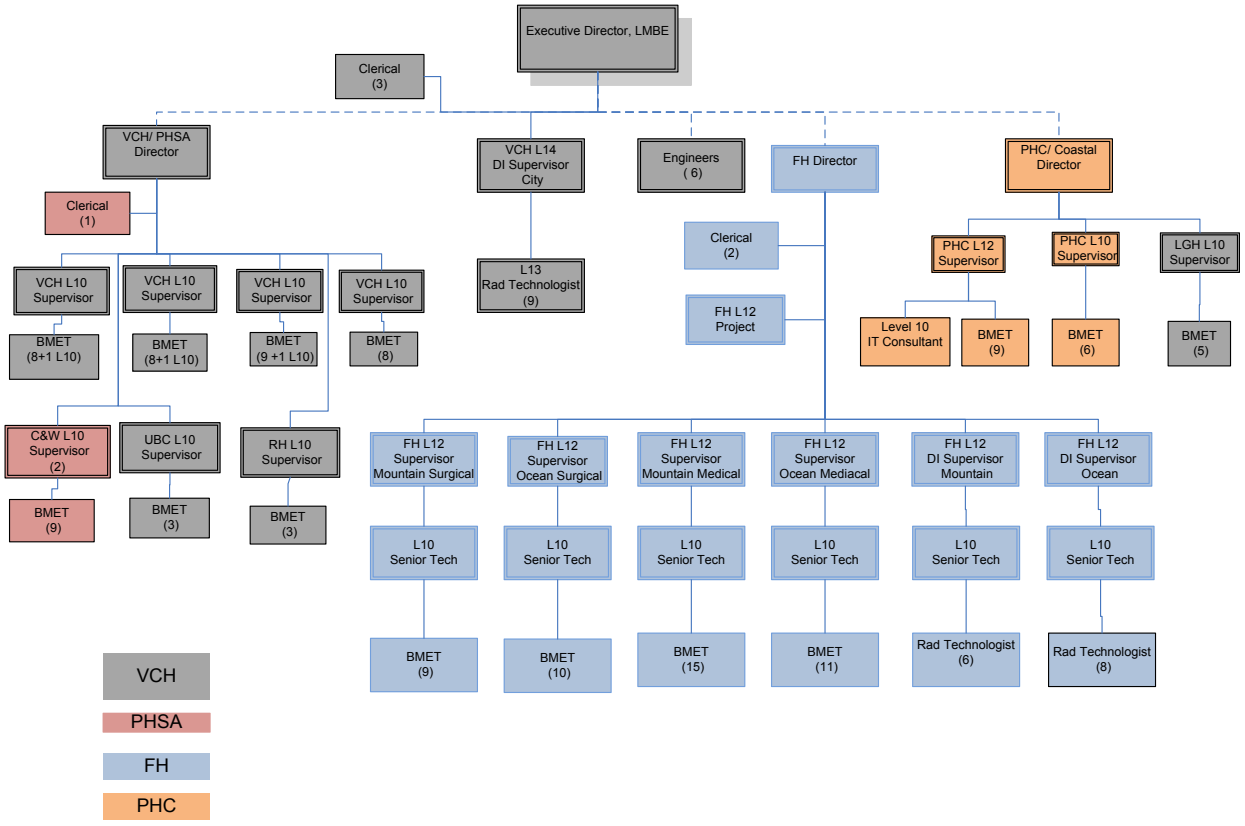
The personal interviews lasted about 1 – 2 hours each and were conducted at the location and date of the participants' choice, which was at one of the 4 work sites/ health regions. The interviews began

with a set of typed questions which allowed the participants to guide subsequent questions (see Appendix A & B). Every attempt was made to ensure that the sessions were relatively informal and open-ended, thus enabling the participants to describe experiences in their own terms and form their personal perspectives. After the interviews, the responses were typed up in a computer and saved in a Microsoft Word document.

2.1. Resources

The current organizational chart of the LMBE organization is shown in Figure 2. There are 184 employees – including the Executive Director, 3 directors, 6 admin staff, 6 Engineers, and 18 supervisors, with the rest being senior techs, consultants, and technologists.

Figure 2 Org chart of LMBE



The people of LMBE are dispersed among the 4 health regions of the Health Authorities (HA). It presents a challenge to the Executive Director when it comes to assessment of the overall age of the people who will be retiring and what type of skill set is needed to replace these people. Table 2 lists all the positions and titles of the staff in LMBE.

To explain a little bit about the different levels of the Biomedical Engineering field which will also shed light on the knowledge level and skill set of the techs in the unionized environment, the management team includes the Directors and Engineers. These are the non-contract staff which mean they are non-unionized. Biomed technologists belong to the HSA union and they start at a pay scale of Level 8, with supervisors and consultants starting at Level 10. Supervisors could go up to Level 12 pay scale, which represents an average of $2 / hour difference in wage.

Table 2: All positions and titles of LMBE

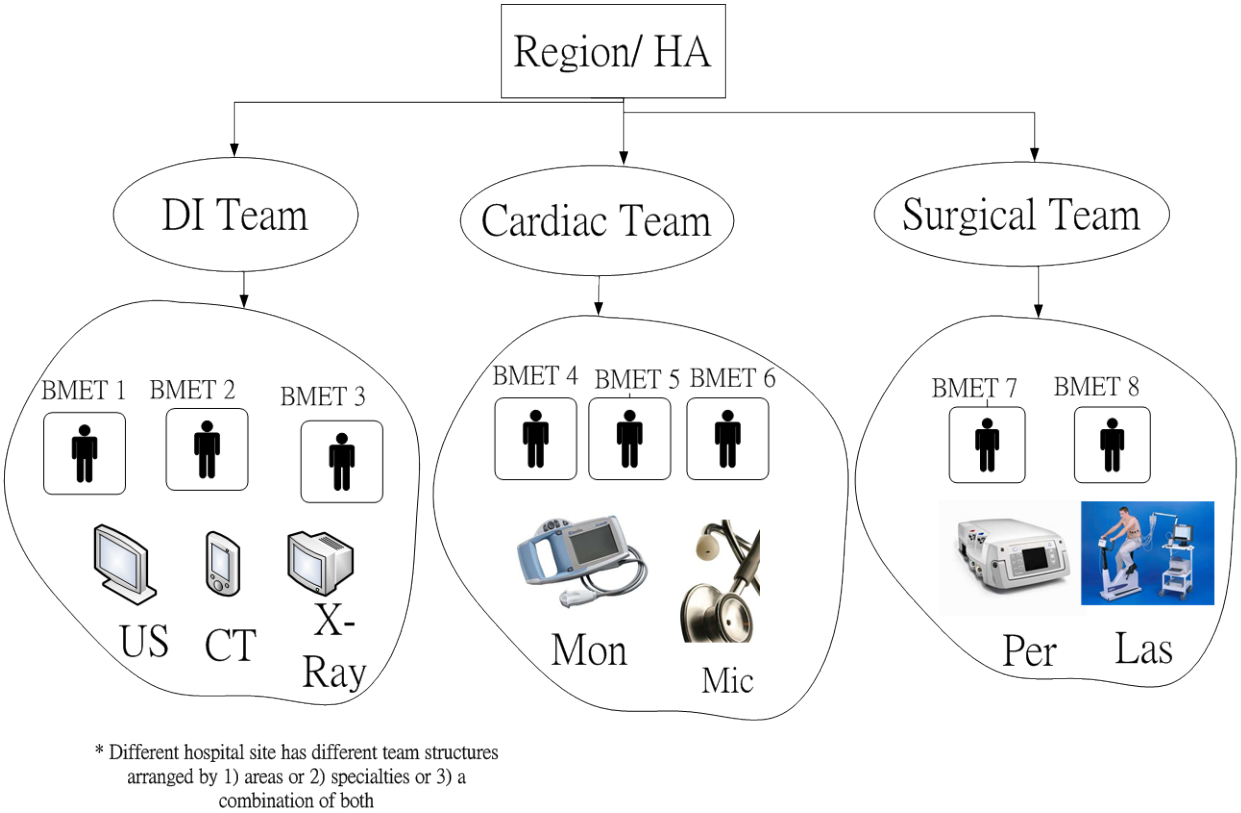
HA	Executive Director	Director	Engineer	Admin	Level 14 DI Supervisor	Level 13 Rad Technologists	Level 12 Supervisor	Level 12 Project Lead	Level 10 Supervisor	Level 10 Consultant	Level 10 Senior Tech	Level 8 Technologist	Total
PHC		1					1		1	1		16	20
VCH	1	1	6	3	1	9			7		3	45	76
PHSA				1					2			9	12
FHA		1		2			6	1			6	60	76
												Grand Total	184

2.1.1. Capabilities

From the resource-based view of business strategy, we need to identify the organization's key resources, evaluating whether these resources are Valuable, Rare, In-imitable, and Non-substitutable. (VRIN) (Wright, Dunford, & Snell, 2001). We start off with the individual capabilities. The organization is in the process of drastically revising its management structure in order to be better geared to the environment forces and in particular, to the customers. LMBE wants to provide a value addition to Health Care in general as it is primarily a service based organisation. There are limited Research and Development (R&D) of new devices and these are limited to the bigger hospitals. Currently, only VGH in VCH has engineers dedicated to the invention and marketing of new devices. Providing the value addition places a lot of demands on innovation, creativity, customer friendliness, and quality improvement. The current workforce will be discussed by dividing the department into three regions based on the areas of coverage by three directors. Starting with a pictorial description of each of the region, the following three sections will describe the current workforce in detail. The common link across the three regions in terms

of management is the Executive Director. All the other personnel report to their individual regional Director who then reports to the Executive Director. The regions have both commonalities and differences in specialties and team structures. There is not a consistent method of organizing the team structures. For example FH organizes its teams according to 1) geographical area: Ocean (cities from Surrey and south of it) versus Mountain (cities north of Surrey) and 2) modalities (medical versus surgical versus DI). PHC organizes its teams according to functions: 1) OR team and 2) Cardiac team. VGH on the other hand, organizes its teams using a mixture of functions and areas of responsibilities. For example Red team looks after BC Cancer Agency, Lasers in Operating Rooms, Perfusion (Per), Emergency, and White Team looks after Cardiology, Lasers in Eye Care Centre, Cath lab; etc. The commonality is that they all look after the same types of equipment such as dialysis machines, anaesthetic machines, x-ray machines, etc. The difference is that every hospital region categorizes the equipment types differently. The bottom line when it comes to recommending training is that techs need to be sent on training for specific types of equipment training – not modality training. (Figure 3)

Figure 3 Example of Types of Training

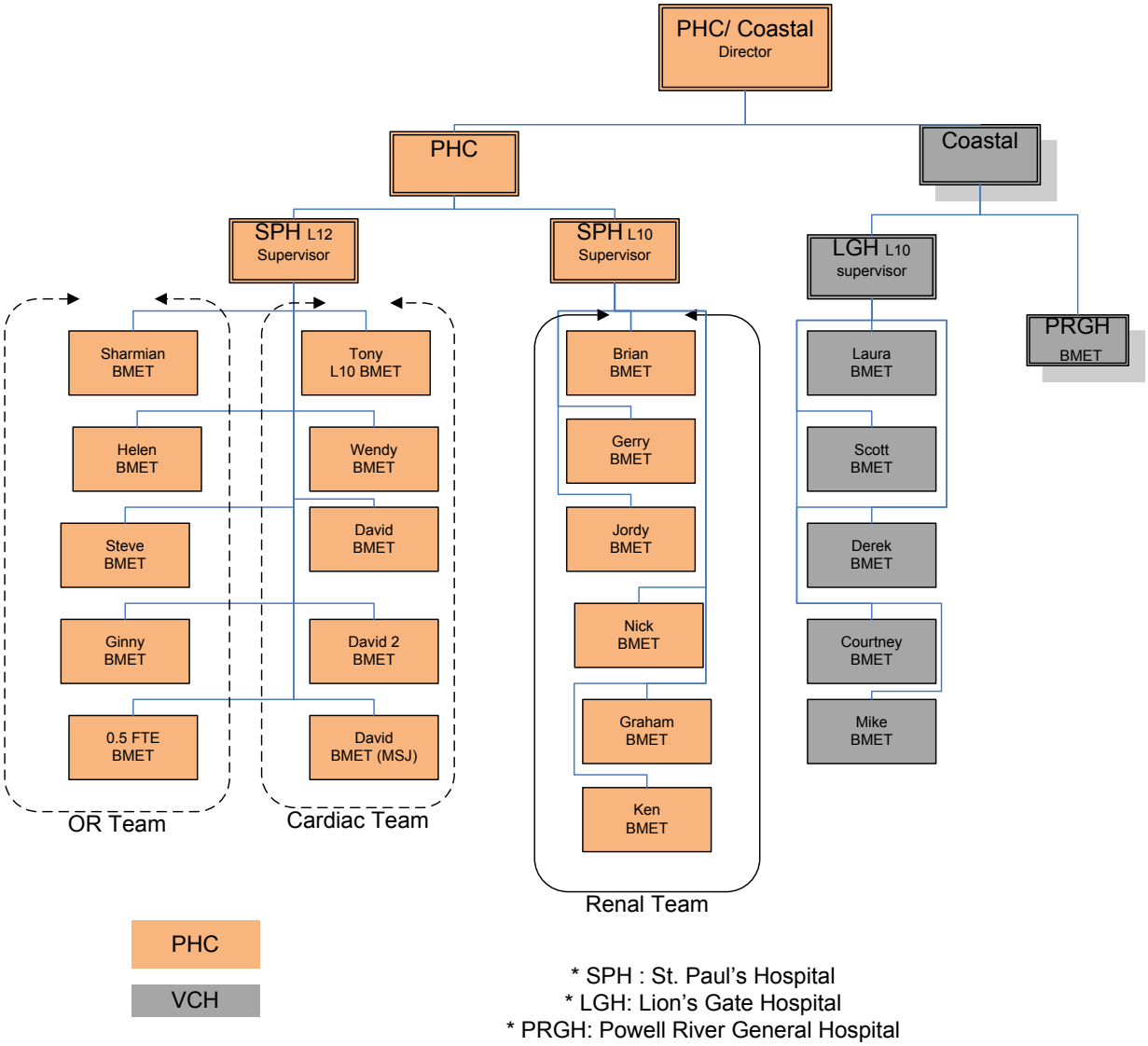


* Different hospital site has different team structures arranged by 1) areas or 2) specialties or 3) a combination of both

2.1.1.1. PHC/ Coastal Region

Below is a diagram of the team structures of the LMBE department PHC/Coastal region.

Figure 4 PHC/ Coastal Director's Areas of Responsibility



PHC

The PHC/Coastal Director looks after 26 staff (7 from VCH – Coastal Health Service Delivery Area) in 4 teams. (Figure 4) At St. Paul's Hospital in downtown Vancouver, the PHC/ Coastal Director

has 3 teams with 2 supervisors. One of the supervisors (Level 12 supervisor) oversees 2 teams whereas the other supervisor (Level 10) oversees 1 team. The Level 12 supervisor's 10 BMETs are equally distributed into two teams of OR team and Cardiac team. The OR team specializes in a range of equipment that are used in the operating room, maternity and Gastrointestinal (GI) areas. The Cardiac Team looks after everything else except OR and Renal devices. For example, they look after Intensive Care Unit (ICU), Emergency (ER), patient wards that have devices, and residential wards. One of the Cardiac team BMET is located at MSJ site and he looks after all the core equipment that is there, such as ICU, ER, and Extended Care Unit machines.

The Level 10 supervisor oversees another team called the Renal team that specializes in dialysis equipment. There are 7 BMETs on the Renal team including the working Level 10 supervisor. The renal team covers a somewhat big geographical region based on their specialty. It is a travelling team in that the Renal team covers 6 community dialysis sites (E. Van, Vancouver Cambie, North Shore, Richmond, Sechelt, and Squamish) plus the acute site of St. Paul's hospital. Currently there is one BMET at each of the 4 local sites excluding Sechelt and Squamish. If and when there are calls to Sechelt and Squamish community dialysis sites, any one of the 7 Renal team BMETs would go on day trips to service the equipment. St. Paul's hospital in PHC has about 6,568 pieces of medical devices looked after by the 2 teams.

Figure 5 SPH Team Specialties

OR Team	Cardiac Team	Renal Team (dialysis)
Operating Room	Cath Lab	SPH renal unit
Endoscopy	EP Room	East Vancouver CDU
SPD	ICU CCU	Richmond CDU
CSICU Perfusion	CSICU Monitors	North Shore CDU
Pulmonary Function	Medicine Floors 7th - 10th	Cambie St. CDU
Anesthesia	ECHO Cardiology	Sechelt CDU
Respiratory	High Acuity (PAE)	Squamish CDU
Outpatient Clinic	IT	
Maternity (Fetal Monitoring)	Rapid Access Unit	
NICU		
MSJ site – surgical	MSJ site - non surgical	
	Residential Sites - non SPH	

Coastal

The PHC/Coastal Director's other team, Lion's Gate Hospital (LGH), looks after approximately 2,953 pieces of medical devices. The 5 BMETs at LGH cover Lion's Gate Hospital, Powell River General Hospital (PRGH) for vacation relief, Bella Bella, Bella Coola, Squamish General Hospital, and Sechelt General Hospital as well. It is noted that at present there is 1 FTE at PRGH – BMET "G". The 7 BMETs at the LGH team is not further divided into specialties. Everyone is a generalist with specialist skills. A discussion on Generalist versus Specialist is detailed in Chapter 3.1.

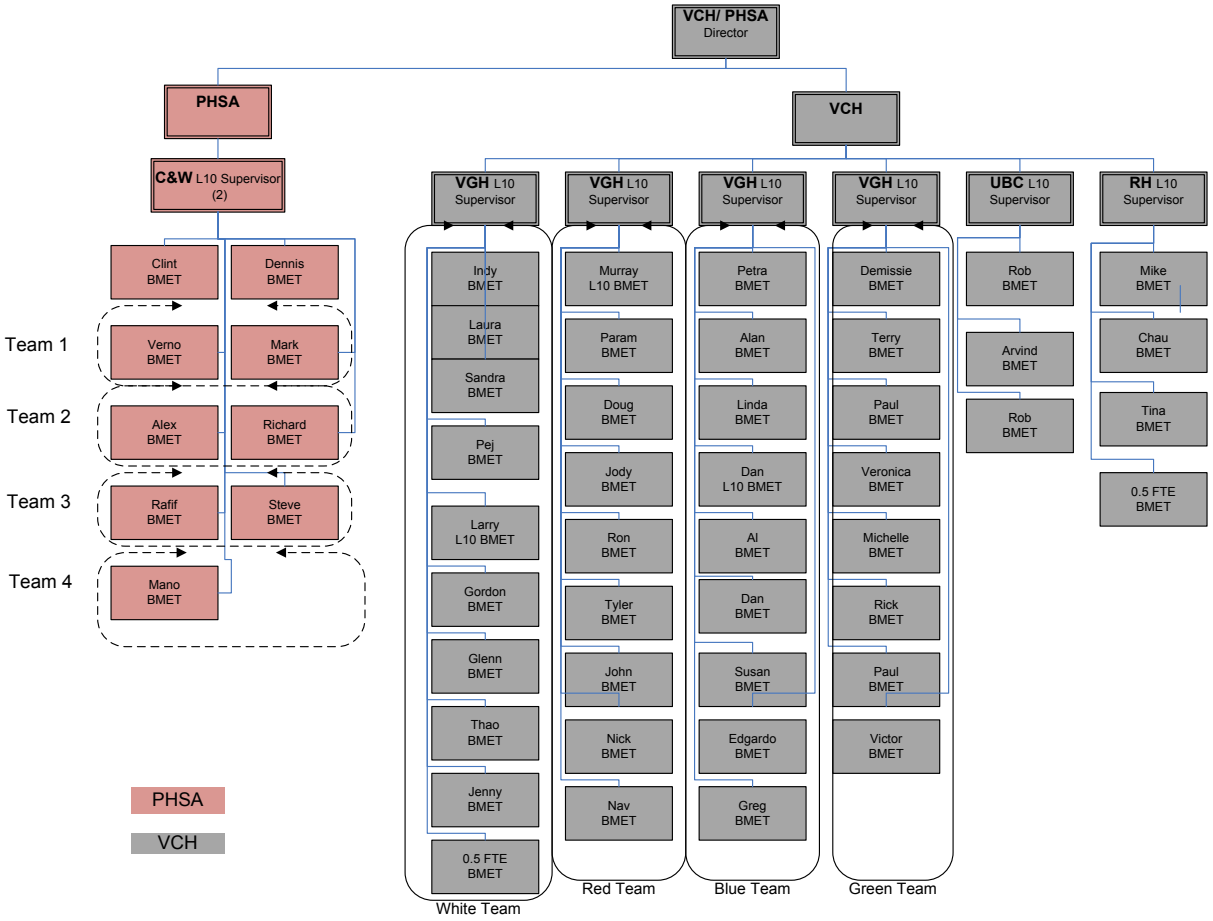
2.1.1.2. VCH / PHSA Region

The second region that we will be looking at is the VCH/ PHSA region, covered by the VCH/PHSA Director. The VCH/PHSA Director oversees 59 staff in the region which covers VGH, C&W, RH and UBC. The majority of the VCH/PHSA Director's staff is located at VGH, which is one of the more labour intensive sites due to the fact that VGH alone holds 955 beds with 13,500 pieces of equipment.

VCH

At VGH, there are 4 teams divided by areas of responsibilities. Due to the vast amount of areas looked after by each team, the teams are labelled White, Red, Blue and Green teams rather than by device specialty like what SPH did. This is another instance of how the different sites call the teams by different names.

Figure 6 VCH/PHSA Director's Areas of Responsibility



The teams' areas of responsibilities are shown in Figure 7. If you compare the teams of PHC and VCH, it is visibly different. For example, the Red team of VCH covers the perfusion area, operating rooms, and lasers, which is very similar to the OR team of PHC. However VCH Red team also covers the emergency unit, which at PHC is covered by the Cardiac team. Therefore each of the 3 directors that look after their areas has to have vast knowledge of their team responsibilities in order to manage the training of employees. It is thought that it would take at least 6 months to a year for a supervisor to be replaced. They have to learn the environment that they are working in, that is whether the teams they are leading are arranged by geographic area, modality, function, or a combination, plus they have to get to know the team members' skill sets in order to assign duties.

The UBC and Richmond Hospital (RH) sites are also part of the VCH HA. Each of these smaller hospital sites has 4 BMETs per site. UBC has approximately 2,827 pieces of equipment whereas RH has approximately 3,450. The 4 BMETs at RH have individual areas of expertise but they are also expected to be able to stand in when any one of their team members becomes ill. As the supervisor at RH said in the interview, "everybody here can do anything. The only two categories of equipment that need techs to go on formal training are anesthetic machines (AU) and ventilators (Ven)". Please see Figure 10 for a complete list of the categories of equipment. In RH, even though all BMETs "can do anything", BMET "C" is considered the "OR guy", BMET "D" is the"ICU/ Cath lab guy" and BMET "E" is the "Maternity lady." BMET "F" is a working supervisor and he also handles projects.

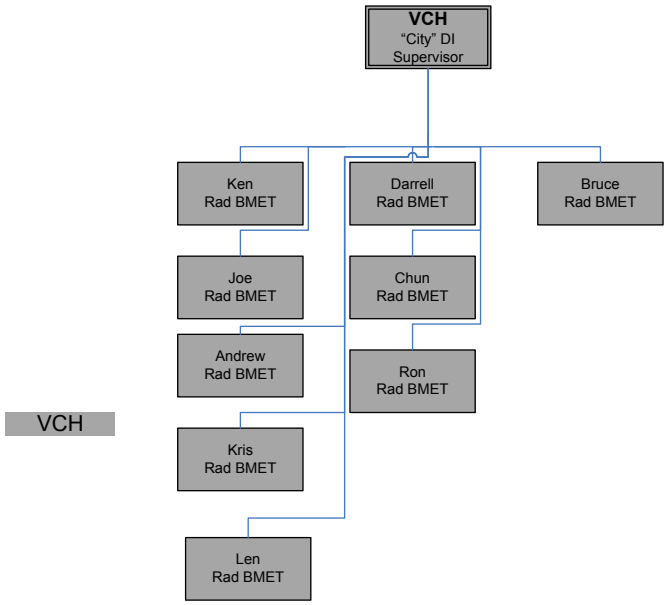
Figure 7 VCH Team Specialties

White Team	Red Team	Blue Team	Green Team
Adult Metabolic Unit	BCCA (Cancer Agency)	Anesthesia - BCCA, JPP, SDCC	Banfield - Nursing
Cardiology	Emergency	Arthritis Center	Bronchoscopy
Cath Lab	Health Center	Banfield- Rehab	Burns and Plastics
CCU1	Lasers -Surgical	Bone Marrow Transplant	CESEI
CIU	Operating Rooms	Cell Separator Unit	CSICU
MAU	ECC	Dialysis	DVL
Daybed	JPP	Hyperbaric Unit	Endoscopy
Dentistry	Perfusion Services	Infusion Pump Program	ICU
Diabetic Clinic	Psychiatry	Mary Pack Arthritis Center	GE Clinic
ECG	SSD	Occupational Therapy	George Pearson Center
EEG	Women's Clinic	PAR	Lions Skin Care Ctr
Eye Care Centre	Pumps - Alaris	Physiotherapy	Lung Function Unit
GTU (Geriatric Triage Unit)		Pre-Op Holding	Ortho Trauma
Heart Services		Rehab Services	Palliative Care
Laboratory		Sexual Medicine	Radiology
Medical Daycare		CP6, T15	Angiograpy - MRI
Neuro-Otology		Feeding Pumps	CT Scan - Nuclear Med
Neurosciences (Neuro ICU)		IVAC Thermometersa (AL)	Lithotripter - Vascular Lab
OPD		Sequential Compression Devices	Respiratory - All Areas
Peri-Operative Services			SOT (Solid Organ Transplant)
Preadmission Clinic			Spinal Unit
Seizure Unit (SIU)			STAT Centre
Stress Lab			Trauma Special Care (TSCU)
Surgical Outpatients			Urology
Wound Care			CP 5, 7, 8, 9, 10
T5,6			HP D10
Pumps -PCA & Epidural & Keys			JPP T 4, 7, 8, 9, 10, 11, 12, 14, 16

VCH is also home to the “City” DI team whose team structure is shown in Figure 8. “City” DI team looks after diagnostic imaging / medical imaging equipment located in the Vancouver area. There are 10 Radiology (Rad) BMETs who have specialized training in X-ray equipment, MRI equipment, and other equipment that are considered DI in nature. The Vancouver area is the area outside of the Fraser Health DI team’s areas. These include SPH, VGH, UBC, C&W, LGH. On any day of the week, the

"City" DI supervisor could assign his staff to any of the worksites depending on the number of emergency calls, available work and FTE bodies per site.

Figure 8 VCH - "City" DI BMET Reporting Structure & Team Specialties



"City" MI	
C&W	
UBC	
VGH	
SPH	
LGH	
RGH	
PRGH	
Squamish	
Whistler	
The rest of Coastal (Pemberton, Sechelt, Bella Coola)	
Medical Imaging Services	
X-ray	X-ray
Ultrasound	Ultrasound
CR	CR
Vascular	CT
MRI	Nuc Med
Mammo	

PHSA

The VCH/PHSA Director also looks after C&W BMETs. Currently C&W has 2 supervisors who rotate being the supervisor of the site half of the time. There are 4 teams of 2 at C&W and 3 people with no teams at all. In total, there are 11 BMETs in 7 teams. This complicated team structure will be restructured in the near future to two teams of 5 or 6 BMETs. C&W's 11BMETs look after approximately 15,000 pieces of equipment. This is a huge number compared to other sites in terms of devices/FTE (see Figure 9 in Chapter 4 "Benchmarking"). This will have to be taken into account when doing the workforce succession planning later on as both the overall size of the FTE's have to be increased as well as the replacement FTE's have to be considered. The type of equipment used in C&W hospital is also of a different kind – mostly paediatric and geared towards small children. There are also a lot of laboratory testing types of equipment which are labour intensive to check. Laboratory equipment is different than general equipment in the sense that there are more labour hours involved than general Biomed equipment (OR, Cardiac, core equipment). Other labour intensive equipment includes Diagnostic Imaging (DI) / Radiology equipment. Since these hospitals have a huge DI content, the Cost of Service Ratio (COSR), which is a measure of the relationship between the cost of service and the acquisition cost of the equipment, would be higher (Cohen, 2010). A discussion of COSR will be covered in Chapter 4 "Benchmarking". Most of PHSA – C&W BMETs are considered specialists.

2.1.1.3. FH Region

The FH region is led by the FH Director. This is the largest of all the three regions in terms of geographic size. The FH region has hospitals ranging from Burnaby Hospital (BH) in Burnaby to Peace Arch Hospital (PAH) in Delta and to Fraser Canyon Hospital in Hope, BC. In total, the FH region has 21 hospitals and sites. The teams are arranged by modality or logical function as opposed to "site-based". This is because there are only so many BMETs that the supervisors could have and to have one FTE per site would be impossible to cover the functional specialties that the site or even the individual BMET has. It poses a challenge when staff members move around from one team to another, causing training deficiencies. The FH Director's areas of responsibility is shown in Figure 9 and the team specialties are displayed in Figure 10. Comparing Figure 10 to Figure 7 to Figure 5, one can see that the team responsibilities of FH are very different from those of PHC and VCH. For example, perfusion in FH is covered by the Medical team as opposed to the Surgical team.

Figure 9 FH Director's Areas of Responsibility

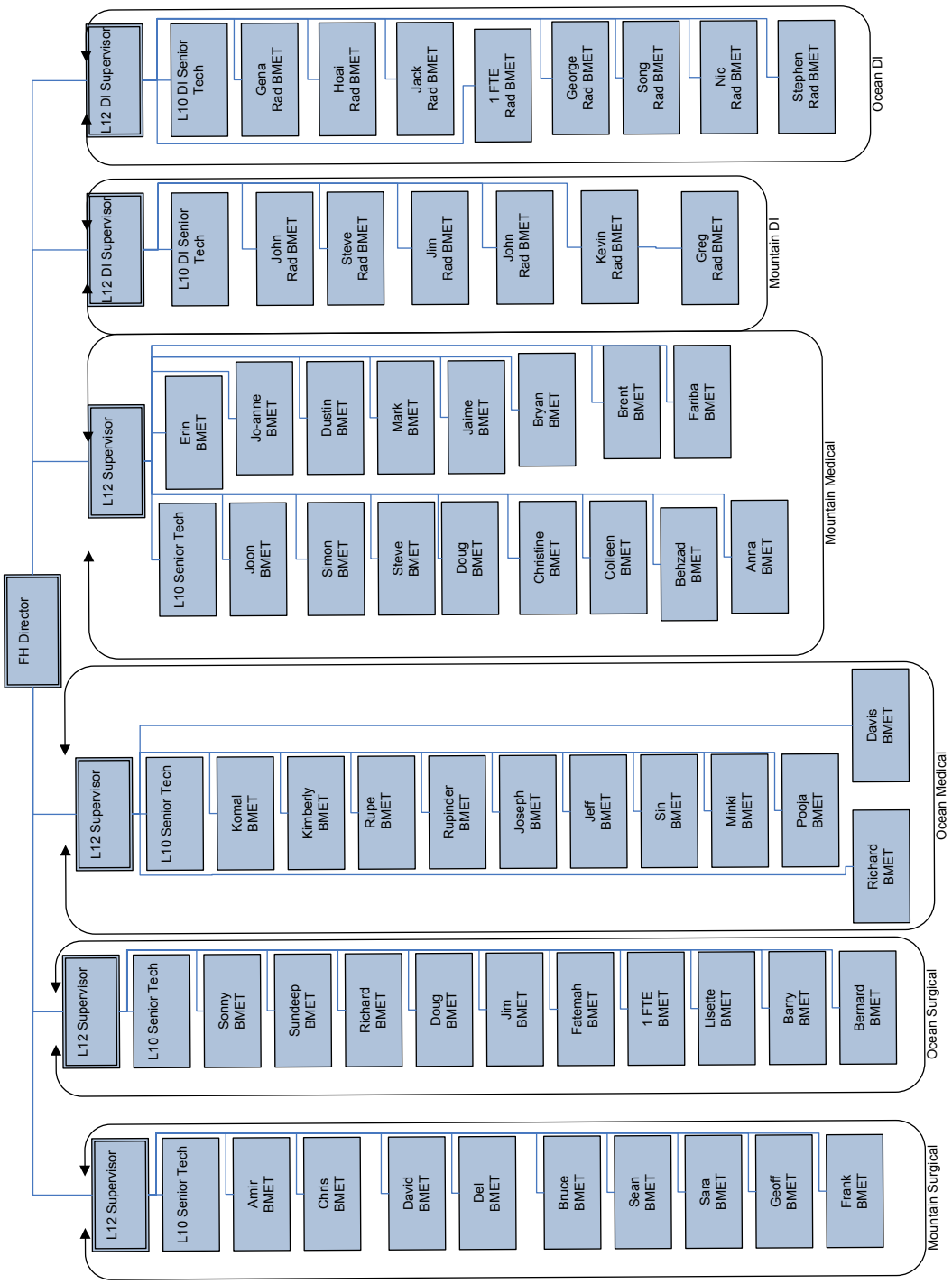


Figure 10 FH Team Specialties

Ocean Surgical	Mountain Surgical	Ocean Medical	Mountain Medical	Mountain DI	Ocean DI
Burnaby Hospital	ARHCC	Burnaby Hospital	Abbotsford Com. Dialysis	ARHCC	Burnaby Hospital
Delta Hospital	Chilliwack General Hospital	Delta Hospital	ARHCC	Chilliwack General Hospital	Delta Hospital
Langley Memorial Hospital	Eagle Ridge Hospital	FVCC	Chilliwack General Hospital	Eagle Ridge Hospital	SOCSC
Peace Arch Hospital	Fraser Canyon	Langley Memorial Hospital	Eagle Ridge Hospital	Fraser Canyon	Langley Memorial Hospital
Surrey Memorial Hospital	Mission Memorial Hospital	Newton Renal	Fraser Canyon	Mission Memorial Hospital	Peach Arch Hospital
	Ridge Meadows Hospital	Peace Arch Hospital	Mission Memorial Hospital	Ridge Meadows Hospital	Surrey Memorial Hospital
	Royal Columbian Hospital	Surrey Memorial Hospital	Ridge Meadows Hospital	Royal Columbian Hospital	
		Panorama Renal	Royal Columbian Hospital		
			Tri-Cities Renal		

Surgical / Maternity Services	Medical / Diagnostic Services	Medical Imaging Services	
Ambulatory Daycare	Cancer Agencies	X-ray	X-ray
Audiology & Speech Pathology	Cardiac Stepdown/ Telemetry	Ultrasound	Ultrasound
Biomedical Engineering	Cardiology & Cardiac Rehab	CR	CR
Day Surgery	Coronary Care Unit		
Extended Care Units	Emergency	Vascular	CT
Psychiatry	Home Health/ Community	MRI	Nuc Med
Laboratory	Intensive Care Unit	Mammo	
Maternity/ Family Birthing Unit	Medical units and wards		
MI Recovery/ Cath Lab/ Interventional Radiography	Monitoring Systems/ Network		
Operating Room	Neonatal Intensive Care Unit/ Nursery		
Pharmacy	Neurology (EEG/EMG/ Sleep lab)		
Physio & Occupational Therapy	Pediatrics		
Post Anesthetic Recovery Unit	Perfusion		
Surgical units and wards	Renal Services		
	Respiratory		

2.2. Current competencies

It is seen from the above description that there are a lot of areas that the BMETs from LMBE look after, and with the areas come the different types of equipment. However, not only does LMBE look after equipment maintenance, they also provide a wide range of technical and engineering expertise in areas that overlap with IMIS and F&P. The following are the current competencies of the LMBE:

- Performing inspections and preventive maintenance.
- Repairing and servicing the more than 80,000 medical devices in the organization.
- Playing a key role in managing medical technology through its entire life cycle from the facilities/program/service planning stage through the purchasing stage, the implementation stage, the usage stage, and finally the disposition stage.
- Managing equipment service contracts to ensure the best decisions are made, the best value is obtained for the lowest cost, and to ensure that contracted services are actually delivered as contracted.
- Maintaining up-to-date records on medical equipment and medical equipment repair and service.
- Installing and implementing medical technology.
- Playing a key technology role in facilities planning.
- Playing a key role in the evaluation, selection, purchase, and implementation of medical technology. This includes assisting in the standardization of medical technology across organizations and ensuring that sites have the right equipment to support the clinical operations.
- Playing a key role in technology related patient safety, including the conducting of medical equipment incident investigations, the monitoring of medical equipment recalls and alerts, and the identification of potential hazards with medical technology.
- Providing key technology assistance and linkages to the clinical programs, HSSBC, IMIS, F&P, vendors, external agencies, etc.
- Providing key linkages to external regulatory and standards bodies such as Health Canada, FDA, ECRI, etc.
- Acting as a technology resource for the organizations.
- Providing education to the staff that uses the technology, such as Laser Safety Program.

As Hamel and Prahalad (Hamel & Prahalad, 1990) put forward, the core competence of an organization is a unique combination of business specialism and human skills that give expression to the organization's typical character. Core competences are the company's characteristic areas of expertise and consist of the synergy of "resources" such as motivation, employee effort, technological and professional expertise, and ideas about collaboration and management. In the downturn of economy where Healthcare costs are high and budgets are tight, we look for ways to improve employee performance with existing resources. Employee performance could either be improved by increasing employee effort or increasing employee motivation. Research has shown that it is somewhat easier to increase employee motivation than employee effort in order to increase employee performance (Speen, 1998).

Although Biomedical Engineering provides a wide range of services and has a wide range of technology expertise, it is often little understood and its resources and expertise are often under tapped. As Biomedical Engineering is grouped under "maintenance of equipment", from a strategic maintenance management point of view, it requires a multidisciplinary approach in order to be analyzed from a business perspective (Murthy, Atrens, & Eccleston, 2002). Most often than not, the cost of maintaining a piece of equipment is a significant fraction (>50%) of the total operating costs. The cost of maintenance encompasses the labour cost, downtime cost, overtime cost, replacement cost, and the intangible cost of coordinating all these processes by the experienced Technologist or Engineer. Thus the value LMBE can provide to the organization is huge.

LMBE identifies five core competencies that afford the organization a unique position and therefore relative advantage in the medical device service industry. These core competencies are based on interviews with various stakeholders and from internal resources:

- A broad range of services that manage a medical device through its entire life cycle, with small reliance on service contracts.
- Novel and effective integration capabilities, such as playing a key role in facilities planning, evaluation, selection, purchasing, and implementation of medical technology.
- The ability to efficiently cross sell technology to clinical staff when it comes to providing key linkages to external regulatory bodies.
- IT-integrated medical device systems when it comes to providing key linkages to IMIS.
- The ability to cover a wide geographical area taking advantage of economies of scope and scale.

LMBE's ability to offer a full line of service from DM's to PM's and evaluation of new technology to purchasing recommendations gives it a unique proposition area. Often times, it takes months to go through a Request For Proposal (RFP) process and with the help of the LMBE, the purchasing process is generally smoother, faster, and fairer.

LMBE's ability to integrate into various other departments of the entire hospital system, such as Acquisition, hospital administrators, doctors, nurses, and finance, gives it a novel and effective upper hand when compared to other smaller departments that find it very difficult to decipher the intricate Healthcare system.

Cross-selling by the LMBE is complemented very nicely by its integration capabilities. It is because of LMBE that a piece of medical device could be approved by Health Canada and be permitted for use in the hospital. This cross-selling requires building long-lasting trust relationships with customers.

Through the years, LMBE has been able to adapt technologically to the rapid integration of IT into medical devices. Such is seen as its core competency as without it, LMBE would not be able to sustain. There are hundreds of devices being networked together to collect and store sensitive patient data and it is through the collaboration of LMBE and IT that this service is being provided rather seamlessly. It is, however, not without lots of trials and errors and compromises.

One of the major competencies of LMBE is its ability to think out of the box by continuously shuffling its manpower to cover great geographical regions. LMBE is currently the largest Biomedical Engineering organization in BC, covering almost the entire province except Vancouver Island and Interior BC. It will continue to maximize its resources by taking advantage of economies of scale and scope. This would be an element that third party service companies would not be able to compete on.

2.2.1. Current individual competencies from a regional support perspective

As mentioned in the previous section, Biomedical Engineering provides a variety of services related to medical technology and equipment planning. Most of the services are provided consistently across all four health authorities to approximately the same degree, but some services are provided to a greater or lesser degree in each organization (e.g. equipment planning, DI equipment service, etc.) and some services are unique to one or two health authorities, for example Endoscope (End) and Surgical Instrument repair (SI).

We have already touched on some individual competencies in the previous few sections. Here we will provide the complete list of the current individual competence plan, which follows closely what ECRI recommends as categories of equipment looked after by Biomed. This will be the benchmark that

we will use when it comes to training recommendation. There are tens of thousands of equipment looked after by Biomed. In order to do a good recommendation on the types of equipment to send an employee on training for, it is more efficient to categorize the expertise rather than on the individual model of the equipment. Due to the fact that the four HA organizations use different acronyms for their equipment, the equipment has been organized for the purpose of this project into more meaningful categories. Since ECRI is the go-to place for the Biomedical Engineering community to search for best practices, this paper will use a combination of ECRI device codes and LMBE's own organization device codes. These device codes will be used in the recommended training plan in Chapter 5.

Figure 11 Categories of equipment looked after by LMBE *Source:* Charles Xiao'S (Biomedical Engineer, VCH) database

Acronyms		**Device Categories**
AU	√	Anesthesia Unit, vaporizers, capnometers and multiple medical gas monitors
BGA	√	Blood gas analyzers
CA	√	Chemistry analyzers
Cam		Camcorder/ camera, laparoscopic insufflators
CathLab	√	Cath Lab system
CS		Clinical software
Def		Defibrillator/ Noninvasive Pacemaker
ECG		Electrocardiographs
EEG	√	EEG
EMG	√	EMG
End	√	Endoscopes
ESU		Electrosurgical units
HA		Hematology analyzer
HBU	√	Hyberbaric Unit
HU	√	Peritoneal dialysis units, hemodialysis units
IMIS	√	IT systems
Inc		Phototherapy units, radiant warmers, fetal monitors, infant incubators

IP		Infusion pumps, Patient -controlled analgesic pumps, syringe infusion pumps
Las	√	Laser, argon surgical lasers, Carbon Dioxide surgical lasers, Nd:YAG surgical lasers, Ho:YAG surgical lasers
LM	√	Leadership, management
Mec		Mechanics, oxygen-air proportioners, oxygen concentrators, patient scales
Mic	√	Microscopes
Mon		Monitor, apnea monitors, multiparameter , physiologic monitors, noninvasive blood pressure monitors, oxygen analyzers and monitors
OL	√	Other laboratory
Oph	√	Ophthalmology
Per	√	Perfusion, autotransfusion units, cryosurgical units, patient warming/ cooling units, circulating fluid, heart-lung bypass units, intra-aortic balloon pumps
PF		Pulmonary function
Prisma Flex		Prisma Flex
SI		Surgical instruments
TM		Treadmills
Ven	√	Ventilator, portable ventilators, heated humidifiers
Core equipment		Patient warming units- air, pneumatic tourniquets, pulse oximeters, infrared thermometers, aspirators, smoke evacuators, sphygmomanometers, suction regulators, temperature monitors/ thermometers, warming cabinets
DI		Digital Imaging workstations
MRI	√	Magnetic Resonance Imaging
NM	√	Nuclear Medicine
US	√	Ultrasound
CR	√	Computer Radiography Systems, fluoroscopic units
Vascular	√	Mini C-arms, mobile C-arms
Mammo	√	Mammography units
CT	√	CT
X-ray	√	Mobile X-ray units

Shaded items = Diagnostic/ Medical Imaging equipment which is a different category of equipment.

√ = equipment that requires factory level service training.

2.2.2. Health Authorities (HA) Competencies

Medical equipment services are provided to the organizations through a mix of in-house service, time and materials, and service contracts. The vast majority of equipment is serviced in-house, representing 90% of the three types of services. Some medical equipment such as wheelchairs, beds, stretchers, etc. is serviced by Facilities, but there is variation across the organizations.

Each of the four HA organizations specializes in certain programs and therefore the BMETs trained to maintain the technologies are also specialists in certain areas. For example, FH and VCH are the trauma centres for the region. PHC, however, does not provide that kind of service, but they specialize in Heart Transplants, Renal services and Perfusion. Vancouver General Hospital (VGH) is the centre for Neuro surgery, but also holds a host of other centres such as the Eye Care Centre, Skin Care Centre, and Hyperbaric Chamber. In general, VGH is the largest hospital in BC that has almost all kinds of treatment for various adult diseases. It also covers a geographic area of 58,560 kilometres (Vancouver Coastal Health, 2010). C&W on the other hand focuses mainly on children diseases and neonates. It is the major centre for moms delivering babies but also has a huge laboratory component due to the Canadian Blood Services being under its umbrella.

According to Hamel and Prahalad (Hamel & Prahalad, 1994), the idea of core competencies is when instead of focusing on product design to achieve competitive strategy, a corporation focuses on stretching and leveraging its intangible assets to achieve competitiveness. In LMBE's case where the majority of business is service delivery as opposed to the creation of new products, it is appropriate to focus on the Competence-based perspective. Competence based perspective (Hafeez, Zhang, & Malak, 2002) argues that it is the core competencies of a firm – not discrete, individual assets – is the source of sustainable competitive advantage. Core competencies are usually the result of "collective learning" processes and are manifested in business activities and processes. Compared to the resource-based view, this approach stresses the development of the right competencies for the long-term success of a firm. The Succession Planning process is aligned with the Strategic Operational goals of the organization and it is part of the management capability of the firm.

Guinn (Guinn, 2000) proposed that Succession Planning, a process based on key competences, could be done without job titles to provide greater flexibility and a more strategic future focus. The first step in employing the core competency model as a business strategy is to: 1) identify existing core competencies, 2) establish a core competence acquisition agenda, 3) build core competencies, 4) deploy core competencies, and 5) protect and defend core competence leadership.

The existing key capabilities are leadership skills, clerical duties, and technical skills. Most of what we will be focusing on in terms of succession planning is leadership competencies and technical competencies. Clerical skill sets will not be discussed here.

From the management perspective, leadership skills are one of the most important skills to obtain. According to one of the directors, "we need leadership skills more so now than before. And I mean leadership, not management skills". There are a few places where an employee within healthcare can obtain leadership skills. In Fraser Health, there are a number of FH programs and leadership courses offered to employees. These programs usually run for three months. There is also the Leadership program for Master's Degrees at Royal Roads University which any employee wishing to move to a management role can apply. Currently, with the directors, supervisors, and engineers, only a total of 27 out of 184 persons are working somehow in leadership capacity. Of the four directors, two will retire in the next five years and one will retire in the next ten years. This leaves one director remaining of the four in ten years' time. As one of the directors who will be retiring within the ten year mark mentioned during the interview, "the ideal candidate to replace me would be someone with an MBA degree plus Biomed background". This particular director has also encouraged a few individuals to pursue the next level of education.

2.2.3. The Role of Biomedical Engineering & Services Offered

The role of BME has typically been to provide a range of medical technology related services to the clinical programs and services and to provide some general technology services to the organizations. These were outlined in the Current Competencies section. However the greater role of BME is to provide expertise in engineering and technology management. LMBE has a vital role to play in determining the potential for implementation and cost effectiveness of new medical technologies through technology assessment. Technology assessment offers the essential bridge between basic research and development and prudent practical applications of medical technology.

However, the types of services and the degree of involvement in technology issue is not consistent across the four organizations. This is primarily based on the history of how the departments and the organizations developed. Due to the recent explosion of healthcare technologies, it is almost impossible for any single individual to stay abreast of these new technologies, much less provide an adequate assessment. To meet this need for comprehensive technology assessment, a multidisciplinary team approach is desirable in a hospital environment.

In all the hospitals of the HA that are being analyzed in this paper, LMBE seeks to assume the role of one of the following: leaders, support staff, and / or facilitators. As leaders, the LMBE convinces the medical and administrative staff of the need to formalize the process of assessment and perhaps

recommend the formation of a multidisciplinary team. In addition, LMBE as leaders subscribe to various journals and disseminate relevant information pertaining to device recall or update. As support staff, the LMBE supports existing committee/team by providing input on issues pertaining to patient safety, conduct literature searches, and find consultants and experts to present or discuss the technologies. Finally, as facilitators, LMBE provides the necessary technical resources to help speed the acquisition process.

2.3. SWOT Analysis

In order to provide a strategic rationale for the importance of HR in this organization, the following Strength Weakness Opportunities and Threats (SWOT) analysis of the LMBE organization is being provided. SWOT is a strategic planning method used to evaluate an organization (Valentin, 2011).

- **S**trengths: internal characteristics of the business or team that give it an advantage over others in the industry.
- **W**eaknesses: internal characteristics that place the firm at a disadvantage relative to others
- **O**pportunities: external chances to improve performance or positive strategic impact in the organization.
- **T**hreats: external elements in the environment that could cause trouble for the business.

Strengths	**Weaknesses**
1. In-depth expertise and experience. 2. Large geographical area coverage. There are tons of resources everywhere leading to increased LMBE visibility. 3. R&D capability. 4. Willing to change its structure as time permits due to changes in external requirements.	1. Single LMBE department within four HA organizations causing bureaucracies. 2. Linkage with many other departments when making internal decisions. 3. Different organizational structures among the various LMBE departments (VCH, PHSA, FH, PHC) leading to non-uniform management approach. 4. Long time employees have gotten used to old ways of working.
Opportunities	**Threats**
1. Opportunity to look outside at other Biomed departments across Canada or internationally for best	1. Government keeps the existing LMBE four HAs organizational structure which results in

practices. 2. Opportunity to look into time and parts cost for certain one of a kind of equipment maintenance around LMBE, rather than training an employee. 3. Look for ways to collaborate between the VIHA and Interior Health Authority Biomed departments to achieve knowledge sharing.	administrative inefficiencies. 2. Third party service provider models (e.g. Aramark) approach MOH. 3. Private companies attracting and hiring experienced BMETs from LMBE.

The following four sections will describe each of these in greater detail. It is recommended that senior management use environmental scanning whereby they assess threats and opportunities in the external environment to better understand the strategic forces in helping shape future initiatives.

2.3.1. Strengths

One of the major strengths of LMBE is that it houses in-depth expertise and experience from its 184 employees. Combining all the experience of the four HA organizations' biomeds, it is able to service just about any medical device on the market. Additionally, due to the differences in the hospital's preference of models of equipment, the biomeds residing in their home base hospitals have specialty in specific model such as GE, Philips, or Siemens patient monitors. If one site makes a new purchase on a different kind of equipment, chances are that the same model could be found at another site. Therefore, training a biomed on a new piece of device does not become an issue if biomeds from another site are willing to travel.

As mentioned in previous sections, LMBE covers a large geographical area, which gives most of BC's population coverage in terms of in-hospital Biomedical Engineering service. There are tons of resources everywhere which gives LMBE increased visibility.

Another strength of LMBE is that it operates almost like a private company in that it has its own R&D capability. Since the beginning, the R&D resource at LMBE has successfully brought to market major devices, such as the Pneumatic Tourniquet system which later on was sold to Zimmer medical in 1985 (McEwen, 2011). Other devices include Canada's first heart-lung machine built by Dr. Rice of PHC's St. Paul's Hospital and the latest Medical Turntable, which is a DVD review solution for Speech Pathology and Radiology, built by John Markez of VCH's VGH.

LMBE is currently the largest Biomedical Engineering department in Canada, and probably within North America due to its recent consolidation of the four HA organizations' hospital Biomedical

Engineering departments. The number of devices and number of employees looking after these devices provide significant economies of scale advantage.

A major strength of LMBE is its "DI initiative". It is one of a kind in Canada in that almost all hospitals in Canada has the DI equipment service contracted out to major companies such as GE and Philips Medical. Greater Vancouver's LMBE department, however, is taking back the service contracts and doing the equipment maintenance of DI in-house. This also reflects the organization's ability to change its scope and structure according to external influences.

2.3.2. Weaknesses

One of the major weaknesses of the LMBE is that being the single largest Biomedical Engineering department within the four HA organizations creates strong institutional boundaries. The flipside of the economies of scale is that such a large organization might become very bureaucratic and there are non-cohesive team structures in various teams.

There are linkages with so many other departments that bureaucratic issues arise when making internal decisions (an example is the recent Computerized Maintenance Management System "CMMS" RFP). This tends to slow down the decision making process and produce obstacles in the acquisition of equipment and tools. The different organizational structures among the various Biomedical Engineering departments are not uniform due to various cultures, policies, and procedures. Multiple structures lead to non-standardized management approach.

Another weakness of the LMBE organization is that long time employees called the "legacy staff" have gotten used to old ways of working. It becomes a challenge when new policies and procedures are being introduced and employee buy-in needs to be achieved.

2.3.3. Opportunities

A major opportunity that the LMBE organization could pursue is the consolidation of a lot of its processes by looking for best practices and streamlining its current procedures. A chapter on Benchmarking will touch on what is in place and how it compares to others.

Another opportunity when it comes to training new employees is that due to the huge cost of factory level service training courses, especially for certain one-of-a-kind equipment, each site could look into paying for the service of the equipment done by another site. The site which has received the service could pay another site which is providing the service in terms of time and parts cost. This is another way of leveraging the economies of scale strength discussed above.

One final opportunity that LMBE could consider is that if none of the sites have the expertise to service a certain kind of equipment, it could collaborate with other in-house Biomedical Engineering departments such as the Vancouver Island Health Authority (VIHA) and Interior Health Authority to achieve knowledge sharing that way.

2.3.4. Threats

Due to the similarity of in-house Biomedical Engineering service offered by LMBE as compared to other third party medical device service companies such as Aramark and Dynamed, LMBE faces the threat of being completely eliminated out of the hospital system if administrators decide to contract out Biomed services in the future. This is a threat but not a huge issue for now as when the time approaches, decisions such as these will most likely require a complete audit which will take months / years to happen.

Similar to the private company takeover of LMBE, government takeover is also a viable threat to LMBE. This is due to the fact that government regulations play a huge force on how LMBE gets its funding and where the budget goes to. If LMBE proves to be not sustainable, there is a possibility that funding will be cut and certain processes cannot be put forth.

Last but not least, there has been a great risk of losing experienced biomeds to private companies. In recent years, two biomeds have happened to resign to work for well-established private companies. With their movement, training monies are lost. This will add to the workforce succession planning funding that has been anticipated later on.

2.4. LMBE Strategic Operational Plan

The vision of the LMBE organization is "The Right Technical Solution, at the Right Time in the Right Place for Quality Care". There are four goals based on interview with the Executive Director:

Goal 1: **Quality of Service:** How well we do the work, how we do the work, and what we need to do to respond to the rapidly changing needs of our clients
Goal 2: **Quality of Work Life:** Create an environment that attracts and retains the best people
Goal 3: **Quantity of Appropriate Service:** The work that we do
Goal 4: **Resource Management:** How we manage our human and fiscal resources

This paper will deal mainly with Goal 2 and Goal 4: Quality of Work Life and Resource Management. In order to provide a Quality of Work Life, one of the objectives is to provide opportunities for engagement and growth. The action plans are to 1) identify growth opportunities for BMETs to become involved with new and challenging tasks or projects and 2) to identify and develop a succession plan. The second portion of the action plan will be covered by this project. In achieving the Goal 4 of Resource Management, the action plans are to 1) develop and implement a training plan, 2) review staffing requirements, and 3) review technical expertise from a regional support perspective. All three action plans will be covered in this project.

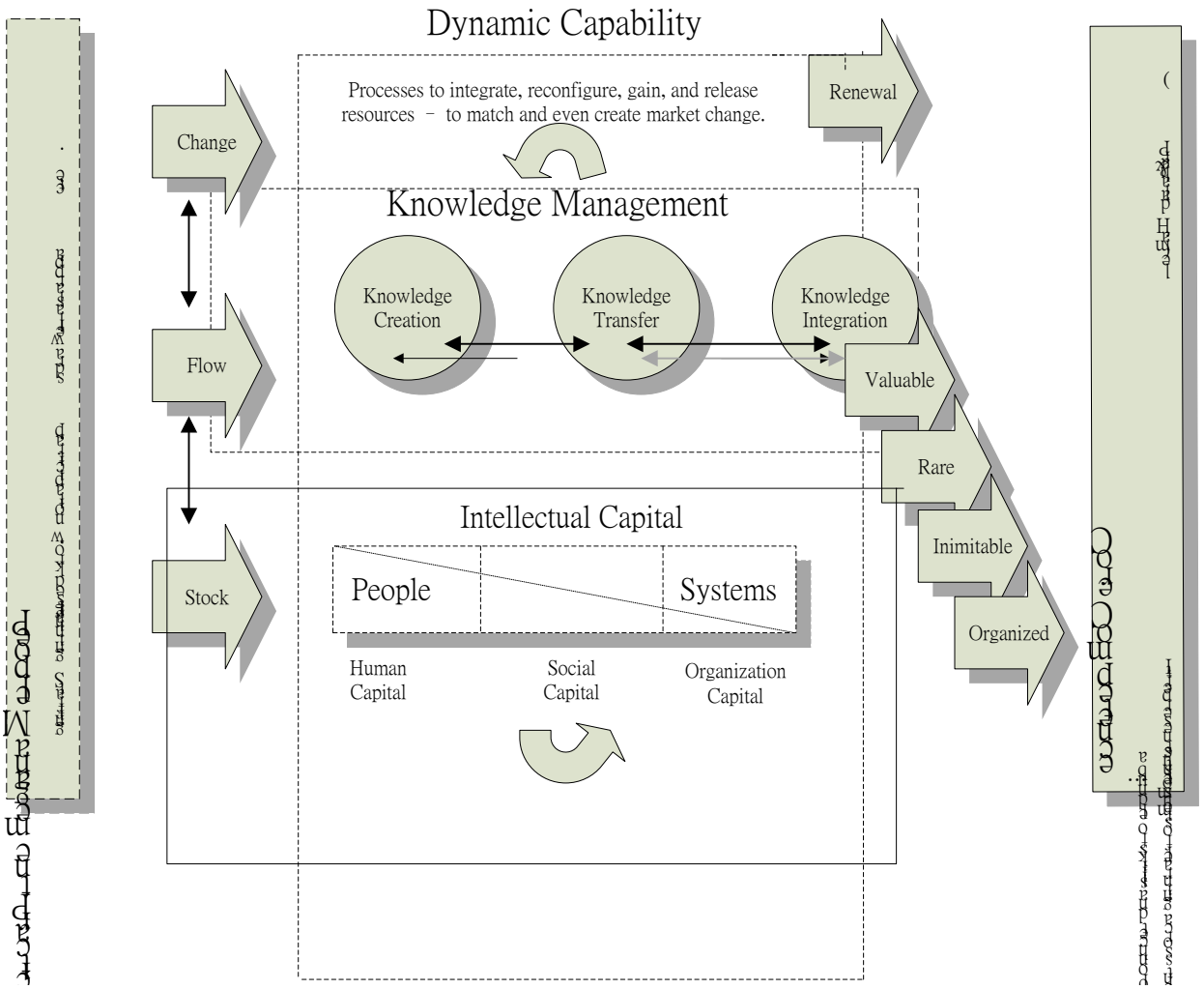
2.5. Resource- Based View

From the resource-based theory of competitive advantage, LMBE could make the case for leveraging its resources and capabilities to form the foundation for achieving its long-term strategy. LMBE first needs to take stock of its individual resources, which include capital equipment, skills of individual employees, patents, brand names if any, finance, and HR management in order to assess its relevant resources. Then in order to identify and appraise its capabilities, LMBE need to make its resources productive. Productive activity requires the cooperation and coordination of teams of resources (Grant, Spring 1991). In order to make its resources productive, motivational theories come into play. While resources are the source of a firm's capabilities, capabilities are the main source of its competitive advantage.

We've discussed our core competencies and capabilities, our resources, and knowledge. Now we need to link strategy and HR management within the resource based view. Wright et al (Wright, Dunford, & Snell, 2001) proposed the model in Figure 11. Under the strategic management of resources, which encompasses predominantly the skills of individual employees and HR management, the questions that need to be asked are:

- *What opportunities exist for economizing on the use of resources?*
- *What are the possibilities for using existing assets more intensely and in more profitable employment?*

Figure 12 Integrating strategy and strategic HRM. Source: "Human Resources and the Resource based view of the firm. (Wright, Dunford, & Snell, 2001)



When assembling our organizational capabilities, it is not simply a matter of assembling a team of resources: capabilities involve complex patterns of coordination between people and other resources. A lot of the capabilities which are derived from the existing knowledgeable employees are perfected through learning and repeating. There are six levels of pay scale for every biomed to go through. Each level of pay scale is equivalent to one year of service. It takes years of experience for a fresh out of school biomed before his or her skill set is considered replaceable to a retiring biomed with 30 years of service.

In order to link resources and capabilities, the key ingredient is the ability of the organization to achieve cooperation and coordination within the teams. This requires that an organization motivate and socialize its members in a manner conducive to the development of smooth-functioning routines. The organization's style, values, traditions, and leadership are critical encouragements to the cooperation and commitment of its members.

In LMBE's case it is imperative that leadership, values, and traditions shape its key resources. LMBE has a diverse number of employees dispersed into different hospitals and sites. The things that connect them all are the leadership and management plus the values and traditions. When employees see that management value them and there is good communication between top management and low employees, their performance will improve. As individual skills become rusty when not exercised, it is important to encourage or give opportunities to individuals with skill sets to use. Hence there is a trade-off between efficiency and flexibility. When individuals focus on a certain skill set to gain competence, their flexibility to service other equipment becomes less accessible. LMBE has to consider this during the recommendation for workforce planning.

There are enormous economies of experience achieved through the collaboration of the HA organizations. Just as individual skills are acquired through practice over time, so the skills of an organization are developed and sustained only through experience. However, LMBE is in an industry where technological change is rapid; therefore new firms may possess an advantage through their potential for faster learning of new routines because they are less committed to old routines. On a positive note, it does hold very complex organizational capabilities. Its capabilities are derived from the integration of ideas, skills, and knowledge drawn from various areas. This will be particularly relevant to the sustainability of its competitive advantage.

3. Primary Research Findings: Current Expertise and Anticipated Gaps

The interview process was done in order to assess the knowledge base and expertise areas of the individuals who are anticipated to retire in the 5 to 10 year period. Based on the age of the employees, number of service, and best estimate of health and financial situations of the 184 employees, 36 will retire in the next 5 years and another 36 will retire in the next 10 years with a total of 72 retiring by year 2021 (Table 3). It should be noted that even though PHSA has 9 employees retiring in 10 years' time, these 9 employees represent 75% of the total staff of 12 at PHSA whereas the 22 retiring employees of FH represent 29% of the 76 FH staff. PHC has 50% of their staff retiring and VCH sees 41% of their staff retiring by 2021.

This chapter starts off by looking at the intangible assets of the organization. Here the idea of Generalist versus Specialist will be explored. Then the evaluations in this chapter will be grouped around the regions taken care of by the three Directors – PHC/Coastal Director, VCH/PHSA Director, FH Director plus the Executive Director.

Table 3: Grand total of number of retirees for the four HA organizations

# of Employee			
HA	**5 Year**	**10 Year**	**Subtotal**
FH	9	13	22
PHC	3	7	10
PHSA	6	3	9
VCH	18	13	31
Grand Total	36	36	72

3.1. Generalist versus Specialist

In order to describe the various skill sets in the organization, we will strive to categorize the technologists into Generalist versus Specialist. Most of the teams here are composed of a mixture of these two types of technologists. It should be clarified that below is based on an assumption and does not necessarily represent what others think.

When a newly out of school Biomed is hired, that person is usually being classified as a Generalist. This is the case even if the Biomed is being assigned to a team. Within a team, for example the Surgical Team, the new Biomed would be involved with the preventative maintenance (PM) of devices as opposed to demand maintenance (DM) which often requires in-depth knowledge of device

function and design. PM's are scheduled maintenance performed on devices prior to it being out of service. This is a proactive approach to the technology management organization and it is a great way to upkeep medical equipment while providing the Generalist an excellent way to learn the equipment inside out. Completing PM's on time is also a requirement for the accreditation of the department and ultimately the accreditation of the hospital where the department resides.

Not all Biomeds aspire to become or stay as a Generalist for the rest of their careers. It is like becoming a General Practitioner (GP) as opposed to a Specialist in the medical field. Most Biomeds who are motivated and who have the time (in terms of less family commitment) want to be a Specialist of some sort of high-end medical device, for example lasers – devices used for accurately targeting certain tissues and dialysis machines – which are highly specialized because they encompass both electrical and hydraulic systems. There are other high-end devices, such as one-of-a-kind types of devices, like the Hyperbaric Chamber at VGH and the Ventricular Assist Device at SPH that require specialists. All these specialized devices will bring to the Biomed who knows how to fix them, and has acquired factory level service of these, enormous prestige and power when it comes to status in the organization. For example, in order to be trained on the laser machine and be called a laser specialist, one has to have proven technical ability and high accuracy in alignment skills due to the fact that they have to be able to do very delicate mirror alignments in order to reflect and transmit laser beams. Such Biomeds are highly valued by the organization and if they leave, their skills would be harder to replace.

There are also many Specialists with Generalist skills, for instance, experienced Biomeds who have worked for the organization for 30 years. Such an employee would have taken almost all of the service training courses available. He or she may have even taken Dialysis at one point and probably has switched between two to three teams in their entire career. This type of Biomed is a Specialist but this employee is more useful than a pure Specialist because they have a wide range of knowledge and experience and one of them can do the work of three people for one day. This type of Biomed would be hard to replace as well.

It is thought that a highly qualified tech has the education and the experience. To develop the expertise within the Biomed and DI field takes (for a recent graduate) the following years:

- Clinical:
  - 2 years for core training
  - 2 years for Clinical expertise
- DI:

- 2 years for general X-ray, MRI, CT (rad rooms, mobile C-Arms, fluoro rooms)
- 2 years for DI expertise

3.2. PHC/ Coastal Region

The PHC and Coastal region encompasses the PHC and Coastal areas. PHC is relatively small whereas the Coastal area spreads from Lion's Gate Hospital (LGH) in the North Shore to Powell River General Hospital (PRGH) to Bella Coola, Bella Bella located in the north sides of Vancouver Island, and Interior BC. Geographically the coastal area is considered to be the furthest and hardest to travel to part of the LMBE organization. There is one hospital site per Bella Coola and Bella Bella. One Biomed goes to each of these sites at least 1 – 2 times a year and each site visit lasts for a 1 week period.

The PHC/Coastal Director's concern in terms of succession planning for the region is hiring for fit within the Coastal regions and the willingness and ability to travel to these remote sites by two ferries and car/ taxi ride. For here, succession planning is not as hard as location planning. For example, it works out that right now there is a FTE working at PRGH. If that particular Biomed retires in 10 years' time, which is likely to be the case as he is reaching age 66 in 2021, then the PHC/Coastal Director would have a hard time finding his replacement. If no experienced Biomeds apply who is willing to move to Powell River permanently, the PHC/Coastal Director would have to hire an FTE at LGH but assign Biomeds to travel to PRGH on a rotational basis.

The PHC employee list that will be expected to retire in the next 5 to 10 years, together with their relevant replacement skill is listed below.

In Table 4, for the first 5 years, if we have to hire a replacement for the 1 HU (hemodialysis unit) and 1 Ven (ventilator) experience, it would take 4 years (2 years for core training + 2 years for Clinical expertise) to train a recent graduate for each of the HU and Ven expertise, totalling 8 years. The training cost is approximately $10,000 per each of the specialty training, which includes flight, accommodation, and cost of the education. Therefore it would take $20,000 for the first 5 years to replace the 2 expertise. Detailed recommendation is found in Section 5 "Recommendations" for the first 2 years.

Table 4: Training needs for PHC in 5 years, 10 years

# of People	HU	Ven
3	1	1

# of People	AU	End	LM	HU	Las	Per	MRI	CT	X-ray
7	1	1	2	3	1	1	2	1	2

***Red – 5 year**

***Orange – 10 years**

As for the Coastal region, there is nobody who is of retirement age within the next 10 years. This is through their birth date calculations and best guess estimation. One particular BMET should be kept in mind in terms of succession planning as he does a lot of centrifuges for the lab and he is a standby supervisor. He poses an insurance liability as opposed to retirement liability. However he is considered a lower risk replacement where his gap is not too hard to fill.

3.3. VCH/PHSA Region

The VCH/PHSA director looks after VGH, C&W, UBC, and RH. Table 5 and Table 6 show the number of employees and their corresponding expertise that will be retiring in the VCH area and the PHSA area in the next 5 to 10 years.

Table 5: Training needs for PHSA in 5 years, 10 years

# of People	BGA	CA	EEG	End	HU	Ven	LM	OL	Inc	CS	Mic
6	1	1	1	1	1	1	1	3	2	3	1

# of People	AU	BGA	CA	EEG	End	HU	Las	LM	OL	Per	Ven	CS	Inc	Prisma Flex	Mic
3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Table 6: Training needs for VCH in 5 years, 10 years

# of People	BGA	CA	EEG	End	HU	Ven	LM	OL	Inc	CS	Mic
6	1	1	1	1	1	1	1	3	2	3	1

# of People	AU	BGA	CA	EEG	End	HU	Las	LM	OL	Per	Ven	CS	Inc	Prisma Flex	Mic
3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

***Red – 5 year**

***Orange – 10 years**

The PHSA team will be expected to have 6 people retiring in the upcoming 5 years, followed by 3 people in the next 5 years (Table 5). All of the Biomeds who are retiring at C&W are Specialists with Generalist skills, therefore their skills would be the hardest to replace. Nevertheless, it is estimated that for the first 5 years, training dollars would have to be spent on someone to improve their IT skills and lab equipment knowledge skills. Even though it is easy to send someone on training, it will be impossible to bring that person up to speed to the level of the retiring employee within a short period of time. It is estimated that it will take 1 – 2 years to train a Biomed to be comfortable with an area, but probably more than 2 years to train that Biomed to be an expert of a field.

At VGH, there are several Specialists who will be expected to retire in the next 5 – 10 years' time. White Team would probably lose their EEG/EMG Specialist and DI would lose their Radiology Biomed, who is also a Specialist with Generalist skills. This particular Radiology Biomed is the only one who covers for the entire Coastal region's general X-ray equipment (which is LGH, Bella Coola, Bella Bella, Squamish, Whistler and Powell River). When asked what the short-term solution would be if this Radiology Biomed does end up retiring in 2013, it is anticipated that there will be some reassignment of Radiology Biomeds in the VCH region to temporarily cover until appropriate replacement is hired. The supervisor will also be expected to travel more.

One Specialist who is a Generalist on the Red Team will be expected to retire in 10 years' time. With regard to planning for his retirement, his supervisor has indicated that '*we will never be able to replace BMET "A". BMET "A" is considered an "intangible asset".'* He has a huge wealth of experience with surgical device and not only does he repair and maintain equipment, he also gives companies feedback with respect to what was wrong with the actual design of devices. These are the types of people that will be impossible to plan for Succession due to their immense amount of knowledge.

3.4. FH Region

Table 7: Training needs for FH in 5 years, 10 years

# of People	EEG	End	HU	Prisma Flex	LM	Per	Ven	MRI	NM	US	Mammo
9	1	1	2	1	1	1	3			1	1

# of People	BGA	AU	EEG	End	HU	Las	LM	Prisma Flex	Mic	Oph	Ven	MRI	CR	CT	X-ray	US
13	1	2	1	2	1	1	4	1	1	1	11	12		11	12	6

***Red – 5 year**

***Orange – 10 years**

Table 7 lists the training requirements for FH due to retirements in the next 5 to 10 years' time. It should be noted that the FH has immediate DI training due to one retiring now and a few more DI Radiology Biomed trainings planned due to upcoming retirements. It is particularly harder for FH to attract Radiology Biomeds with experience due to various reasons. Therefore they are expected to spend more than average on DI training. DI is a specialized field of Biomedical Engineering where the acquisition cost of the equipment is considerably higher than the resource cost to maintain it. However the DI equipment is also fairly hard to repair due to its sheer size and rarity. A lot of these devices are "one" or "two"-of- a- kind. For example, PHC-SPH has 2 MRI equipment of GE vendor and VGH has 1 ultrasound lithotripter used for blasting kidney stones. From the interviews with the DI supervisors, it is a goal to have all Radiology Biomeds trained on General X-ray as these are the most commonly used DI devices and they have a lot of these. Then for the "one" or "two" of- a- kind types of DI equipment, it is more efficient to train one or two Biomeds and they will travel to various hospitals for service calls.

There are a few supervisors who will be retiring in the FH area, however their replacements would not pose too much of a difficulty as these supervisors also have a senior tech underneath. When the posting comes up, the senior techs are the ones who will most likely be promoted if and when they apply through the formal process. And then, after the senior techs move up, it is just a matter of replacing the senior tech, and subsequently the Biomed who will be hired as replacement will usually be an out-of-school diploma graduate.

3.5. Summary of Findings

The interviews and observations produced the estimation that 72 of the 184 employees of LMBE will retire in 10 years' time. This represents 39% of the workforce. It further confirms the fact that skills need to be replaced and an action plan needs to be looked at now in order to phase in the hiring of new personnel. What is alarming is that PHSA has only 11 working Biomeds (plus 1 Admin) but 9 will be retiring in 10 years' time – representing **82%** of the BMETs. This is a potential serious loss of skill that would have to be addressed urgently. A lot of the PHSA Biomeds, as mentioned before, are Specialists with Generalists skills. Therefore it would take 2 years to train a new graduate up to be comfortable with core equipment maintenance, then another 2 years to train up to be a specialist. It would take 4 years per new hire to replace the 9 retirees. In total, it would take 4years x 9 BMETs, resulting in **36 years** to train up all the replacements. If the trainings are done simultaneously and spread over 10 years, it would take about 36 ys/ 10 = 3.6 years average to train a Biomed every year.

Appendix C lists all the expertise that will be lost on a year by year basis by each of the four HA organizations. Year 2012 is a good year in that only 3 areas of expertise are lost – 1 HU, 2 LM. Year 2013 starts to pick up in that PHSA will lose a BMET with HU, Prisma Flex, Mic, laboratory skills. VCH will lose a person with DI experience. Year 2019 sees the loss of 5 sets of AU expertise - 2 from VCH, 1 each from FH, PHC, and PHSA.

By year 2021, LMBE will have lost 20 LM expertise carried by Directors and Supervisors, 15 HU, 13 AU, and 13Ven expertise. Other areas of expertise that represent a significant loss include HBU, Las and X-ray expertise.

4. Benchmarking

Before going into the Recommendation section of the paper, it is a good idea to look at what other people are doing and how LMBE compares to them. This helps in the recommendation process, especially for the number and types of training required. Benchmarking also helps us frame our workforce planning process better as some of the steps could be added or eliminated based on what others have used.

Benchmarking is the measurement of our department or organization's practices, policies, and procedures against similar departments at other facilities. In healthcare, the turbulence caused by short cycles of technological innovation and obsolescence has made benchmarking impossible and difficult. Workforce needs are constantly changing. The complexities and the fact that healthcare funding is allocated by federal and provincial sources make it political in nature. There are constant efforts to reduce costs while increasing efficiencies. We will look at benchmarks for hospital-based Biomedical Engineering department performance, using published metrics from AAMI and ECRI. Then we will also look at benchmarks for the workforce succession process using current practices from close competitors like GE Medical and Microsoft Corporation.

4.1. Biomedical Engineering Performance

It is important to know the primary measures for the LMBE organization and even if it is overstretched, we need a value to make our case. So the first focus will be on staffing. Staffing seems straightforward, but presenting the staffing numbers in the right context and providing the proper context is the main challenge when benchmarking any performance parameter. The main contextual elements for staffing are the ratio of beds to full-time equivalent (FTE) employees and the ratio of devices to FTE employees / the ratio of devices supported per tech.

Research on the two main Biomedical Engineering performance benchmarking organizations ECRI and AAMI shows that a simple average of beds per FTE, such as 40 beds/FTE, is no longer accurate for hospitals that range from acute care sites to residential care sites. For example in a paediatric hospital, such as C&W Hospital (PHSA region), a single bed could consist of 10 pieces of devices, whereas another site such as MSJ site medical ward single bed could contain 2 pieces of devices. However looking at eight different bed size ranges in 100-bed increments from less than 100 beds up to 800 beds, the bed/FTE ratio ranged broadly from 18 to 49. Table 8 gives an idea of the number of beds versus number of devices versus number of FTEs per site and is used as a comparison, not as a hard and fast rule.

Table 8: Comparison of Bed/FTE for the four HA's

	Beds	BMET FTE	Bed/FTE
PHC	1483	19	78
VCH	9000	64.5	140
PHSA	500	11	45
FH	9825	66	149

Table 9: Comparison of Devices/FTE for the four HA's

	Devices	BMET FTE	Devices/FTE	ABS metric (benchmark)
PHC	6961	19	366	329
VCH	23164	64.5	359	329
PHSA	14727	11	1339	329
FH	33422	66	506	329

In comparison, Table 9, which gives an idea of the number of devices supported per FTE for the four HA organizations, may be better at internal benchmarking. However it does not take into account the size of the hospital, the various specialties within the HA's, types of devices (DI equipment vs. lab equipment vs. general clinical devices) supported, and most importantly the time involved with getting hold of the devices due to geographical regions. Staffing benchmarks are typically "normalized" to account for bed size (e.g. beds/ FTE) or inventory (e.g. FTEs/ 1,000 devices). There must be a meaningful and causal relationship between the variables. That is, changes in one must influence changes in the other. There are a number of statistical tests used to validate whether this is the case. One test that is commonly used to compare two variables is correlation. The extent of correlation is designated as r and is expressed as a value from 0 to 1. An r value of 0 means that there is no meaningful relationship between two variables and that they should not be combined into an indicator. A correlation of 1 is a perfect or ideal relationship. Using data provided to ECRI Institute by member institutions, we looked at the correlations of several hospital parameters with the number of FTEs in the Biomedical Engineering department and obtained the results shown in Table 10. Correlations of 0.9 or so are considered fairly high and our

findings therefore suggest that any of the variables would be suitable for establishing an indicator such as Beds/ FTE, FTEs/ Admissions, or Devices/ FTE.

Table 10: Correlations between the total number of FTEs in the Biomedical Engineering departments, according to data provided to ECRI Institute.

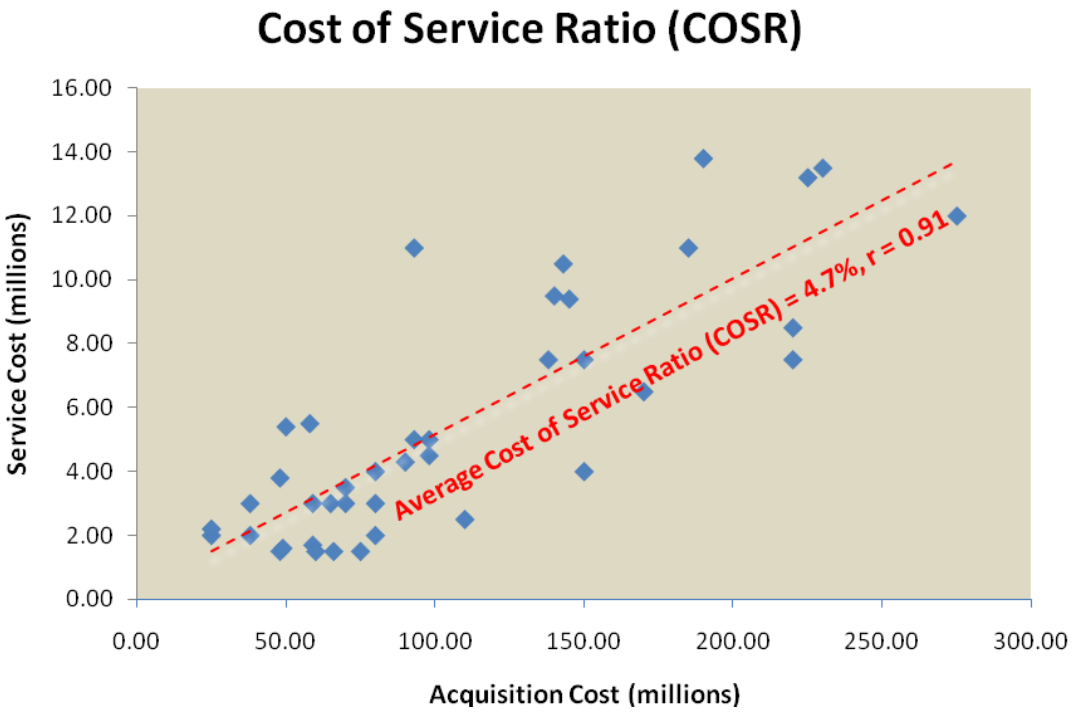
Hospital parameter	*r*
Admissions	0.91
Staffed beds	0.9
Inventory	0.88

Source: ECRI, 2009 "Measuring Up"

It is important to understand the context of the indicators as different operating environments can affect the applicability of indicators. For example, it is important to determine whether the hospital that is compared to provides a range of services similar to each other's services. Let's say a Biomedical Engineering department offers extensive nurse training that contributes to the safe and effective use of medical equipment and that its goal is 100% inspection completion. If the rest of the other hospitals that are being compared to don't strive for – and don't staff for – such high performance standards, the staffing may appear to be excessive, even if it is operating very efficiently and offering critical value-added functions.

AAMI's benchmarking solution uses a more complex calculation that further analyzes the relationship between the Cost of Service and the Acquisition Cost of the device. Then from there, the number of FTE's is recommended. Figure 12 shows a scatter plot of the results of 43 reported COSR validated entries. Acquisition costs ranged from a low of $25 million to $830 million (mean $160 million), and service costs from a low of $1.4 million to a high of $28 million per year (mean of $7 million). A COSR mean of 4.7% (range 1.9% to 12.5%) and a linear correlation of 0.91 shows that service costs do track acquisition costs in a linear manner and 5% anecdotal benchmark referenced by many BME continues to be not only a ballpark norm for this ratio, but statistically relevant.

Figure 13 Cost of Service Ratio (COSR) for 43 survey entries. Source: AAMI's Benchmarking Solution, 2010. (Cohen, 2010)



One common problem with the ABS data is that it is not intuitive that the hospital with a COSR of 1.9% does not support imaging systems. Other prior studies have shown that imaging equipment repair and maintenance expenses can account for up to 50% of a hospital's medical systems support costs. This is the same for laboratory equipment and dialysis equipment costs.

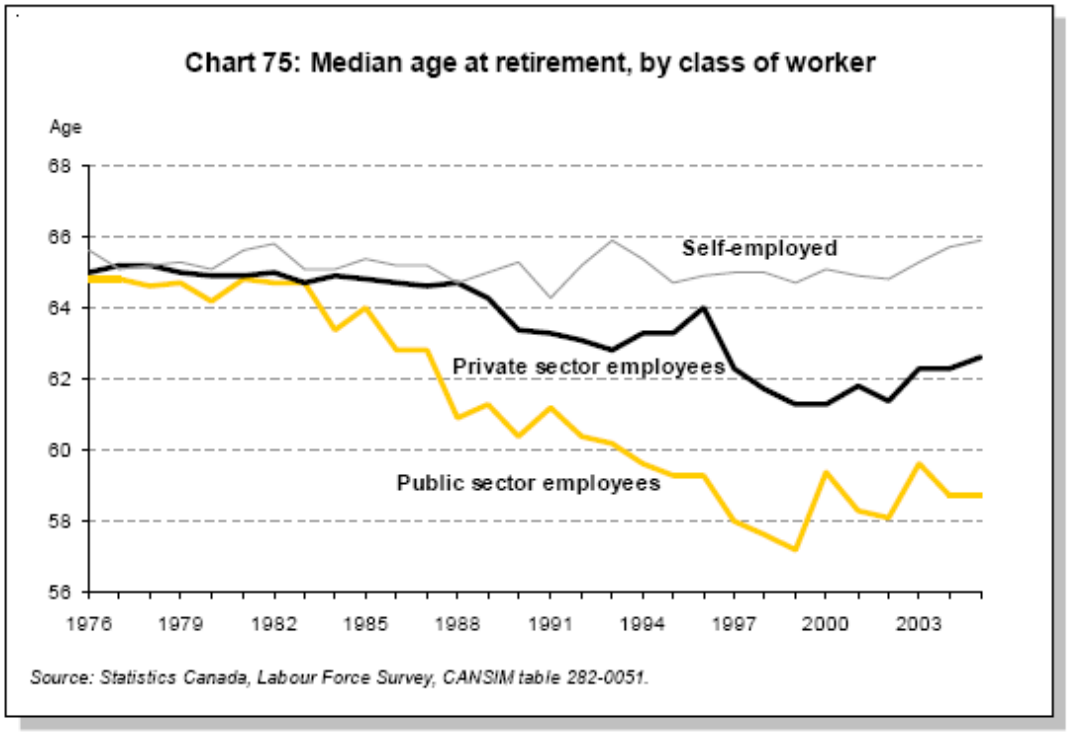
4.2. Succession Planning Process

Our next benchmarking would be on the actual Workforce Succession Planning. Here we will look at various existing succession planning processes in corporations such as GE Medical and Microsoft. It is impossible to find a Workforce Succession Planning process in the public sector, not to mention the Biomedical Engineering field in hospitals across Canada. In fact there is no such practice in place. However it is crucial to have a succession planning process in place for LMBE due to the needs of the ever-changing organization, huge retiring workforce, and for talent management.

A look at Statistics Canada's 2005 labour force survey (Figure 13) shows that since 1976, public sector employees are retiring consistently at a younger median age than those in the private sector or the

self-employed. The median retirement age among public sector employees (i.e. education, health care and government) declined steadily from 64.8 years in 1976 to 57.2 years in 1999. Then it went back up to 58.7 years in 2005 and now it is estimated that anybody who reaches 60 would retire in 2011.

Figure 14 Median age at retirement, by class of worker



Workforce succession planning programs are not only for the biggest and wealthiest companies. Companies with as low as 100 employees have found the need for planning to be useful not only for internal alignment, but also to fill in unacceptable employee turnover rates, labour cost efficiency, and finally the need to fill key executives reaching retirement age (Goldsmith & Carter, 2010).

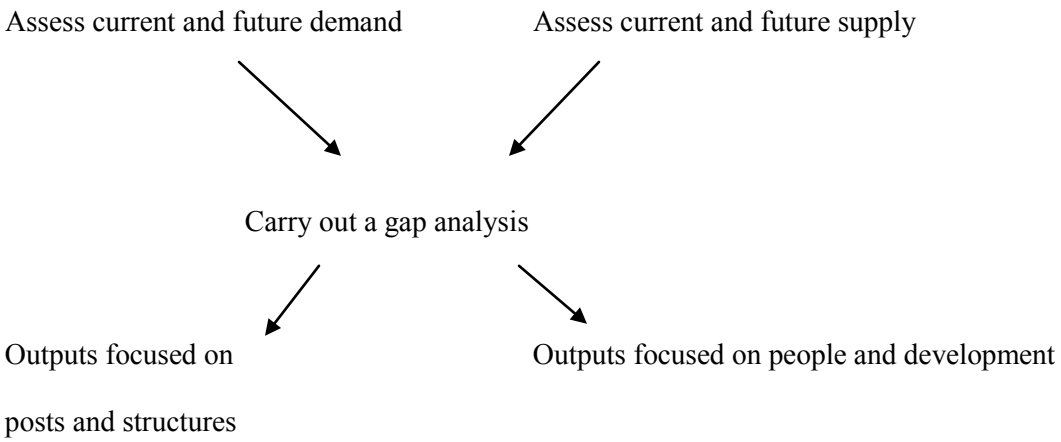
The basic steps in a succession planning are 1) building the business case, 2) developing the key roles by making the forms and instructions, 3) fostering opportunities for growing careers, 4) identifying training needs, 5) launching the process, and 6) monitoring the progress (Yarnall, 2008). This could take a number of different forms.

1. As and when vacant positions are available and arise. Here these are dealt with very little planning.
2. One step or job layer succession. In this approach, successors for one job step ahead and are identified with the focus on readiness for promotion to the next level.

3. Planned development or 'layer and slice' succession. Here a small group of possible successors are identified as having long-term potential for a targeted layer of jobs. Both post and people plans are taken account of in this approach.
4. Developing potential. The focus here is on creating a diverse and high quality pool of employee talent. This is a more person-centred approach.

The main activities of succession management are illustrated in Figure 14. The process is about matching up the likely future demand with the likely supply and taking steps to minimize the gap between the two, both through a focus on developing people for the future and by restructuring role requirements and optimizing organizational design.

Figure 15 Key succession processes



4.2.1. GE Medical

Now taking a look at GE Medical which is one of the largest manufacturers of diagnostic imaging devices in North America (Goldsmith & Carter, 2010), their recruiting process includes a solution that incorporates an internet-based applicant tracking system, automation of processes once done manually, measurement of staffing and activity costs, and establishment of new benchmarks and goals continuously.

Specifically in terms of workforce succession planning, GE adopts the McKinsey's 9 Box Matrix to measure the performance and potential of all employees (The GE-McKinsey nine-box framework, 2008). Jack Welch religiously used this matrix to groom his future leaders. Initially the 9 Box Matrix was used as a strategic framework for the big conglomerate to determine where best to invest its cash but later it was adopted as a HRM strategy. Figure 15 is the 9 Box Matrix used for determining when to invest and put more cash into the business. GE Medical needed to compare potentially very different business units

from capital intensive to marketing intensive to ones that require economies of scale. Instead of relying on the projections provided by the manager of each individual business unit, the company can determine whether a business unit is going to do well in the future by considering two factors:

1. Attractiveness of the industry
2. The business unit's competitive strength within that industry.

Figure 16 9 Box Matrix for Assessing Industry Attractiveness

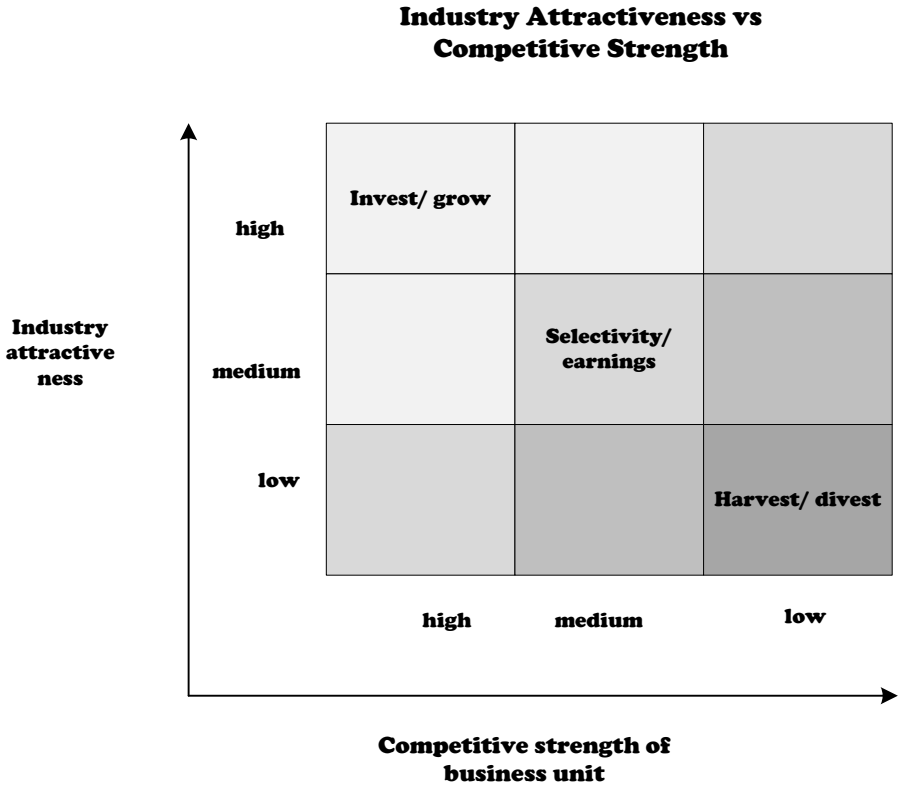
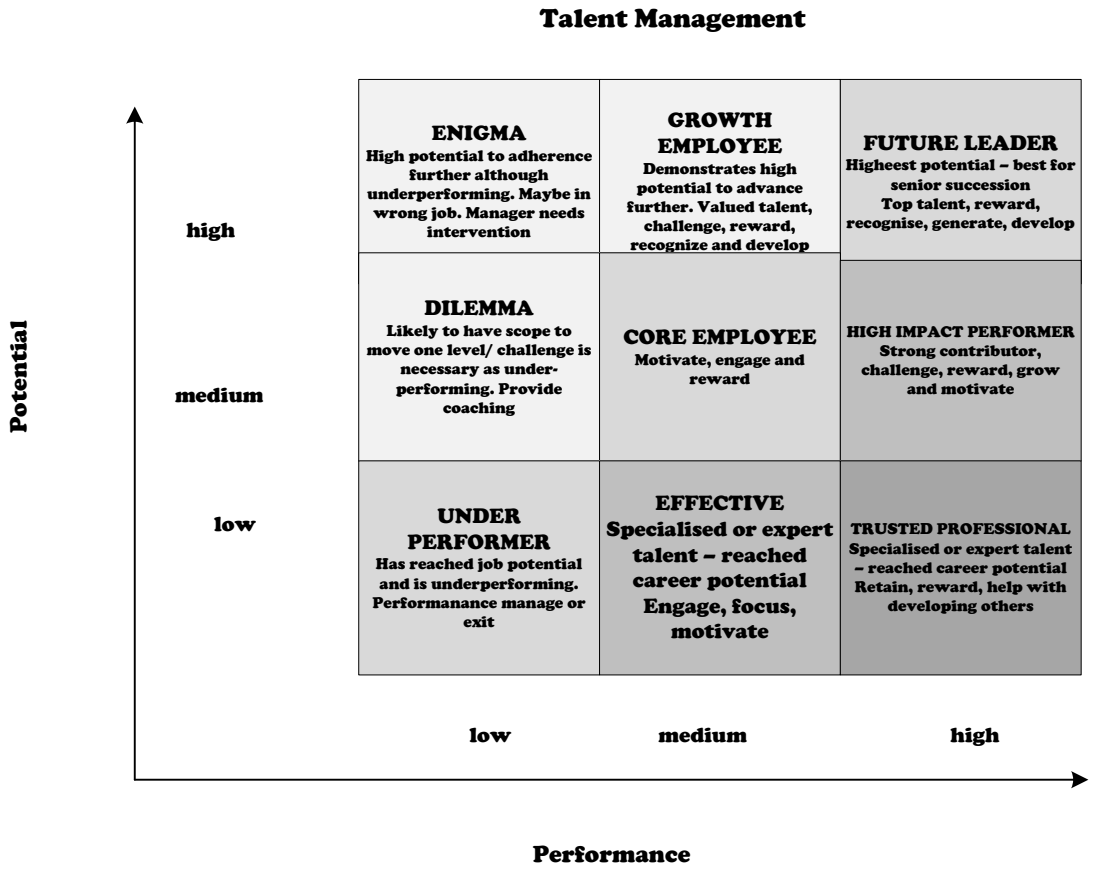


Figure 16 is the 9Box Matrix used for Talent Management. One can see that the McKinsey's 9Box Matrix is a very useful organization development tool that offers managers a framework for making sound decisions in business and human resource management.

Figure 17 9 Box Matrix for Talent Management



4.2.2. Microsoft

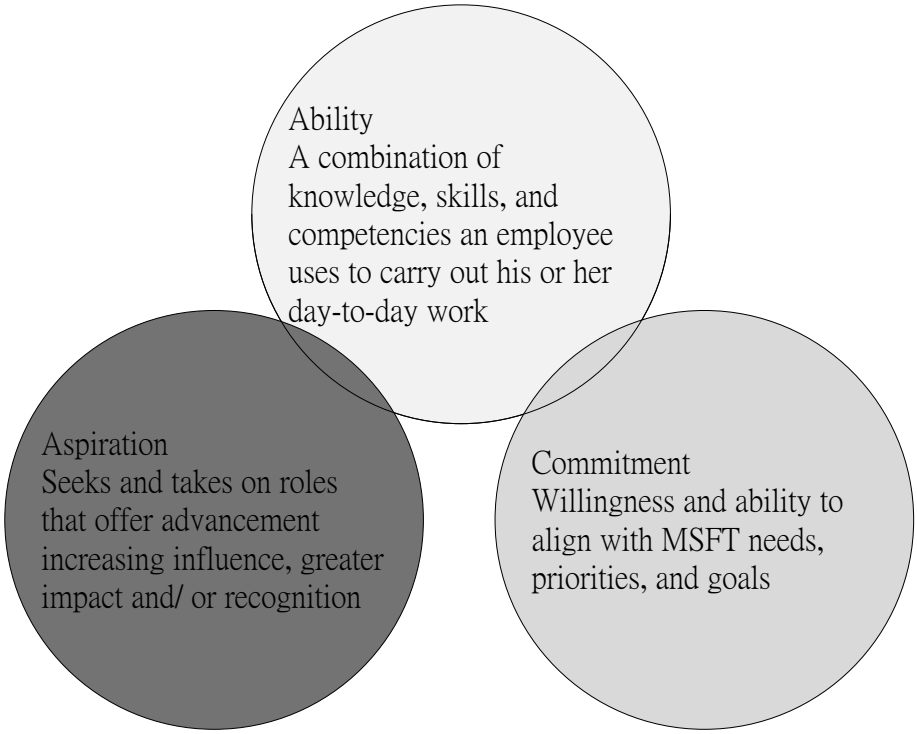
Microsoft has a different approach to workforce succession planning. It makes a commitment to all employees to develop opportunities for on-going learning. Annually, Microsoft invests more than $375 million in formal education programs directed at the employee, manager, and leader (Goldsmith & Carter, 2010). In addition to the development offered above, Microsoft invests in a smaller group of employees who have the potential for, and strong interest in, taking on more senior critical roles as individual contributors or managers. These individuals are identified and considered for more focused career development, which may include participation in one of several professional development experiences known as high-potential development programs.

In identifying employees as high-potential, Microsoft believes that it is important to appreciate that natural "gifts" are not sufficient and that an employee can reach his or her full potential by combining the natural "gifts", doing what he or she does with that talent (hard work, perseverance, courage), the

experiences he or she is given, the support of others along the way, and the context/culture within which he or she operates.

At Microsoft, high-potential development goes beyond traditional management or leadership development. Instead, it focuses on accelerating the development of these individuals to advance to the next career stage. Microsoft first identifies High-Potential employees:

Figure 18 High-Potential Criteria. Source: Adapted from Corporate Leadership Council High-Potential Management Survey, 2005.

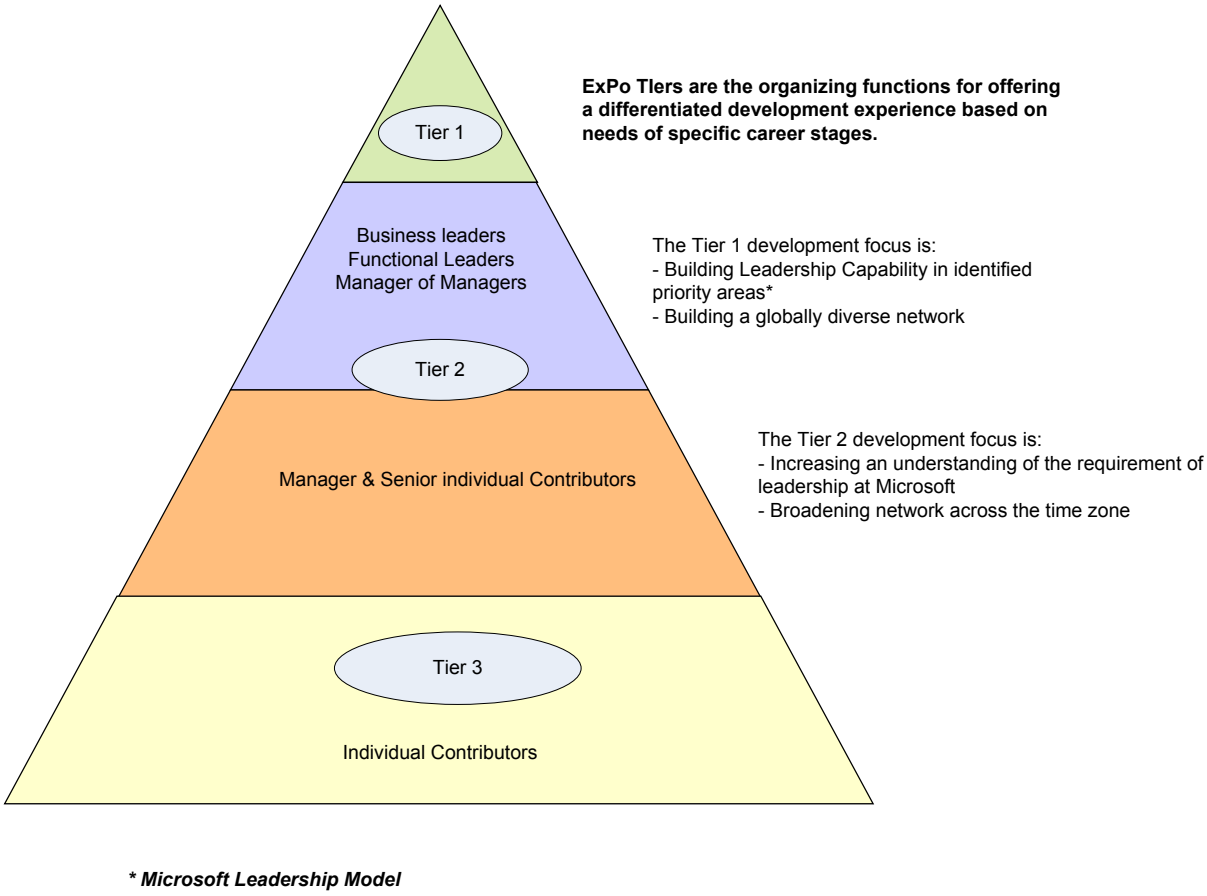


A high potential employee is someone with the ability, commitment, and aspiration to advance to and succeed in more senior, critical roles (Figure 17). These roles include individual contributor, manager, technical, and executive leadership. It is noted that a high-potential is different from a high performer in that a high performer may demonstrate exceptional ability, but not demonstrate commitment and/or aspiration to advance to more senior roles or to do so in an accelerated timeframe. High-potentials are a subset of high performers that are promotable into the next potential band. In other words, not all strong performers are high-potentials.

Next, Microsoft sorts the high-potential talent into tiers by their career stages. It adopts the ExPo Tiers where Tier 1's development focus is building leadership capability in priority areas and building a globally diverse network. Tier 2 focuses on building an understanding of the requirements of leadership at

Microsoft and broadening the network across time zones. Tier 3 builds commitment and aspiration to leadership through greater self-awareness and understanding of Microsoft business (Figure 18).

Figure 19 Key ExPoTiers. Source: "Best Practices in Talent Management (Goldsmith & Carter, 2010)"



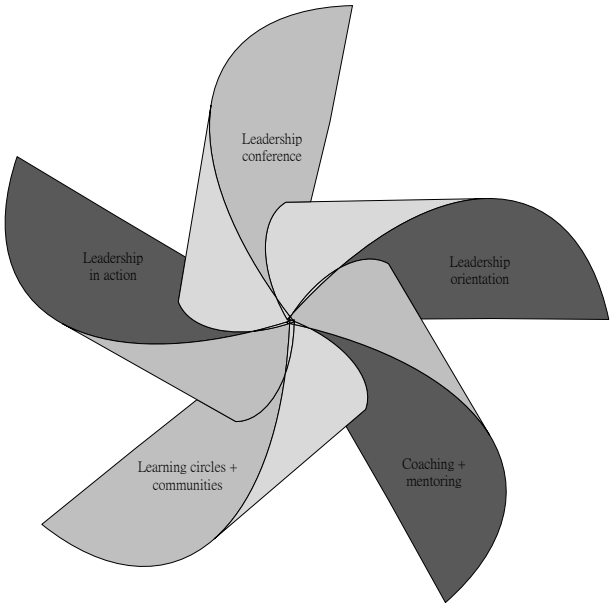
Once sorted into the appropriate tiers, Microsoft develops the high-potentials according to five key areas. Research indicates that the five key areas, if executed effectively, have significant impact on high –potential development. The five key areas are shown in Figure 19. Briefly, the orientation introduces the high-potentials to the core elements and provides expert instruction. In it, a Microsoft sponsored 360-degree assessment tool is used to assess the leadership competencies. The leadership conferences are business conferences, roundtable discussions, and live meetings that bring executives and high-potentials together for mutual benefit and learning. Conferences are conducted across tiers, usually Tiers 1 and 2, with occasional participation from Tier 3. They are designed to facilitate reflection, build critical relationships from one level to the next, and provide additional forum for sharing learning from the job.

The Leadership in Action pinwheel seeks to develop leadership qualities, analytical skills, and strategic thinking by way of experience-based exercises. All participants in Tiers 1, 2, and 3 are engaged in one integrated experience. Projects are real business challenges from Tier 1 team leaders which help them gain fresh perspectives on their business challenges from the high-potential population.

The Learning Circles pinwheel describes small peer-based learning groups designed to connect diverse groups of high-potentials, both functionally and geographically, to mutually support each other in developing themselves as leaders. Comprised of five to seven high-potentials who meet either face-to-face or virtually, learning circles integrate the learning from current role experiences with development priorities to provide a more impactful learning experience. Learning circles enable high-potentials to drive personal development as a future leader by linking formal learning with on-the-job experiences and create greater business impact by sharing support and accountability.

Finally the Coaching and Mentoring pinwheel describes a one-to-one learning process whereby the coaching and mentoring provide a thought-provoking process that inspires the individual to maximize his or her personal and professional potential.

Figure 20 ExPo Development Framework. Source: "Best Practices in Talent Management (Goldsmith & Carter, 2010)"



4.3. Summary of Benchmarking

The major lesson learned from this chapter is that LMBE operates at a very lean level in terms of number of devices / FTE. In terms of number of beds/ FTE, the data show that LMBE could have supported more beds. However the correlation between number of beds and number of FTE is not as strong as that between number of devices and number of FTE. Most of the recommendation will be based on the number of devices /FTE benchmark.

In terms of process recommendation, it is clear that LMBE should adopt a similar model to those that were depicted in the two companies that were researched as it has no formalized process for grooming potentials. It could look into adopting a matrix system or a tier system, whereby staff are categorized according to performance and/or potential level, or by career stages like what Microsoft did. Then, senior management could develop the high potentials using different methods such as coaching, mentoring and sending people on conferences.

5. Recommendations (WHEN, HOW)

This paper has looked at two different high-technology corporations' succession planning processes and has compared LMBE both internally and externally to published Biomedical Engineering performance indicators in terms of beds/FTE and devices/FTE. Based on these findings, the following recommendations are suggested.

5.1. Training

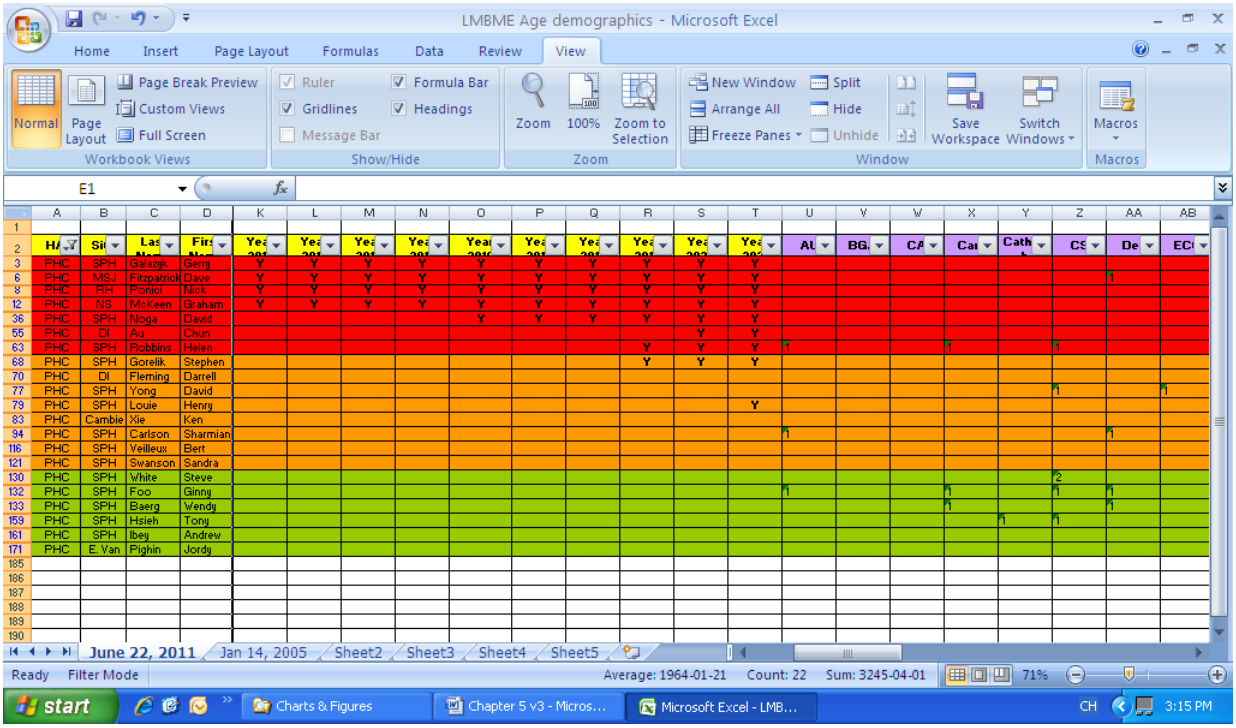
The field of Biomedical Engineering revolves around public sector employees, highly skilled workers, and the aging population. Due to the difficulty in assessing when an employee will retire, the assumption used is that as soon as an employee reaches the age of 60, there is a 90% chance / confidence level that he or she would retire. The difference of age is minimal and could range from 1 to 5 years. The 184 employees of LMBE have been grouped according to age (as age is the most accurate representation of service skill level). Employees who are aged 50 or more are considered high risk employees and their skill sets will be focused on as immediate targeted areas of replacement. Employees who are aged 40 – 49 are medium risk employees who will not retire in the next 10 years. However, these people do come with certain skill sets that have taken 10 years or more to accumulate. We will consider replacing these skill sets after the high risk employees. Employees who are aged 39 or below are considered the "green" group in that they are the least likely to retire and therefore will pose no knowledge gap loss in the near future.

Figure 20 gives a summary of the high risk skill set that will need to be replaced in the next 5 to 10 years. The actual Excel spreadsheet is located in 

It is a live document in that every year, the number of employees who will be retiring shows up in red. Their corresponding skill set is shown at the top row. The amber colour areas show employees who are between 40 to 50 years old and the green colour areas show employees who are less than 40 years. Based on interviews with various individuals, the skill sets of experienced employees are hard to replace just by sending a person on training. The experience and relationships built by these experienced employees with the clinical staff / customers are the most difficult to build and replaced. It could take 1 week to send a junior BMET on training but it will take at least 2 to 5 years to bring them up to speed on the experience. When recommending the training plan, thought was placed on the motivational factors of high-potential employees versus low-potential employees. However, interview results have generated the conclusion that old / experienced BMETs are overall less motivated to do

menial job tasks as compared to young/vibrant BMETs. Initially it was thought that developing a process for identifying high-performing/ high-potential employees would be a good start to the workforce succession planning project but later this idea was replaced with a Continual Job Monitoring due to its difficulties.

Figure 21 Training Needs



It is thought that when assessing LMBE's training needs, consideration would be given in the order of 1) eligibility in terms of reaching "magic 90" and best guess, 2) age, 3) years of experience, and 4) the 27 most difficult categories of technical training:

AU, BGH, CA, CS, Cathlab, EEG, EMG, End, HBU, HU, Inc, Las, Prisma Flex, LM, Mic, OL, Oph, Per, Ven, MRI, NM, US, CR, Vascular, Mammo, CT, X-Ray

**Please refer to Figure 10 "Categories of equipment looked after by LMBE" for a complete list.

5.1.1. Year One (2012)

In 2012, the retirement prediction is as follows. A few of the employees predicted to retire in 2012 should have retired already by now but chose to work longer for various reasons. Their risk levels are low because if they did not retire today, chances are they will not retire the following year. Research has shown that family income, marital status, and spousal death have contributed to the decisions to come back to work after retirement (Maestas, 2010). There are 17 employees who are aged 60 or above, but only 8 have reached their "magic 90". When looking at their experience years, the high risk employees are the ones with higher age, higher number of years of experience, and more difficult skill set.

Table 11: 2012 Focused Training Needs

Position	Age	Experience	Expected Retirement Year	Risk	Skill set	Time to train	Cost to train
Renal BMET (PHC)	67	45	2005	Lo	HU	24 months	$20,000
BMET #1 (FH)	65	33	2008	Lo	Generalist	6 months	
BMET #2 (PHC)	64	44	2010	Lo	Generalist	6 months	
BMET #3 (VCH)	62	36	2010	Lo	Generalist	6 months	
Engineer (VCH)	58	37	2010	Hi	LM	3 months	
BMET #4 (VCH)	59	32	2012	Lo	Generalist	6 months	
Project Lead (FH)	58	31	2012	Med	LM	3 months	
Supervisor (FH)	59	19	2012	Med	LM	3 months	$1,000
Total							$21,000

It is recommended that based on Table 11, the Executive Director should put aside $21,000 the first year for training a new HU BMET in PHC and someone with LM skills in FH. The hemodialysis technology training is out of town and is going to be held in Germany. Leadership / management training could be taken through FH's existing management training programs that are offered to the employees of FH. The rest of the employees who are expected to retire in 2012 are considered Generalists and they are of Med or Lo risk, meaning that if they leave, someone else in the organization could step up right away. Their skill set could also be distributed to more than one employee so no additional training is needed.

5.1.2. Year Two (2013)

Table 12: 2013 Focused Training Needs

Position	Age	Experience	Expected Retirement Year	Risk	Skill set	Time to train	Cost to train
Supervisor (PHSA)	60	36	2013	Hi	BGA, CA, EEG, End, Inc, LM, OL, Core equipment	24 months	$30,000
Manager (VCH)	62	29	2013	Med	LM	3 months	$1,000
BMET #1(FH)	60	34	2013	Hi	HU	24 months	$20,000
Rad BMET (VCH)	64	37	2013	Hi	CR, CT, X-Ray	24 months	$20,000
BMET #2 (PHSA)	58	34	2010	Hi	HU, Mon, OL, Core equipment	24 months	
Total							$71,000

Due to number of techs who will be retiring in year 2013 who are high risk, the Executive Director should put aside a total of $71,000 for training. $1,000 should be used for LM training which could be local or at VCH employee training programs. There is an experienced Radiology Service Technologist that does a lot of travelling for the Coastal region who is anticipated to retire in 2013. It is recommended that $10,000 be set aside for general X-ray training, then 6 months later, another $10,000 used for CT or CR training.

There is a working supervisor in PHSA who is anticipated to retire in 2013 and has a vast amount of lab equipment knowledge. The training expense to replace this supervisor is recommended to be phased in. That is $10,000 to be spent 1st round on specific lab equipment (BGA) that needs to be serviced right away, $10,000 be spent on training for CA, and another $10,000 to be spent on either EEG or OL.

There is also an experienced hemodialysis BMET who will be retire in FH in 2013. For the succession of this particular BMET, two options are recommended:

Option A)

Due to the recent expansion of the hemodialysis program in FH and the shortage of experienced BMET in that area, $20,000 should be spent on HU training in FH for year 2013. It is also noted that the hemodialysis machine of the model Belco will come out of training contract in 2013 and therefore any training and parts needed for the continue support of Belco will need to be covered by the department.

Option B)

If the Belco dialysis machine is to be rendered out of support and the entire fleet of machines are to be replaced in the upcoming year, $20,000 should be held off until new machines are purchased. With new machines, there will be at least a 1 year warranty period for maintenance and parts.

5.1.3. Process Recommendation

Research indicates that clear objectives are critical to establishing effective workforce planning. Not only are the recommendations above needed, a process needs to be put in place in order for the workforce planning to take place. These were seen in both GE Medical and Microsoft Corporation. Such well-established practices include:

- Identifying those with the potential to assume greater responsibility in the organization
- Providing critical development experiences to those that can move into key roles
- Engaging the leadership in supporting the development of high-potential leaders
- Building a database that can be used to make better staffing decisions for key jobs
- Improving employee commitment and retention
- Meeting the career development expectations of existing employees
- Countering the increasing difficulty and costs of recruiting employees externally

Therefore it is recommended that the training list be continuously monitored and recommendations such as the above be put together on a yearly basis to assess workforce succession planning. Also, it is important that the evaluation of potential employees be done on an annual basis to properly assess employee performance. From there, key successors can be identified earlier on rather than waiting too late. The employee performance evaluations will also help meet the career development expectations of employees because during the evaluation process, employees are engaged in that they are asked what they would like to be trained on. Managers take the ideas and either implement the recommendations or suggest alternatives depending on staffing needs. It is a constant juggle between employee needs and organizational needs when it comes to awarding training to staff.

5.2. Reorganization

The aging workforce and increased workload due to the technology push has rendered it expensive and difficult to assign training to BMETs. New BMETs who are being hired belong to the Gen Y and are generally perceived as “entitled”, “lazy”, “having greater job mobility”, and seeing work as a means to enjoy life, not as a means to an end (Dr. Hansen, 2011). Therefore employers nowadays have to adopt a new way of working with Gen Y employees.

Rather than spending large amounts of money in training, which the new employees may not appreciate as much as the Gen X employees, an alternate plan is to think of other ways for workers to accomplish the same tasks. A complete reorganization or restructuring of the entire LMBE workforce into a more flexible work environment for BMETs to work anywhere may accomplish the job. Not only will the work flexibility be enticing to Gen Y employees, the ability to assign work to any of the hospital sites that lacks the expertise may be beneficial to the employer as well.

One method of reorganization is to not have a “home base hospital” for the BMETs. Each hospital that has a Biomedical Engineering department could have work spaces with tools appropriate for the job to be done. On a weekly basis, BMETs are scheduled to go to different work spaces. These work spaces would be assigned to BMETs based on their home address, areas of expertise, and the HA that they’d prefer to go to for that week. The supervisors would have veto power for any of the requests on a daily basis due to call backs and urgent medical device issues. Through this, the flexibilities of the employee and the employer are being addressed. Both parties follow a mantra of working smarter, not harder.

The next generation of workers would see a generation that is not afraid of challenging the status quo. Similarly, employers need to be able to provide them with a progressive career path that will empower them and make them happy to come to work. The key for the management team is to develop a stronger commitment to keeping employees by providing benefits and perks, professional development opportunities, and other options for Gen Y workers seeking deeper fulfilment.

If the reorganization recommendation is chosen, a more detailed plan will need to be established before the implementation of it. It will be the more difficult, time-consuming, and costly route in the short run, but will produce a long-term solution to the succession planning process.

5.3. Implementation Plan

The implementation plan of the LMBE Workforce Succession Plan starts off with the following steps:

- ☐ Determine what processes are available for use currently, an example would be the posting process for transfers of positions from within LMBE. FH has a good process.
- ☐ Adopt the posting process for all sites.
- ☐ Draft a policy statement to be reviewed by senior management.
- ☐ Distribute policy statement of posting process to all staff.
- ☑ Develop job descriptions of specific titles within LMBE.
- ☐ Develop career pathways for high-potential employees with plans for their development. This could be incorporated into annual performance reviews.
- ☑ Identify training needs and develop programs to help managers understand procedures and assess potential candidates.
- ☐ Launch the process.
- ☐ Continual job monitoring and evaluation process in order to track the average age and years of service. Alternately, identify available succession-planning software on the market.

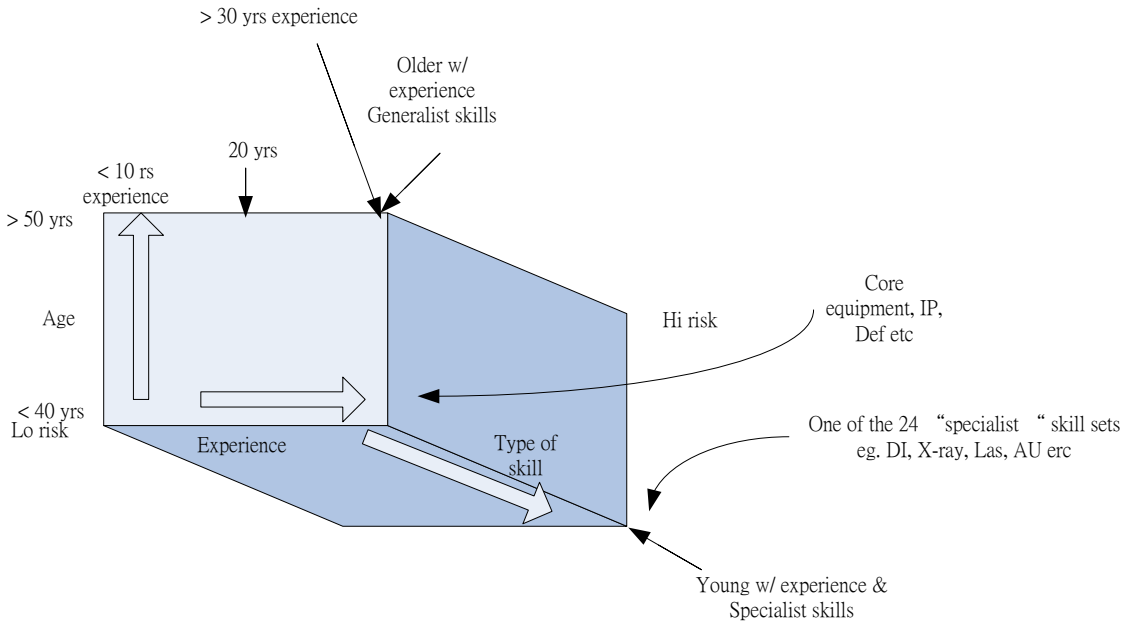
It can be seen that 2 out of the 9 steps have been completed so far. It is recommended that the management team get together to review the training Excel sheet and make changes to update it. Then they should decide whether the workforce succession planning should proceed further or not. If it is to be continued, then they should all be committed to keeping it up to date. It is recommended that a key person be appointed as the Master List keeper.

The Workforce Succession Committee should define the criteria for estimating whether someone's skill is "hi", "med", or "lo" risk. The considerations listed in this paper stated that a worker's risk is high when 1) eligibility is met in terms of reaching "magic 90" and best guess, 2) they reach the age of 60 or more, 3) they have years of experience, and 4) their skill sets are located in one of the 27 most difficult categories of technical training:

AU, BGH, CA, CS, Cathlab, EEG, EMG, End, HBU, HU, Inc, Las, Prisma Flex, LM, Mic, OL, Oph, Per, Ven, MRI, NM, US, CR, Vascular, Mammo, CT, X-Ray

Based on the above, the following matrix is created to illustrate the skill set of Generalist versus Specialist, and Experienced versus inexperienced BMETs.

Figure 22 Risk Matrix



Management needs to also decide which of the recommendations to move forward with: 1) focused training based on expected retirement forecasts or 2) reorganization of the LMBE plus training or 3) a combination of both. Keep in mind that happy employees lead to strong business. In the past, people were promoted primarily on seniority. Now, companies such as GE Medical and Microsoft are establishing employee career planning based on grooming employees from within. Proctor & Gamble recruits people out of school and motivates them to move up within the company (Lafley, 2009). Similarly, promotion within Biomedical Engineering should be based on capability rather than seniority alone. Modern career planning recognizes that when it comes to an employee's future, workers are more apt to stay if a clear development and career path exists. Title and salary are no longer the number one priorities. Younger workers are more interested in self-fulfilment and work-life balance. The management team should start with clearly defined organizational goals and objectives and determine the talent gaps to meet those goals.

6. Conclusion

It is understood that starting a Succession Planning process in the public-sector is both an innovation and a challenge. In order for the implementation to be successful, employee buy-in to the process must be achieved. Therefore strategic leadership from the top is crucial to create followers taking succession seriously. In looking forward, public-sector leaders must surmount four types of barriers to employee buy-in on succession planning (Rothwell, 2010): (1) the leader's reluctance to take up the succession "tasks", (2) the assumption that succession issues are beyond the scope of the leader's work, (3) confusion about how the succession task should be framed – is it a matter of replacing oneself or of strategic "positioning", and (4) lack of information about how to take up the task- how to plan for succession in the midst of a shifting political environment and given regulatory and political constraints.

This project confirms that there is a need for a formalized workforce succession planning process to take place in LMBE. Research into existing succession planning processes in the industry shows that there are varied but similar approaches to getting a process in place. It is recommended that LMBE put forward a workforce succession planning process in order to retain talent and replace skill gaps.

With regard to the actual recommendations, three of them are being presented. The first recommendation is "focused training based on expected retirement forecasts". In this recommendation, the skill sets of the BMETs and supervisors are categorized into 27 distinct categories that absolutely need factory level service training. Then the 184 employees are evaluated and assigned skill sets individually. Based on their age and years of experience, their expected retirement ages are calculated. The retirement predictions are then tabulated and arranged by "skill set lost" for the first 5 years, then "skill set lost" for the next 5 years. The "skill set lost" are also further tabulated for year 2012 and year 2013, arranged by HAs. This represents a detailed recommendation plan by year.

The second recommendation is "reorganization of the LMBE plus training" recommendation. This recommendation is being presented because according to the findings, 39% of all employees will retire by year 2021. This is a huge number and will take away 20 sets of LM skills, 15 sets of HU expertise, plus 20 or more AU and Ven expertise skill sets. The "reorganization of LMBE plus training" will take the focus away from continually investing in training, but shift to utilizing resources more efficiently. The severe loss of areas of expertise means that LMBE will have to look at long term solution to the succession planning process. This is a more difficult and time-consuming option.

The third recommendation is a combination of both first and second options. This is recommended because of the difficulty in establishing option two despite its ability to produce long term success.

It is recommended that LMBE focus on short-term needs (1-5 years) for now and then shift to long-term needs (5-10 years). There is a lot of employee shuffling on a monthly basis even without retirees. Therefore it is quite hard to keep track of who is doing what position at any point in time. Additionally, external pressures will continue to drive change within Biomedical Engineering. With healthcare cuts and reduced incentives, LMBE faces the threat of losing experienced Biomeds to third party private service companies. At some point, supervisors and directors need to make difficult choices in order to invest in retraining new graduates to replace the aging workforce. With the advent of new medical device technologies, like IT based medical systems, robotic surgical instruments, gene therapy and wireless technologies, it may be more cost effective to invest in spare machines rather than training someone. A lot of these technologies that are coming out are one-of-a-kind, and to train a BMET on this type of technology requires investing both money and time to gain the experience. Keeping in mind that technology refreshes every 10 years, new innovations will come up in 10 years' time. Whenever a BMET retires, timing is crucial in the decision-making process of retraining. Sometimes it makes sense to wait and buy service time and materials for a year or two before spending tens of thousands of dollars on training a BMET.

Appendices

Appendix A

Interview questions for Managers/ Supervisors

1) How many of your staff would you anticipate to retire in the next 1- 5 years? How do you go about finding out the data?
2) How would you deal with the retirement succession plan now? Would you start thinking about training now or wait until they retire?
3) What are their specialties?

Employee	When retire? (# years)	Specialty / specialties	Replacement personnel considered?	Other comments

4) What do you think are the existing deficiencies in the skill set/ gap of their department?
5) Is vacation fill an issue for you? If so what is the impact? What would you recommend as a plan for short term vacation fill? Long term vacation fill?
6) What type of knowledge transfer method is taking place right now? What is your staff distribution like?

Appendix B

Interview Questions for Executive Director

1. What is the Strategic Operational Plan that you have for LMBE for the next 5 years?
2. What would you think are the key success factors in this industry (LMBE)? List 3 -5 of the success factors. (p. 91 Grant 2008)
3. Based on the key success factors listed in question 1 above, what variable or variables would you control in order to maximize the "yield"?

Note: recognize the potential for complementary products to add value (p. 119 Grant 2008)

4. What are the resources (tangible and intangible) that exist in the firm that you think are most important? (p. 131 Grant 2008)

Tangible - Financial resources

- Physical assets

a) What opportunities exist for economizing on their use? Is it possible to use fewer resources to support the same level of business or to use the existing resources to support a larger volume of business?

b) What are the possibilities for employing existing assets more profitably? Is it possible to further reduce cost by assigning duties/ tasks to a smaller number of roles/ people?

Intangible
- What are they, if any?
- How would you effectively assess the performance and potential of employees?

5. Competency modeling (p. 134 Grant 2008)
    - Have you heard of it / would you consider using it?
    - It involves identifying the set of skills, content knowledge, attitudes, and values associated with superior performers within a particular job category, then assessing each employee against that profile.
    - The results of such competency assessments can then be used to identify training needs, make selections for hiring or promotion, and determine compensation. A key outcome of systematic assessment has been recognition of the importance of psychological and social aptitudes in linking technical and professional abilities to overall job performance. (EI – emotional intelligence)
6. How would you manage competency rather than product competency? (Prahalad and Hamel)
7. On a scale of 1 -5, what would you classify our resources / capabilities as "scarce" with 1 being extremely scarce and 5 being not scarce at all?
8. On a scale of 1 – 5, what would you classify our resources/ capabilities as "relevance" with 1 being extremely relevant and 5 being irrelevant?

9. Would you consider our resources and capabilities as imitable? (i.e. *transferable or replicable*) ?
10. Would you be most inclined to re-grouping employees based on a) tasks, b) products, c) geography, or d) process? (p. 184 Grant 2008) I guess in our case, we only have the choices of a) tasks or c) geography.
11. What do you think are the risks of the Strategic Operational Plan that was mentioned in question 1 above?

Appendix C

Year 2012			
Expertise	**FH**	**VCH**	**Total**
AU			
BGA			
CA			
CathLab			
CS			
EEG			
EMG			
End			
HBU			
HU	1		1
Inc			
Las			
Prisma Flex			
LM	1	1	2
Mic			
OL			
Oph			
Per			
Ven			
MRI			
NM			
US			
CR			
Vascular			
Mammo			
CT			
X-ray			

Year 2013				
Expertise	**FH**	**PHSA**	**VCH**	**Total**
AU				
BGA				
CA				
CS		1		1
CathLab				
EEG				
EMG				
End				
HBU				
HU		1		1
Inc				
Las				
Prisma Flex		1		1
LM				
Mic		1		1
OL		1		1
Oph				
Per				
Ven				
MRI				
NM				
US				
CR			1	1
Vascular				
Mammo				
CT			1	1
X-ray			1	1

Year 2014					
Expertise	**FH**	**PHC**	**PHSA**	**VCH**	**Total**
AU				1	1
BGA					
CA					
CathLab				1	1
CS					
EEG				1	1
EMG				1	1
End					
HBU					
HU					
Inc			1		1
Las				1	1
Prisma Flex					
LM				5	5
Mic					
OL					
Oph					
Per					
Ven				1	1
MRI					
NM					
US					
CR					
Mammo	1				1
Vascular					
CT					
X-ray	1				1

Year 2015				
Expertise	**FH**	**PHSA**	**VCH**	**Total**
AU			2	2
BGA				
CA				
CathLab				
CS				
EEG				
EMG				
End				
HBU			1	1
HU			2	2
Inc				
Las			1	1
Prisma Flex				
LM			3	3
Mic				
OL		1		1
Oph				
Per				
Ven			1	1
MRI			1	1
NM				
US			1	1
CR				
Vascular				
Mammo				
CT				
X-ray				

Year 2016				
Expertise	PHC	PHSA	VCH	Total
AU		1	1	2
BGA		1		1
CA		1		1
CathLab				
CS		2		2
EEG		1		1
EMG		1		1
End		1		1
HBU			1	1
HU	1			1
Inc		1		1
Las				
Prisma Flex				
LM		1		1
Mic				
OL		1		1
Oph		1		1
Per				
Ven	1	1		2
MRI				
NM				
US				
CR				
Vascular				
Mammo				
CT				
X-ray				

Year 2017				
Expertise	FH	PHC	PHSA	Total
AU				
BGA			1	1
CA			1	1
CathLab			1	1
CS			1	1
EEG			1	1
EMG			1	1
End			1	1
HBU				
HU		2		2
Inc			1	1
Las				
Prisma Flex				
LM	1			1
Mic				
OL			1	1
Oph			1	1
Per				
Ven	1		1	2
MRI	1			1
NM	1			1
US	2			2
CR				
Vascular				
Mammo				
CT				
X-ray	2			2

Year 2018			
Expertise	FH	VCHA	Total
AU		1	1
BGA			
CA			
CathLab			
CS			
EEG	1		1
EMG			
End	1	2	3
HBU		2	2
HU	1	3	4
Inc	1		1
Las	1	1	2
Prisma Flex	1	1	2
LM		1	1
Mic	1		1
OL			
Oph			
Per		1	1
Ven	2	1	3
MRI			
NM			
US	1		1
CR			
Vascular			
Mammo			
CT			
X-ray	1		1

Year 2019					
Expertise	FH	PHC	PHSA	VCH	Total
AU	1	1	1	2	5
BGA	1				1
CA					
CathLab					
CS		1			1
EEG	1				1
EMG					
End	1	1			2
HBU					
HU			1		1
Inc		1			1
Las		1	1	1	3
Prisma Flex			1		1
LM	2	1	1		4
Mic			1		1
OL					
Oph	1				1
Per		1	1		2
Ven	1			1	2
MRI					
NM					
US	1				1
CR					
Vascular					
Mammo					
CT					
X-ray	1				1

Year 2020				
Expertise	**FH**	**PHC**	**VCH**	**Total**
AU	1			1
BGA				
CA				
CathLab				
CS				
EEG				
EMG				
End	1			1
HBU				
HU	1			1
Inc				
Las				
Prisma Flex	1			1
LM			1	1
Mic				
OL				
Oph				
Per	1			1
Ven	1			1
MRI		1		1
NM				
US				
CR				
Vascular				
Mammo				
CT		1		1
X-ray		1		1

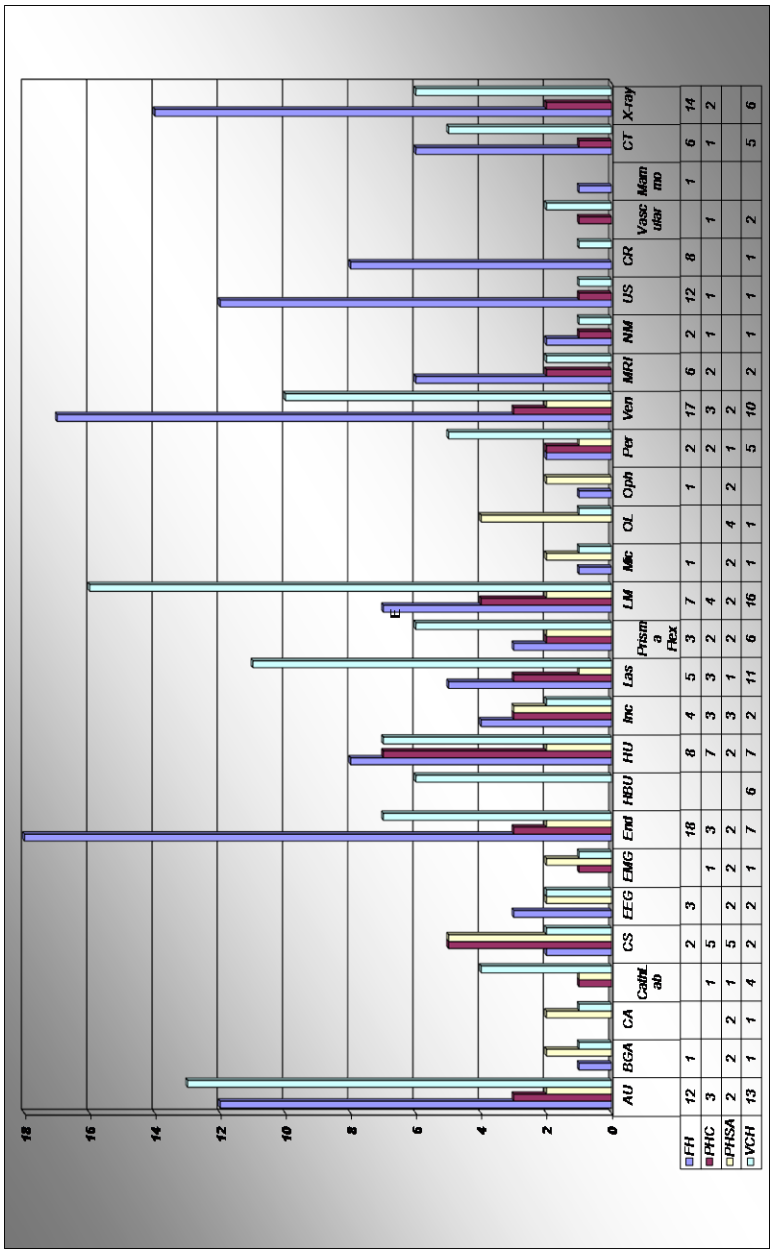
Year 2021				
Expertise	**FH**	**PHC**	**VCH**	**Total**
AU			1	1
BGA				
CA				
CathLab				
CS				
EEG				
EMG				
End			1	1
HBU				
HU		1	1	2
Inc				
Las			1	1
Prisma Flex			1	1
LM	1	1		2
Mic				
OL				
Oph				
Per			1	1
Ven			1	1
MRI				
NM				
US	1			1
CR	1			1
Vascular				
Mammo				
CT				
X-ray	1			1

Grand total by Year 2021					
Expertise	**FH**	**PHC**	**PHSA**	**VCH**	**Grand Total**
AU	2	1	2	8	13
BGA	1		2		3
CA			2		2
CathLab			1	1	2
CS		1	4		5
EEG	2		2	1	5
EMG			2	1	3
End	3	1	2	3	9
HBU				4	4
HU	3	4	2	6	15
Inc	1	1	3		5
Las	1	1	1	5	8
Prisma Flex	2		2	2	6
LM	5	2	2	11	20
Mic	1		2		3
OL			4		4
Oph	1		2		3
Per	1	1	1	2	5
Ven	5	1	2	5	13
MRI	1	1		1	3
NM	1				1
US	5			1	6
CR	1			1	2
Vascular					
Mammo	1				1
CT		1		1	2
X-ray	6	1		1	8

Original training in 2011	HA				
Expertise	FH	PHC	PHSA	VCH	Grand Total
AU	12	3	2	13	30
BGA	1		2	1	4
CA			2	1	3
CathLab		1	1	4	6
CS	2	5	5	2	14
EEG	3		2	2	7
EMG		1	2	1	4
End	18	3	2	7	30
HBU				6	6
HU	8	7	2	7	24
Inc	4	3	3	2	12
Las	5	3	1	11	20
Prisma Flex	3	2	2	6	13
LM	7	4	2	16	29
Mic	1		2	1	4
OL			4	1	5
Oph	1		2		3
Per	2	2	1	5	10
Ven		3		9	12
MRI	6	2		2	10
NM	2	1		1	4
US	12	1		1	14
CR	8			1	9
Vascular		1		2	3
Mammo	1				1
CT	6	1		5	12
X-ray	14	2		6	22

Appendix D

Figure 23 Distribution of training expertise in 2011



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